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An Analysis of Competencies for Managing Science and Technology Programs

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AN ANALYSIS OF COMPETENCIES FOR MANAGING SCIENCE AND TECHNOLOGY PROGRAMS

THESIS

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Abstract

The purpose of this research is to analyze competencies needed for successful program management of Research and Development (R&D) programs—also known as Science and Technology (S&T) programs within the Department of Defense (DoD). Current competency models are in development for the DoD Acquisition, Technology, and Logistics (AT&L) functional areas. Using an interim competency model developed for the Program Manager career field comprised of 36 technical competencies and 27 professional competencies, the research compares competencies' criticality scores rated by traditional acquisition program managers (PMs) with those rated by S&T program managers. In 42 out of 63 instances (67%) the criticality scores had statistically significant differences. Only four of those 42 competencies were rated "more critical" by S&T PMs; the other 38 of the 42 (90%), were rated "less critical" with statistically significant lower scores than those of their acquisition PM counterparts. The analysis of the open-ended interview questions suggests that although the AT&L PM competency model may seem to have face validity, the descriptions currently defining the PM competencies may not have adequate content validity for an S&T program management competency model, thus warranting further resources towards defining an independent competency model for S&T PM workforce management initiatives.

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I dedicate the fruits of my labor to my family, who rallied behind me through the uncertainties, strife, and unending hours of work. I attribute my success to God, who has blessed me with the mind, strength, and spirit to persevere, keeping it all in perspective.

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Glossary of Terms

1. Acquisition, Technology and Logistics (AT&L) Workforce: all individuals who occupy AT&L positions, to more accurately reflect the breadth of the types of functions and duties performed by employees
   - Desk Guide for AT&L Workforce Career Management
2. Competency: an observable and measurable pattern of knowledge, skills, abilities, behaviors, and other personal characteristics that an individual needs to perform work roles or occupational functions successfully
   - Office of Personnel Management
3. Competency Model: a framework that describes the full range of competencies required to be successful in a particular occupation
   - Office of Personnel Management
4. Program: a group of related projects managed in a consolidated way
   - Program Management Institute
5. Program Management: centralized coordinated management of a group of projects to achieve a program's strategic goals
   - Program Management Institute

AN ANALYSIS OF COMPETENCIES FOR MANAGING

SCIENCE AND TECHNOLOGY PROGRAMS

I. Introduction

Staying cognizant of and being responsive to the multitude of environmental changes which can shape a profession's proficiency standards are constant challenges, especially in today's fast-paced and technologically evolving workplace. The Department of Defense (DoD) Acquisition, Technology, and Logistics (AT&L) community and in particular its program managers (PMs) have received much congressional and media attention regarding proficiency challenges over the last two decades. Tremendous pressure from public scrutiny has demanded that PMs perform with competency, adaptability, and accountability, regardless of the myriad positions they might assume across AT&L organizations or program lifecycle phases. Thus, many studies and best-practices about the profession of program management—or project management, as it is commonly termed in private industry—have filled professional journals in recent years. Nevertheless, current literature suggests the AT&L workforce still faces current and future challenges in acquiring and maintaining the right mixture of expertise required for proficient program management in today's quickly changing work environment. Therefore, this research will attempt to analyze technical and professional competencies identified for superior PM performance within DoD, specifically comparing those identified for traditional Acquisition program management with those needed for Science and Technology (S&T) program management.

The purpose of this chapter is to outline the efforts of this research by introducing the background of the Department of Defense (DoD) Acquisition, Technology, & Logistics (AT&L) workforce environment that is driving competency modeling initiatives, the scope and methodology for this research, and the expected benefits and limitations of the research results.

DoD AT&L Background

The last two decades have witnessed many challenges to the DoD AT&L community. In the aftermath of acquisition scandals based on individual integrity breaches, program cost/schedule overruns, and contract award disputes, AT&L leadership faces tremendous scrutiny for holding its workforce accountable—particularly those given the enormous responsibility of managing its costly acquisition programs. At the same time, DoD faces a looming talent loss with the projected retirement of its aging workforce and a nation-wide competition for dwindling expertise and experience (Department of Defense Acquisition, Technology and Logistics, 2007a:7). Thus, multiple agencies have levied directives for new management initiatives to produce a high-performing, agile workforce to bring the DoD AT&L mission successfully through the myriad challenges ahead (Hausmann and Tregar, 2006: 4):

- 2002 President's Management Agenda focusing on five areas of management weakness across the government for improvement, specifically identifying human performance management systems
- 2002 and 2004 Government Accountability Office (GAO) reports emphasizing the importance of competencies for improving effectiveness and addressing employee shortages due to downsizing

- 2005 Office of Management and Budget (OMB) policy letter recommending changing acquisition certification from a course-based to a competency-based strategy

- 2006 Quadrennial Defense Review (QDR) recommending a performance-based approach to measuring human capital

- 2007 DoD AT&L Human Capital Strategic Plan describing the improvement of competency management.

Hence, AT&L and its component agencies are investing research and development efforts towards a competency model by which organizations can identify, define, and prioritize the desired competencies into their various workforce management programs.

Competency Modeling

The concept of competency modeling has evolved over the last three decades. Literature attributes the genesis of the concept to personality and social psychologist David McClelland, who in 1973 suggested that competencies—rather than intelligence—were more related to job performance outcomes, thus spurring a new era in re-defining workforce management (Shippmann and others, 2000:711). Twenty-five years later, a diverse group of eight researchers attempted to trace the evolution of, and current standard for, competency modeling through a two-year task force commissioned by the Society for Industrial and Organizational Psychology (Shippmann and others, 2000:704). This Job Analysis and Competency Modeling Task Force (JACMTF) conducted an extensive literature search and interviewed subject matter experts (SMEs) regarding the development and use of competency models, producing a comprehensive overview titled "The Practice of Competency Modeling" (Shippmann and others, 2000:704). Like other literature, the task force attributes the boon in competency modeling within industry and

business to authors C.K. Prahalad and Gary Hamel and their 1990 *Harvard Business Review* article titled, "The Core Competence of the Corporation," which became the journal's most reprinted paper in history to date (Shippmann and others, 2000:712).

The new emphasis on individual-level competencies as the foundation for a business's core competence also prompted government organizations to invest resources towards competency-focused initiatives. The United States Office of Personnel Management (OPM) began efforts in 1990 which have continued to evolve (Rodriguez and others, 2002:310). Faced with tremendous changes in the pace, paradigms, and practices of the 1990s, organizations recognized "the value of a workforce that is not only highly skilled and technically adept, but more importantly, a workforce that can learn quickly, adapt to change, communicate effectively, and foster interpersonal relationships" (Rodriguez and others, 2002:310). OPM also "envisioned a uniform, competency-based common language that would enable federal agencies to describe jobs in the same way, eliminating inconsistencies across agencies and HR functions" and thus "promote a common understanding of the critical elements of each job among HR personnel, management, and employees" (Rodriguez and others, 2002:311).

These aims have propelled the federal government, and in particular the Federal Acquisition Institute (FAI), to direct studies, validation, and execution of current competency models for its workforce. Aside from the regular reviews of standards and compliance under the Defense Acquisition Workforce Improvement Act (DAWIA), the FAI "led an inter-agency working group to develop common, essential competencies for the program and project management community" (Office of Management and Budget,

2007:1). Most recently, the Office of the Undersecretary of Defense for Acquisition, Technology and Logistics (OSD(AT&L)) issued a memorandum to its AT&L Program Management (PM) workforce announcing its joint competency initiative "to establish a standard competency model for each career field in the DoD AT&L workforce" in order to "map the array of competencies and performance criteria required to be successful in the acquisition career field" (Ahern and Anderson, 2008: 1). AT&L Director of Portfolio Systems Acquisition, David G. Ahern, and Defense Acquisition University (DAU) President, Frank J. Anderson (2008:1), expect the initiative to allow for the assessment and refinement of "the requisite competencies within the current DoD Program Management workforce" as well as the development of "appropriate strategies to shape the skill sets and capabilities" of PMs needed in the future.

Research Question & Scope

The overarching question for this research study is whether program management competencies differ across the AT&L spectrum. Using the current AT&L program management competency model, one investigative question is whether a one-size-fits-all competency model for program management is sufficient, or whether some competencies are more or less critical for different program manager positions—specifically within Research and Development (R&D) programs. If so, the final investigative question tests whether those differences are statistically significant enough to recommend additional research and resources towards a specialized PM competency model to guide current and future workforce management initiatives for R&D program managers.

For purposes of this research scope, only competencies identified predominantly by PMs managing traditional acquisition programs and those identified for PMs managing R&D—or Science and Technology (S&T)—programs are analyzed. Because AT&L uses the term 'Science and Technology Manager' (STM) to label this functional category, 'S&T' will be the term used throughout this research and assumed synonymous with R&D. The representative sample group for data regarding STM competencies includes personnel from the Air Force Research Laboratory (AFRL) at Wright Patterson Air Force Base, OH. AFRL is recognized as the leading organization for managing S&T programs within the Air Force and in collaboration with other S&T agencies across DoD, industry, and academia.

Methodology

The methodology for this research follows an exploratory approach combining elements of qualitative and quantitative design. It begins with a literature review to explore existing research about the AT&L environment, competency modeling, and program management career field issues. Based on literature reviews and communications with DoD program management career field stakeholders, the 2006 *AT&L Program Management Career Field: Interim Competency Model* is determined to be the most relevant study upon which to model this research. To achieve the most valid results, the data collection process attempts to mirror a subset of the methodology outlined in the AT&L study as closely as feasible for the portions applicable to this research scope. The AT&L competency model incorporates methodologies consistent with competency modeling practices documented in current literature: "determine what

leads to superior performance and to identify top performers to find out what they do" (Lucia and Lepsinger, 1999:18).

Data Collection.

Like the AT&L study, the first of a three-step data collection and analysis process relies on an "Expert Panel" consisting of highly knowledgeable functional leaders to establish a baseline set of competencies and to select the superior-performing subject matter experts (SMEs) to evaluate those competencies. The second step involves interviewing SMEs through semi-structured open-ended questions and structured closed-ended questions. The data collection for this research relies on SMEs responding to three Likert scale questions regarding the importance, frequency, and experience level first used for 36 technical competencies and 27 professional competencies as previously identified from the AT&L study. It also includes three open-ended questions of interest to this research. Although the AT&L study's methodology prescribes a final validation survey, this third step will remain a recommendation for future work extending beyond the scope of this research study.

Data Analysis.

Once data are collected from the S&T program managers, they are computed into results to compare with those from the AT&L study. Descriptive statistics are analyzed within and between the two study samples, then inferential statistics are used to analyze the comparisons through hypothesis testing and t-tests relevant to the research investigative questions. These assessments, combined with a qualitative assessment of

the interviewees' responses to open-ended questions, become the basis for conclusions and recommendations for future research.

Constraints & Limitations.

The exploratory nature of this study, involving qualitative and quantitative methods, incurs some natural and research-induced constraints that limit generalizing to the population at large. However, the specific construct validity issues addressed in Chapters 3 and 4 actually elucidate opportunities and recommendations for improving the development of competency modeling and its application towards shaping workforce management initiatives within Air Force Science and Technology organizations.

Expected Benefits

The expected benefit of this exploratory research is to contribute to the development of AT&L competency models for program management, specifically in support of superior S&T program management performance. The results are broadly relevant to workforce management issues such as selection, training and development, performance evaluation, and succession planning. They are specifically relevant to the Individual Development Plans (IDPs) of current and future S&T program managers.

II. Literature Review

The purpose of this chapter is to present literature addressing the background of the Department of Defense (DoD) Acquisition, Technology, & Logistics (AT&L) workforce environment and current issues, along with the evolution and current practices of competency modeling.

DoD (AT&L) Background

The DoD budget represents the largest portion of discretionary spending by the United States government. Consequently, taxpayers duly expect their government officials to hold accountable those responsible for such critical expenditures. The responsibilities placed on the DoD's cadre of military and civilian AT&L program managers are "enormous," to include: managing complex and evolving weapon system configurations; coordinating across a "broad array of military service and DoD officials, outside suppliers, internal and external oversight entities, as well as technical, business, contracting, and management expertise;" and incorporating state-of-the-art and often untested technologies while facing global logistics and environmental challenges (Government Accountability Office, 2005:3). However, scandals since the 1980s have cast doubt on the integrity and/or competency of DoD AT&L personnel, prompting Congress and the media to require regular measures of public accountability for program management performance and results. In response, the DoD has launched several "Acquisition Reform" and "Transformation" initiatives since the early 1990s targeting its AT&L workforce.

AT&L Workforce Environment.

One initiative stemming from the *1989 Defense Management Report* was the 1990 Defense Acquisition Workforce Improvement Act (DAWIA), which was initially enacted by Public Law 101-510 under Title 10 of the U.S. Code and intended to "improve the effectiveness of the personnel who manage and implement defense acquisition programs" (Defense Acquisition University, 2006). Furthermore, it called for "establishing an Acquisition Corps and professionalizing the acquisition workforce through education, training, and work experience" as part of the 1991 Defense Authorization Act. Periodic changes have been made to the DAWIA initiative since its inception, with updates and status reports publicized in literature and presented to Congress.

About five years after DAWIA's initiation, DoD officials reported that since its provisions had gone into effect in October 1993, each military department had established an integrated military and civilian acquisition corps with regulated qualifications and performance standards (Department of Defense, 1995). Although they met initial compliance regulations and improved workforce development programs, each service had developed its separate policies and implementation strategies—such as position selections and mobility requirements—despite DAWIA goals of uniformity across the acquisition career field (Garcia, Keyner, Robillard, and Van Mullecom, 1997:295). Thus, continued disparity and recurring acquisition scandals prompted additional workforce studies and reports.

The 2005 Government Accountability Office (GAO) report titled *Best Practices: Better Support of Weapon System Program Managers Needed to Improve Outcomes*, addressed specific flaws impairing workforce success, suggesting that senior leader support and disciplined knowledge-based processes were two critical enablers still lacking in DoD program management (Government Accountability Office, 2005:4). Continued concern over the challenges of ensuring a robust acquisition workforce permeated all federal organizations. In its *2005 Policy Letter 05-01 to the Heads of Civilian Executive Departments and Agencies*, the Office of Management and Budget (OMB) acknowledged that "the quality and effectiveness of the federal acquisition process depend on the development of a capable and competent workforce" (Office of Management and Budget, 2005: 1). Furthermore, it reemphasized the *Services Acquisition Reform Act of 2003* expansion of the definition of acquisition workforce to include all individuals who perform acquisition-related functions: "traditional contracting functions, requirements definition, measurement of contract performance, and technical and management direction" for the sole purpose of ensuring such individuals would be "trained and developed using common standards" (Office of Management and Budget, 2005: 1). Lastly, OMB tasked the DoD to establish a framework of core competencies and develop "specialized competencies for particular areas of focus" (Office of Management and Budget, 2005: 4).

Thus, the DoD began its 2005-2006 Defense Acquisition Performance Assessment (DAPA) Project. Senior acquisition leaders and external consultants planned and executed a meticulous methodology to identify performance improvements:

> We reviewed over 1,500 documents to establish a baseline of previous acquisition reform recommendations, held open meetings and operated a public web site to obtain public input, heard from 107 experts, received over 170 hours of briefings, conducted a detailed survey and interviews of over 130 government and industry acquisition professionals, and subsequently developed 1,069 observations. From these specific assessments, we identified necessary performance improvements and defined implementation criteria for each area of improvement. (DAPA Panel, 2005:2)

Acknowledging the current situation as "characterized by massively accelerated cost growth in major defense programs, lack of confidence by senior leaders, and no appreciable improvement in the defense acquisition system" in two decades, Acting Deputy Secretary of Defense Gordon England set the following DAPA Project goals: "improve the DoD's acquisition system to provide capabilities to win the global war on terror; meet other challenges to national security; and regain senior leadership confidence" (Department of Defense, 2006).

Contributing towards these goals, Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics (AT&L) also commissioned the Defense Science Board (DSB) to evaluate DoD AT&L business processes and human resources capital (Defense Science Board, 2006:5). The DSB panel reported "the acquisition system is the weak link in the transformation chain" (Defense Science Board, 2006:13) with ineffectual acquisition reform efforts along with "inefficient and inflexible" career rules based on a "one-size-fits-all model of arbitrary career profiles" (Defense Science Board, 2006:36). The report also suggested the system "invests inefficiently in education and training, and needs to be better synchronized with career paths" (Defense Science Board, 2006:36). These workforce development deficiencies were again highlighted by Government

Accountability Office (GAO) testimony in 2007 before the Committee on Homeland Security and Governmental Affairs, U.S. Senate, entitled *Federal Acquisitions and Contracting: Systemic Challenges Need Attention* (Government Accountability Office, 2007:1). The testimony stated the government must develop an accountable and capable AT&L workforce responsible for strategic planning and management of programs and contracts—especially as the "workload and complexity of responsibilities have been increasing without adequate attention to the workforce's size, skills and knowledge, and succession planning" (Government Accountability Office, 2007:1).

To better address these issues, the previously four independent acquisition services consolidated into a single integrated Defense Acquisition Corps and established the AT&L Workforce Senior Steering Board (SSB) to oversee an AT&L Workforce Management Group (Department of Defense, 2006b: 4). The DoD also expanded its previously limited notion of "acquisition workforce" under the term "AT&L Workforce" to include all individuals who occupy AT&L positions to "more accurately reflect the breadth of the types of functions and duties performed by employees" (Department of Defense, 2006b: 1). This initiative further specified particular areas of focus according to the following AT&L position category functions outlined in Table 1.

Table 1: AT&L Position Categories

AT&L Position Category	**Code**
Auditing	U
Business, Cost Estimating, and Financial Management	K
Contracting	C
Education, Training, and Career Development	X
Facilities Engineering	F
Industrial/Contract Property Management	D
Information Technology	R
Life Cycle Logistics	L
Production, Quality and Manufacturing	H
Program Management	A
Program Management Oversight	V
Purchasing	E
Systems Planning, Research, Development, Engineering -- **Science and Technology Manager**	I
Systems Planning, Research, Development, Engineering -- Systems Engineering	S
Test and Evaluation	T

Within each of these workforce functions, AT&L initiated efforts towards implementing the 2005 Office of Management and Budget (OMB) recommendation to change the certification of the acquisition community "from a course-based to a competency-based strategy" (Hausmann and Tregar, 2006: 5). According to the *Defense Acquisition Transformation Report to Congress*, pursuant to section 804 of the John Warner National Defense Authorization Act for Fiscal Year 2007, "a sense of urgency has been established by the Department to streamline and simplify the Acquisition System with aggressive initiatives to provide lasting solutions for predictable performance" (Office of the Secretary of Defense, 2007:3).

Additional workforce performance initiatives are outlined in the 2007 *AT&L Human Capital Strategic Plan v. 3.0*, claiming "people" as the department's most important asset, with commitment to maintaining a "high performing, agile, and ethical workforce" as the number one priority (Krieg, 2007). The 3.0 version added a sixth goal entitled "Recruit, develop, and retain a mission-ready workforce through comprehensive talent management" as outlined in Table 2 (Office of the Secretary of Defense, 2007:11).

Table 2: AT&L Human Capital Strategic Plan v3.0 Goals

	AT&L Human Capital Strategic Plan v3.0 Goals
1	Align and fully integrate with overarching DoD human capital initiatives
2	Maintain a decentralized execution strategy that recognizes the Component leaders' lead role and responsibility for force planning and workforce management
3	Establish a comprehensive, data-driven workforce analysis and decision-making capability
4	**Provide learning assets at the point of need to support mission-responsive human capital development**
5	Execute DoD AT&L workforce communications plan that is owned by all AT&L senior leaders (One Team, One vision, A Common Message, and Integrated Strategies)
6	**Recruit, develop, and retain a mission ready workforce through comprehensive talent management**

Regarding the fourth goal, the Undersecretary of Defense for AT&L states that the "rapid pace of change with learning concepts and technologies has enabled us to help our workforce learn and be successful on the job by delivering the right knowledge and skills at the point of need" (Office of the Secretary of Defense, 2007:9). Thus, in alignment with the DAPA Project, GAO reports, DSB recommendations, and senior leader direction, OSD(AT&L) workforce committees are continuing to pursue strategies for

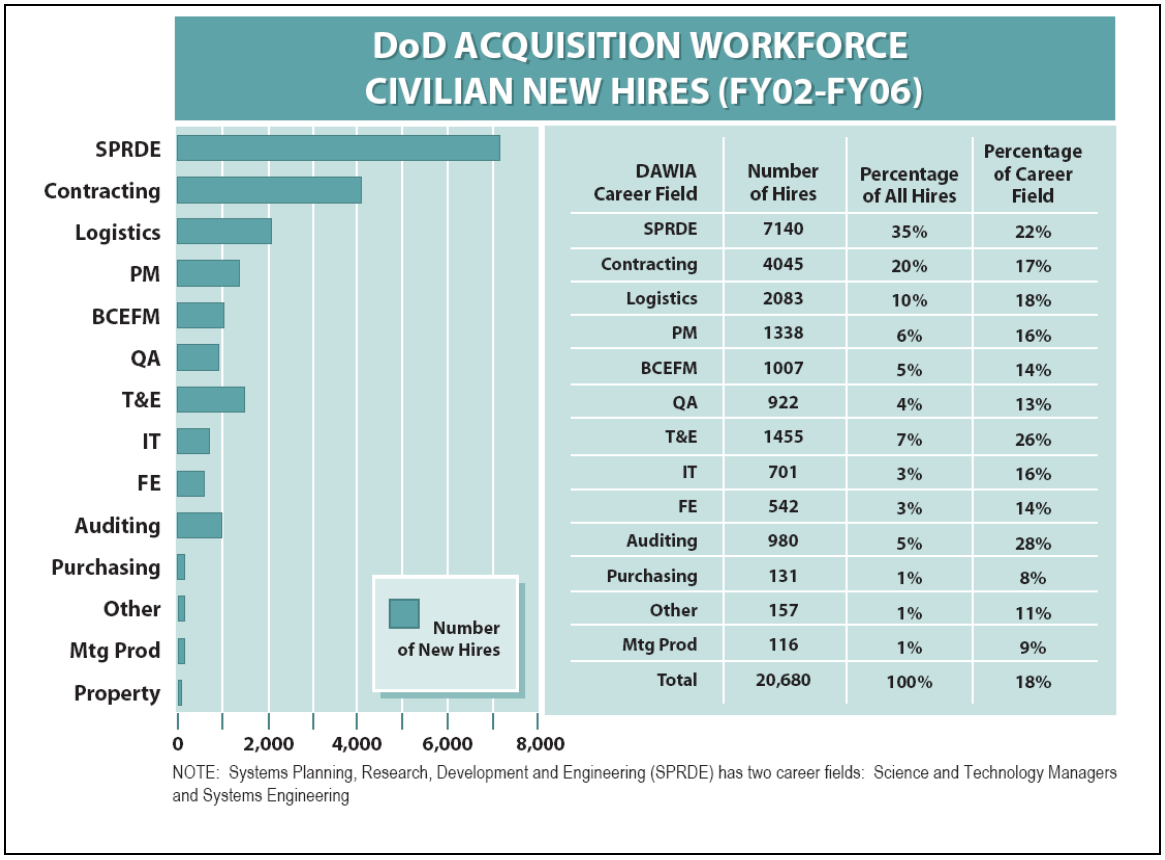
ensuring AT&L professionals are better organized, trained, and equipped to achieve optimum performance potential specific to their AT&L functional areas.

Current Workforce Issues.

Identifying and prioritizing the requirements for each type of program/project manager position across the AT&L spectrum becomes essential to effectively hiring, developing, and retaining competent employees. Although each DoD component structures its acquisition organizations differently, their program managers fulfill similar roles and responsibilities across the defense acquisition management framework spanning multiple levels of product maturity: the *pre-acquisition phase* consists of concept refinement and technology development; the *systems acquisition phase* consists of system development and demonstration plus production and deployment; and the *sustainment phase* consists of operations and support (Department of Defense, 2003:2). Despite differences in mission requirements and challenges across these phases, AT&L program managers have traditionally been developed under the same Acquisition Professional Development Program (APDP) certification model. For new program managers with lower levels of responsibility and under the supervision of experienced PMs, sufficient time and opportunity exist within the traditional APDP model for developing the skills, knowledge, and abilities (SKAs) for higher levels of competency. However, with 50% of its AT&L workforce becoming retirement eligible over the next five years (Department of Defense Acquisition, Technology, and Logistics, 2007a:10), the DoD needs strategies for mitigating the impacts of losing this specialized expertise and for maintaining a proficient and adaptable "bench strength" (35).

In a proactive attempt to mitigate this projected experience loss, in Fiscal Years 2002-2006 the DoD targeted 7,140 new hires in the Systems Planning, Research, Development and Engineering (SPRDE) functional area (comprised of Science and Technology Managers and Systems Engineering careers fields) and 1,338 new hires in Program Management (PM), representing a combined 45% of all new hires as outlined in Table 3 (Office of the Secretary of Defense, 2007:12).

Table 3: DoD Acquisition Workforce Civilian New Hires



DAWIA Career Field	Number of Hires	Percentage of All Hires	Percentage of Career Field
SPRDE	7140	35%	22%
Contracting	4045	20%	17%
Logistics	2083	10%	18%
PM	1338	6%	16%
BCEFM	1007	5%	14%
QA	922	4%	13%
T&E	1455	7%	26%
IT	701	3%	16%
FE	542	3%	14%
Auditing	980	5%	28%
Purchasing	131	1%	8%
Other	157	1%	11%
Mtg Prod	116	1%	9%
Total	20,680	100%	18%

Another specific recommendation in response to the anticipated shortages of acquisition workforce expertise has been to recruit "the best qualified technical leaders and specialists from the private sector at the mid-career and senior levels" under the

establishment of an omnibus legislative initiative (Defense Science Board, 2006:13). However, because this projected mass retirement and resulting experience loss plagues the entire national workforce, "competition between government and industry for new hires will intensify" (Office of the Secretary of Defense, 2007:13). Nevertheless, the entrance of new mid-level managers into the acquisition career field is already a reality for active-duty officers and mid-level government civilians cross-training or career-broadening for career advancement or force-shaping reasons. However, the learning curve for overcoming the complexities of the DoD acquisition environment at the mid-to-upper levels of responsibility can be particularly steep. Furthermore, time and opportunities for traditional on-the-job training (OJT) or formal classroom training are difficult due to increasing operational demands yet decreasing personnel numbers and budgets.

Two initiatives to overcome such obstacles and better meet the individual training needs of its diverse workforce have been the recent deployment of Defense Acquisition University's "Core Plus" framework and revised "Just-in-Time (JIT) Assignment-Specific Training" strategies (Department of Defense Acquisition, Technology and Logistics, 2007a: 26). Core Plus strives to address the *AT&L Human Capital Strategic Plan* Workforce Goal #4: "provide learning assets at the point of need to support mission-responsiveness human capital development" (Department of Defense Acquisition, Technology and Logistics, 2007a: 26). Being both performance-focused and competency-based, Core Plus "integrates improved competency management and the DoD AT&L Performance Learning Model (PLM)" with foundational core training and

"additional training based on organization, job specific, and individual professional development needs" (Department of Defense Acquisition, Technology and Logistics, 2007a: 26). Both Core Plus and JIT training are marked progress towards eliminating wasted or irrelevant content—either for the wrong employees or at the wrong times—and improving competency-based models of training. However, the models are only as useful as the quality of the competencies identified and defined within them.

Competency Modeling

As part of the Office of Personnel Management (OPM) *Human Capital Assessment and Accountability Framework* for tracking agency performance and effectiveness, the DoD acted on the 2006 Quadrennial Defense Review (QDR) recommendation for the *AT&L Human Capital Strategic Plan* to be competency-focused and performance-based (Hausmann and Tregar, 2006:16). A joint competency management initiative was deployed under the leadership of Defense Acquisition University (DAU) and with the expertise of analysts from the Center for Naval Analysis (CNA) specializing in competency modeling (Office of the Secretary of Defense, 2007:12). This partnership, along with inputs from the Federal Acquisition Institute (FAI), should enable both civilian and military AT&L employees to "work towards the same group of competencies and have greater flexibility and mobility to acquisition jobs throughout the Federal workforce" (Hausmann and Tregar, 2006:16). By applying best practices of competency modeling which have evolved over the last three decades, a standard competency model for each career field in the AT&L workforce is under development.

Historical Evolution.

The modern concept of competency modeling stems from the work of social psychologist David McClelland, who opposed the practice of traditional intelligence tests as a means for measuring aptitude and performance as outlined in his 1973 paper "Testing for Competence Rather than Intelligence" (Garman and Johnson, 2006: 13). McClelland's "proposed competencies—outcome-relevant measures of knowledge, skill, abilities, and traits and/or motives" became widely accepted especially through the 1990s as organizations were facing rapid workforce changes and needing a more flexible framework for managing workforce requirements (Garman and Johnson, 2006: 13). Organizations began using competencies to identify high-performing outstanding employees, becoming the basis for recruitment, selection, and development strategies for the greatest return on human capital investment (Rodriguez, Patel, Bright, Gregory, and Gowing, 2002: 310). The federal government was also experiencing similar workforce challenges, so the Office of Personnel Management (OPM) began integrating elements of competency models in 1990, recognizing the potential for wide-spread application across the federal government and in particular its human resource management challenges (Rodriguez and others, 2002: 310). However, many industries still struggled with ambiguities and inconsistencies within this fledgling model.

In 1997, the Professional Practice Committee and the Scientific Affairs Committee of the Society for Industrial and Organizational Psychology conducted a two-year investigation into the antecedents of competency modeling and examined the current range of practices to date (Shippmann and others, 2000: 703). The report compared and

contrasted *competency modeling* to *job analysis*, presenting strengths and weaknesses of each as they existed then, and recommended how practitioners and researchers could use a combined conceptual framework to guide future efforts towards developing standards for practice. It also identified and defined ten variables for effective modeling methodologies based on levels of rigor required (Shippmann and others, 2000:713). The authors suggested that the practice of competency modeling could possibly extend beyond the traditional—albeit rigorous—job analysis methodologies to date, simply due to its strength in identifying *commonalities* vice differences "across jobs, job groups, occupational groups, business segments, and so forth, in an effort to build platforms of information…used to support a broad range of applications" (Shippmann and others, 2000:733).

The Office of Personnel Management (OPM) recognized the value of both and "sought to incorporate traditional job analysis methodology into the development of competency models to provide an empirical foundation for the use of competencies by employees, managers, and human resource (HR) professionals" (Rodriguez and others, 2002: 310). In the late 1990s, OPM initiated what would become a 3-part study to consolidate information about competencies in the context of "emerging structures," changing roles, and various competency models (Office of Personnel Management, 1999:1). There were several trends the study sought to take into account: organization restructuring, downsizing of the HR workforce and delegating of HR authority, and influx of new technologies (Office of Personnel Management, 1999:1). One issue that the OPM's study helped clarify for puzzled practitioners was how competencies related

to traditionally binned knowledge, skills, and abilities (KSAs). The study explained how KSAs would serve as the foundation for competency models by focusing "typically on what is needed to do the job today," while competencies would build upon those same KSAs but also include traits, motives, and behaviors and thus "be used to assess and train employees for future needs" (Office of Personnel Management, 1999:9). The OPM study also suggested that clustered sets of competencies are useful in determining "superior" versus just "basic" performance (Office of Personnel Management, 1999:9).

The Federal Acquisition Institute (FAI) also valued how the "competency approach provides an empirically based framework that focuses on the full range of competencies required for success on the job" (Federal Acquisition Institute, 2003:4). Building on the guidance outlined by OPM, in 1999 the FAI initiated a competency-based career development program (Federal Acquisition Institute, 2003:2). In its 2003 *Report on General Competencies for the Federal Acquisition Workforce*, FAI outlines the methodology and results of conducting a competency-based assessment through its piloting of the Contract Specialist career field (Federal Acquisition Institute, 2003:4). The report recognizes that not all acquisition professionals may be required to demonstrate all the same competencies, nor to the same performance level; rather, organizational structure, missions, duties, or tasks will shape which competencies are critical and at what level (Federal Acquisition Institute, 2003:4). This same approach is enforced in the Project Management Institute's *Project Manager Competency Development Framework*, which explains how some industries or organizations may require technical competencies specific to domain, regulatory, legal, or safety standards

and thus should supplement their framework with specific competencies to meet specific needs (Project Management Institute, 2007:3). Establishing a standardized competency-based framework for each functional area will allow "leadership of the acquisition community [to] provide consistency across agencies, across acquisition positions, and across performance management efforts" (Federal Acquisition Institute, 2003:5). The benefits extend down to the individual level as well, providing the "common language to communicate about job requirements to potential recruits, preferred course content to educational institutions, and performance expectations and career development opportunities to employees," thus potentially motivating employees to "stay and grow in the field" (Federal Acquisition Institute, 2003:5). By better communicating position expectations, "higher quality applicants from wider, more diverse sources" could enable a better fit between employees and positions and thus a "more direct link between the work and agency goals and budgets" (Federal Acquisition Institute, 2003:5). Other applications include rotational assignments or career broadening, on-the-job or just-in-time training, and performance expectations or individual development plans (IDPs) necessary within a changing workforce environment.

Current Practices.

Both competency modeling and job analysis have continued to evolve and are currently integrated within the Office of Personnel Management (OPM) framework for workforce management purposes. OPM defines *job analysis* as a "systematic procedure for gathering, documenting, and analyzing information about the content, context, and requirements of job…to develop a clear understanding of the tasks performed on the job,

as well as the competencies needed for successful performance" (Office of Personnel Management, 2007: 3). Consistent with other definitions now accepted across the literature, the Office of the Undersecretary of Defense for Acquisition, Technology and Logistics (OSD(AT&L)) defines a *competency* as an "observable, measurable pattern of knowledge, skills, abilities, behaviors and other personal characteristics that an individual needs to perform work roles or occupational functions successfully" (Ahern and Anderson, 2008: 1). Thus, the definition of *competency model* is "a framework that describes the full range of competencies required to be successful in a particular occupation" (Office of Personnel Management, 2007:19). In addition to establishing behaviors aligned with technical competencies, the OPM framework also includes general—or professional—competencies candidates should possess (Office of Personnel Management, 2007:19). The ability to provide broader flexibility in describing desired capabilities across functional areas as well as align human capital management with organizational strategic goals is the overarching strength to competency models (Prahalad and Hamel, 1990:91). This premise is the foundation for DoD's *AT&L Human Capital Strategic Plan*, which aims to assist senior leaders in implementing workforce strategies to address critical skill gaps and target new education and training resources to meet the strategic challenges of the future (Office of the Secretary of Defense 2007: 12).

Chartered with this mission, the Defense Acquisition University (DAU) sought assistance from the Center for Naval Analysis (CNA) with developing competency models for each of the functional areas within the AT&L workforce. The CNA analysts relied extensively on the theory and methodology advocated in *The Art and Science of*

Competency Models by authors Anntionette D. Lucia and Richard Lepsinger (Tregar, 2008). Lucia and Lepsinger outline four workforce management systems for integrating competency models: selection (hiring), training and development, performance appraisals, and succession planning (Lucia and Lepsinger, 1999:114). To date, the training and development arena is the primary target of competency-based initiatives within DoD. The CNA efforts resulted in an Interim Competency Model for the AT&L program management career field (Hausmann and Tregar, 2006:4) and upon which this research methodology is modeled. The AT&L model—still under refinement—is also serving as a framework for pilot programs testing competency-based initiatives for other workforce applications. For example, from 2005-2007 the Air Force Electronic Systems Center at Hanscom Air Force Base, MA, partnered with OPM to undergo a competency-based assessment process for employee selection as part of a workforce selection and succession development effort (Office of Personnel Management, 2007:1). Similar efforts are being assessed for other Air Force acquisition organizations, such as the Air Armament Center at Eglin Air Force Base, FL, and the Air Logistics Center at Warner-Robins Air Force Base, GA (Higgins, 2007: 20).

According to AT&L, the goal is to develop models or audits of all career fields by October 2008, with sample assessments of six additional career fields by December 2008 (Department of Defense Acquisition, Technology and Logistics *4th Estate*, 2007b: 9). The intent is to align the competencies within each model with the DAWIA certification program, DAU courseware, Human Capital Strategic Plan initiatives, and Individual Development Plan program (Department of Defense Acquisition, Technology and

Logistics *4th Estate*, 2007: 9). The methodology outlined in the 2006 AT&L report, *Program Management Career Field: Interim Competency Model,* serves as the basis on which this research is patterned as detailed in Chapter III: Methodology.

III. Methodology

The methodology for this research is patterned on a 2006 study conducted by analysts from the Center for Naval Analysis (CNA) and Defense Acquisition University (DAU) on behalf of the Department of Defense (DoD) Acquisition, Technology and Logistics (AT&L) leadership and workforce. The initial effort is outlined by Hausmann and Tregar (2006) in their review, *Improving the Certification, Training, and Development of the AT&L Workforce: Program Management Career Field Interim Competency Model*. This chapter outlines the data collection and analysis process of the original AT&L study, the data collection process for this research study, and the analysis process for comparing the results of the two studies.

AT&L Interim PM Competency Model

The AT&L study follows a competency model methodology prescribed across the literature from both private and public sectors (Hausmann and Tregar, 2006:5). It mirrors a common development strategy espoused in academic and business literature which follows a six-stage process (Boulter, Dalziel, and Hill, 1998:32):

1. Performance criteria: define the criteria for superior performance in the role
2. Criterion sample: choose a sample of people performing the role for data collection
3. Data collection: collect sample data about behaviors that lead to success
4. Data analysis: develop hypothesis about the competencies of outstanding performers and how these competencies work together to produce desired results
5. Validation: validate the results of data collection and analysis
6. Application: apply the competency models in human resource activities as needed

The AT&L model compresses these stages into a three-step qualitative approach: first, convene an expert panel to establish the competency framework and identify subject matter experts (SMEs); second, use "key situation structured interviews" with the SMEs to validate and expand on the competencies based on specific examples of behavior, followed by specific questions rating the competencies to compute criticality rankings; third, conduct a validation survey of the hypothesized competencies in order to generalize or make inferences about competency-based initiatives for the workforce at large (Hausmann and Tregar, 2006:6). At the time of its 2006 interim report, the AT&L study had completed the first two steps; the third step—the final validation survey—is currently underway (Tregar, 2008).

Step 1: Expert Panel.

This first stage of the data collection process involved gathering highly-knowledgeable functional leaders to develop the competency model framework and identify subject matter experts (SMEs) from their career field. The focus group, with the assistance of Defense Acquisition University (DAU) guidance and past PM competency model reviews, proposed legacy program management competencies which would become the baseline the SMEs would later expand upon and rate (Tregar, 2008). The expert panel identified SMEs with more than two years of experience who were recognized as "superior performers" from within their career field and having the ability to clearly communicate examples of competencies required in the job (Hausmann and Tregar, 2006:25). The AT&L study's expert panel consisted of participants from across

the federal government—both Department of Defense (DoD) and civilian agencies (Hausmann and Tregar, 2006:26).

Step 2: SME Data Collection.

With the baseline competencies and framework established, the Subject Matter Expert (SME) data collection process used in-person interviews via focus groups along with electronic online tools (Hausmann and Tregar, 2006:27). The SMEs were multi-service, serving at Wright Patterson Air Force Base OH, Naval Air Station Patuxent River MD, and Army Redstone Arsenal in Huntsville AL (Hausmann and Tregar, 2006:31). A total of 70 SMEs participated (with usable data from 69) representing the following demographics (Hausmann and Tregar, 2006:34):

- 78.3% were from DoD; 21.7% were from a Civilian Agency
- 77.1% were from the Program Management career field (the others represented information technology, systems engineering, business financial management, manufacturing, and contracting career fields)
- 72.9% had more than 12 years of experience; 15.7% had 7-12 years of experience; 8.6% had 3-6 years of experience; 2.9% had less than 2 years of experience
- 86.8% were certified at the Senior/Expert level; 13.2% at the Journeyman level; and 0% at the Entry level

While this demographic data show the majority of SMEs as experienced, top-certified DoD program managers and thus reinforcing the credibility of their inputs for the intended outputs, the researchers acknowledge that the lack of proportional workforce representation limits the study's ability to generalize sample results to the workforce at large—hence the need for the final validation survey (Hausmann and Tregar, 2006:35).

Nevertheless, the researchers felt the consistency in the responses was adequate for use as an interim competency model for program management professional development purposes (Hausmann and Tregar, 2006:35).

In obtaining the SME inputs via the in-person interviews, the researchers followed a methodology known as "key situation" or "critical incident technique," during which SMEs are asked to "describe an effective situation or experience when they felt particularly effective and confident on the job" (Hausmann and Tregar, 2006:27) and identify key actions which resulted in an effective outcome (Hausmann and Tregar, 2006:28). As a means to quickly identify situations, organize thoughts, and write descriptively, the researchers had SMEs follow the "STARR" process: 'Situation/Task' (explain the situation context, actions, work effort); 'Action' (outline steps taken toward an effective outcome); 'Reasoning' (explain rationale that led to the actions); and 'Results' (present outcomes of the key situation) (Hausmann and Tregar, 2006:28). After describing the PM situations in detail, the SMEs listed which of the pre-identified set of *technical competencies* were associated with each event. Additionally, the SMEs rated *professional competencies* with respect to the situations from those listed in the Office of Personnel Management (OPM) Executive Core Qualification standard (Hausmann and Tregar, 2006:28). The SME's interviews and ratings align with literature regarding the importance of including both professional and technical competencies in a competency model: "effective PMs share a common foundation of basic knowledge and skills; top performing PMs also exhibit key leadership behaviors that allow them to employ these building blocks more effectively to achieve superior results" (Gadekin, 2005:11).

Based on the SME interviews, the AT&L research team used a qualitative content analysis to refine the competency framework with specific behavior-based descriptions for each competency definition (Hausmann and Tregar, 2006:32). The SMEs then rated the competencies based on their perceptions of importance, frequency, and career levels when first used per the following questions and Likert scale responses (Hausmann and Tregar, 2006:29):

- Importance: "What is the degree of impact this work function has on job performance?" (1-Not Important; 2-Somewhat Important; 3-Important; 4-Very Important; 5-Extremely Important)

- Frequency: "How often is this competency used in performing work? (1-Never; 2-Sometimes; 3-Often; 4-Frequently; 5-Very Frequently)

- Level First Used: "At what point in your career did you FIRST use this work function to perform your job?" (1-Entry; 2-Journeyman; 3-Senior/Expert)

The research team then computed a "criticality score" for each competency based on the group average of the importance and frequency means. These criticality scores suggest a prioritized ranking of the competencies most critical to successful program management and at levels first needed, which becomes the basis of comparison for this research study regarding critical competencies for managing Science and Technology programs.

S&T PM Competency Study

Because the scope of this research is to analyze program management competencies—but within the context of Department of Defense (DoD) Science and Technology (S&T) programs—the AT&L PM study serves as a valid model from which to start. Although "starting from scratch is appropriate for developing a competency model […] to yield role-and company-specific results," it is more time-consuming than

the alternative approach of starting with a validated model which is "best suited for leadership and management roles that cut across several functions" (Lucia and Lepsinger, 1999:53). Thus, a content analysis of the competencies identified for two Science and Technology Manager (STM) courses presented in Appendix C (Department of Defense, 1999:131) and those from the AT&L PM model suggests initial face validity exists for using the same competency framework.

Step 1: Expert Panel.

With the competency model framework predefined by the AT&L study, this step in the research methodology provides an opportunity to consult with functional S&T and PM leaders for insights on historical and organizational background information relevant to the scope of this study, and to identify potential S&T program management SMEs for data collection. The expert panel members provide background information and guidance into issues, questions, or concerns that could possibly shape the SME interviews and future data analysis. This step also alerts stakeholders of the research goals and potential benefits, in this case garnering research sponsorship from Headquarters Air Force Materiel Command's Requirements Directorate and Technology Transition Division, along with organizational endorsement by the Air Force Research Laboratory Directorate of Personnel. With a list of SMEs identified based on the same criteria as the AT&L study—at least two years of experience managing S&T programs and considered a "superior performer"— an invitation could be extended to SMEs to voluntarily participate in the research study.

Step 2: SME Data Collection.

Upon meeting the criteria for an Institutional Review Board exemption (Appendix A), the researcher electronically mails an invitation to all SMEs requesting their voluntary participation in this study. The SMEs then select their preferred method of interface—in person, telephone, or email—for providing responses to a structured interview format consisting of four parts (Appendix B):

- Part I: closed-ended demographic questions regarding years of experience, certifications, level, and academic degrees
- Part II: three closed-ended questions regarding the importance, frequency, and levels first used for 36 technical competencies
- Part III: three closed-ended questions regarding the importance, frequency, and levels first used for 27 professional competencies
- Part IV: three open-ended questions regarding any competencies missing from the existing model, the usefulness of applying a competency model for hiring/evaluation criteria, and the criticality of technical degrees for successful program management within S&T

A pilot test of the structured interview, useful for assessing how new procedures or instruments work (Patten, 2005:55), estimates 30 minutes for completion. Actual time varies by respondent depending on how much discussion transpires during the interview, or between interruptions for those responding electronically.

As recommended in other studies, a single interviewer conducts the structured interviews in order to "ensure a uniform approach to the data collection process" (Greiner, Dooley, Shunk, and McNutt, 2002:125). The format remains consistent beginning with a brief discussion explaining the purpose, process, and bounds of the research and structured interview. Although maintaining the same competencies,

definitions, and measures of evaluation, additional demographic data and three open-ended questions are added to the S&T PM interview. After collecting individual data from each SME, the responses are consolidated into a master Excel spreadsheet and the original notes destroyed. No identifiable data or indicators link respondents to their responses.

Data Analysis

With the data compiled into a master Excel spreadsheet, the results can be grouped, computed, and analyzed. A quantitative analysis can be applied to the descriptive statistics of the demographic data and competency ratings, with a qualitative analysis applied to the open-ended responses.

Part I: Demographic Data.

The first part of the structured interview consists of self-reported demographic data: the participants' experience based on years managing S&T programs or supervising those who do; expertise based on professional certifications and skill levels; education backgrounds based on degrees awarded; and organizational influences based on years serving in each of the Air Force Research Laboratory (AFRL) organizations. The data is categorized then reported in terms of frequency and percentages in order to describe the respondents to the research audience.

Parts II & III: Competency Criticality Means.

The second and third parts of the structured interview consist of closed-ended questions for each technical and professional competency defined in the AT&L study. Each respondent's numerical answers are based on a 5-point Likert-scale for the first two

questions about a competency's importance and frequency of use. The sample mean for each of the first two ratings are then computed by summing all respondents' numerical ratings for each question then dividing by the sample size. Once the means for a competency's importance and frequency ratings are computed, the criticality score for each competency is computed by averaging the two means: $[(\bar{X}_i + \bar{X}_f)/2]$. Based on the criticality scores of competencies for both sample groups, the research can compare the descriptive statistics to assess differences in prioritized rankings. This analysis addresses the investigative question of whether differences exist in performance competencies—either more or less critical—between traditional acquisition program managers and those managing Science and Technology programs.

The next investigative question—whether differences between the criticality means are statistically significant—requires the use of inferential statistics, which "help draw references about the effects of sampling errors on the results that are described with descriptive statistics" (Patten, 2005:97). The statistical hypothesis test is structured as follows:

- H_o: There is no statistically significant difference between the means, translated as 'there is no *true* difference between the criticality scores of competencies for Acquisition PMs and S&T PMs, other than that which is created merely by chance due to sampling error'
- H_a : The difference between the means is statistically significant….translated as 'the differences between the criticality scores of competencies for ACQ PMs and S&T PMs is due to more than mere sampling error'

Before proceeding to a null-hypothesis statistical significance test, or the Student's t-distribution test, the following conditions must be assessed (McClave, Benson, Sincich, 2005:486):

- independence or dependence of the samples
- random or not random selection of the samples
- normal or abnormal distribution of the data
- equality or inequality of the variances

This study can assume independence and acknowledge the limitations of the purposive, non-random sampling. However, the latter two assumptions require further analysis.

Regarding the normality of the data distribution, several types of descriptive methods can be used to check for normality. Graphical techniques such as a histogram or stem-and-leaf display will suggest a visual representation of the shape of the curve, which for normality should be mound-shaped and symmetric about the mean (McClave, Benson, and Sincich, 2005:285). Another graphical test of normality is the Q-Q plot, which presents the observed values as dots plotted along a straight diagonal line of expected values for a normally distributed data set (Field, 2005:96). However, to balance the subjective analysis of graphical displays, an objective mathematical test for normality is the Shapiro-Wilk test which compares the scores in the sample to a normally distributed set of scores with the same mean and standard deviation (Field, 2005:93). If the test is statistically significant ($p < .05$)—as computed through a statistical software package—then the distribution is significantly different from a normal distribution (Field, 2005:93). However, a drawback to using this mathematical analysis exclusively is that

the larger the sample size, the more the tendency to get significant results from small deviations in normality—thus masking whether the deviation from normality is enough to bias statistical procedures (Field, 2005:93). Therefore, this research applies all four methods to conservatively assess the distribution normality of the sample. It should be noted that without the original AT&L study data, similar assessment of normality is not possible; however, because the sample sizes are both considered large [(n_1=65-69) $\geq$ 30 and (n_2=41) $\geq$ 30], the Central Limit Theorem "guarantees that the sampling distribution of ($\bar{X}_1 - \bar{X}_2$) will be approximately normal regardless of the shapes of the underlying probability distributions of the populations (McClave, Benson, and Sincich, 2005:483).

The final consideration for use of the t-test is the assumption of equality of the variances. Looking at the standard deviations of both samples, they clearly are not the same. However, a more rigorous statistical test of this assumption would be the 2-tailed F-distribution test based on inferences about the ratio of the two variances, and applicable when both samples are random, independent, and normally distributed (McClave, Benson, Sincich, 2005:528). The outcome of the F-test—whether or not to reject the null hypothesis that the variances are equal—will drive which computation for degrees of freedom (v) to use in combination with the computed test-statistic for analyzing the probability (p-value) of statistical significance (McClave, Benson, Sincich, 2005:524). Upon addressing independence, randomness, normality, and unequal variance of the two unequal sample sizes, the Satterhwaite's approximation / Welch's adaptation for test statistic (t) and degrees of freedom (v) apply as shown in Figure 1 (McClave, Benson,

Sincich, 2005:492). If the resulting *p*-value is <.05, the difference in the means for that competency is considered statistically significant, thus rejecting the H_o hypothesis.

$$t = (x_1 - x_2) \Big/ \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$

where:
x = mean
s^2 = sample variance
n = sample size

t is based on degrees of freedom equal to:

$$v = \frac{(s_1^2/n_1 + s_2^2/n_2)^2}{\frac{(s_1^2/n_1)^2}{n_1 - 1} + \frac{(s_2^2/n_2)^2}{n_2 - 1}}$$

Figure 1: Satterhwaite / Welch Equations

Part IV: Open-Ended Questions.

The final part of the study involves a qualitative analysis of the responses to the three open-ended questions based on a grounded theory approach. As an inductive method of analysis, it should lead to the emergence of theories through consideration and analysis of the data (Patten, 2005:153). The responses are examined for "distinct, separate segments (such as ideas or experiences of the participants) and are 'coded' by identifying them and giving each type a name" (Patten, 2005:153). The research is intended to identify themes to elucidate the opinions of the S&T program managers regarding competency modeling and its potential applications to current or future human resource management issues.

Constraints & Limitations

The methodology used in this study has some natural and research-induced constraints which could limit its broader applications, or generalizations, to the S&T / R&D program management community at large.

Data Collection.

The primary constraint involves sampling issues. In addition to sample size limitations, the participants are not randomly selected; rather, both studies use purposive sampling—specifically expert sampling—because targeting subject matter expert opinions is the primary aim versus proportionality. Additional sampling bias could result from the element of volunteerism by respondents since "volunteers may be fundamentally different from non-volunteers," as well as the element of convenience sampling—primarily AFRL SMEs located at Wright-Patterson AFB (Patten, 2005:45). As such, the demographic data of the participants is not necessarily representative of the broader AT&L community's S&T program managers. Another potential constraint could involve researcher/response bias, where the interviewer interaction might affect the outcomes through clarifications or the influence of social desirability.

Data Analysis.

The issue of construct validity is at the crux of the study. Upon initial inspection, the AT&L PM competency model appears to have face validity—that is, it appears to be a valid instrument applicable to S&T program managers (Patten, 2005:61). By proceeding through the interview process, the research tests the actual content validity—that is, whether the competencies defined within the competency model are appropriate

for what is intended to be measured and analyzed (Patten, 2005:68). If issues with content validity emerge, they could flaw the results through systematic error, thus bringing the reliability of the criticality scores into question.

Nevertheless, for the purpose of this research scope and for comparability between studies, the sample participants and consistent methods support the intent of the research. Any observations to be discovered become opportunities for further research and refinement of this exploratory topic, ultimately leading to a reliable competency model for aiding successful S&T program management performance.

IV. Results & Analysis

This chapter summarizes the data collected from the Science and Technology (S&T) program managers (PMs) and analyzes it in comparison with results from the AT&L interim report *Improving the Certification, Training, and Development of the AT&L Workforce*. It first presents descriptive statistics on the demographic data of the respondents. Next it presents descriptive statistics on the S&T PM responses for the technical and professional competencies studied, along with inferential statistics comparing these results with those from the AT&L study. Lastly, it presents the results and analysis from the three open-ended interview questions unique to this research study.

Part I: Demographic Data

Consultations with Expert Panel members from the S&T Program Management community at the Air Force Research Laboratory (AFRL) resulted in the identification of 85 Subject Matter Experts (SMEs) who qualified as "superior performers" with at least more than two years of experience in S&T program management. Initially, 52 volunteered to participate in the study, but through attrition the final sample size consisted of 41 SMEs.

Years of Experience.

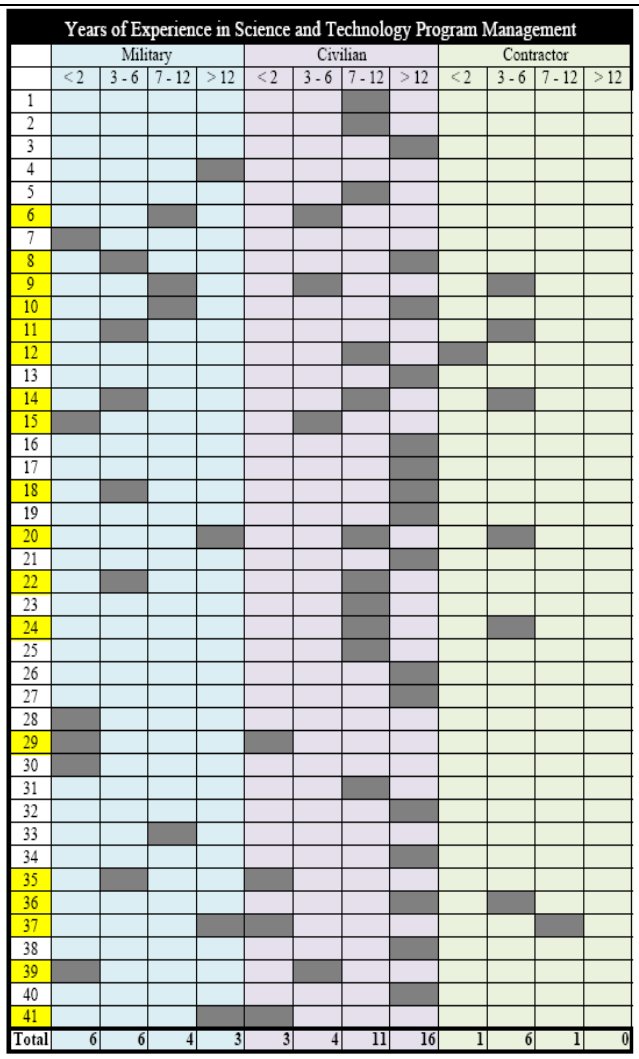
Experience was recorded according to four categories, to include any time serving as a military, civilian, or contracted employee in S&T program management. A picture of an individual's full career—not just current position status—was valuable in gaining fuller insight into the types of positions and perspectives that might be shaping a SME's

responses to the interview questions. Of the 41 respondents, 46% have served as active duty military, 83% have served as a civilian employee, 20% have served as a contracted employee, and 44% of those have some combination of experience across the three categories. The number of years served within each type of position status is broken out in Table 4.

Table 4: SME Years of Experience

* <u>44 % Combined Experience (18)</u>
    - 39 % > 12 years
- **46 % Military Experience (19)**
    - 15.8 % > 12 years
    - 21.0 % 7-12 years
    - 31.6 % 3-6 years
    - 31.6 % < 2 years
- **83 % Civilian Experience (34)**
    - 47.1 % > 12 years
    - 32.4 % 7-12 years
    - 11.8 % 3-6 years
    - 8.8 % < 2 years
- **20 % Contractor experience (8)**
    - 0.0 % > 12 years
    - 12.5 % 7-12 years
    - 75.0 % 3-6 years
    - 12.5 % < 2 years

* (n = 41); highlighted respondents represent combined experience



The highest category of service represented in this sample group is civilian service (83%), with 47% of those having more than 12 years of experience managing S&T programs or supervising those who do. Like the AT&L study, due to purposive SME sampling, employees having higher levels of experience dominate the sample group with disproportional representation of employees having fewer years of experience. An additional experience factor collected was the number of years respondents have spent across the different Air Force Research Laboratory (AFRL) Technology Directorates (TDs)—providing insight into potential organizational influencers shaping responses. They are broken out by percent across the TDs, Headquarters Plans & Programs (XP) office, or "other" S&T organization as shown in Figure 2. It should be noted, however, that due to the sampling of convenience factor required for conducting the in-person interviews, the respondents are mostly representative of those AFRL organizations co-located at Wright Patterson AFB, OH, rather than all of AFRL's SME population across multiple geographically separated locations.

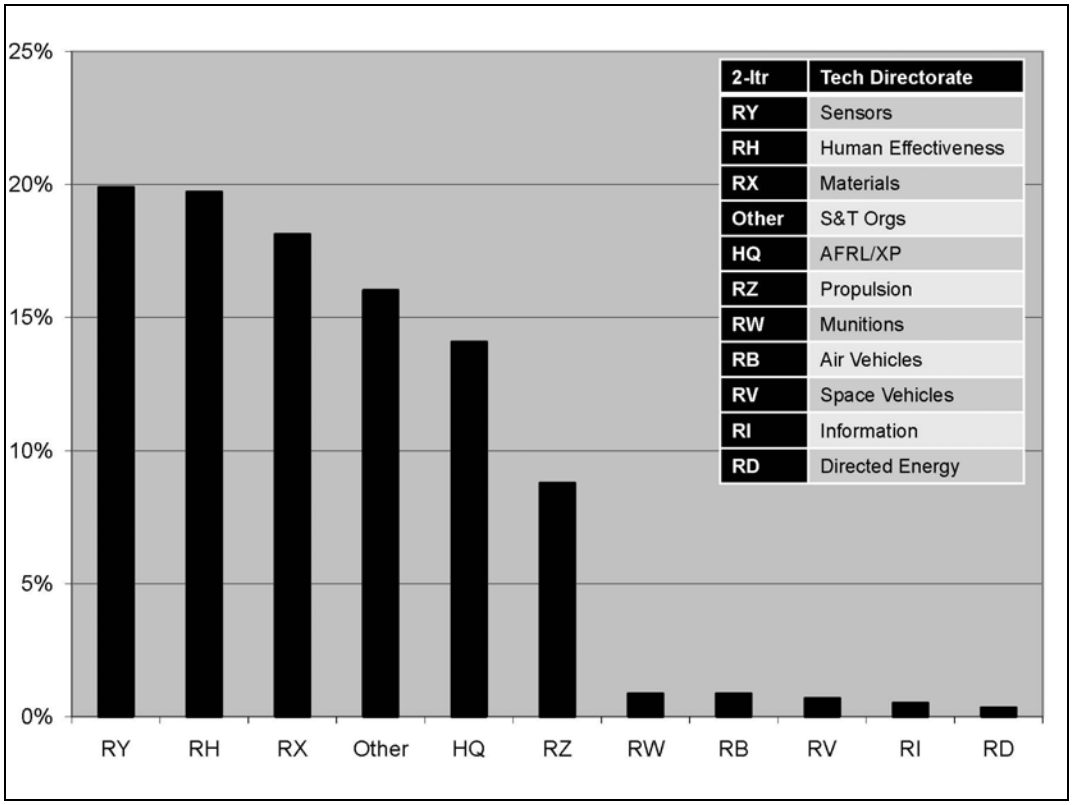


Figure 2: Organizational Experience

Professional Certification Levels.

The next type of demographic data collected includes the types and levels of professional certifications held by the S&T PM subject matter experts (SMEs). Per the Defense Acquisition Workforce Improvement Act (DAWIA), the AT&L workforce must acquire certification levels based on years of experience in specifically coded positions, training, and education in accordance with standards outlined by the Acquisition Professional Development Program (APDP). The APDP certification types and levels held by the SMEs interviewed for this study are outlined in Figure 3.

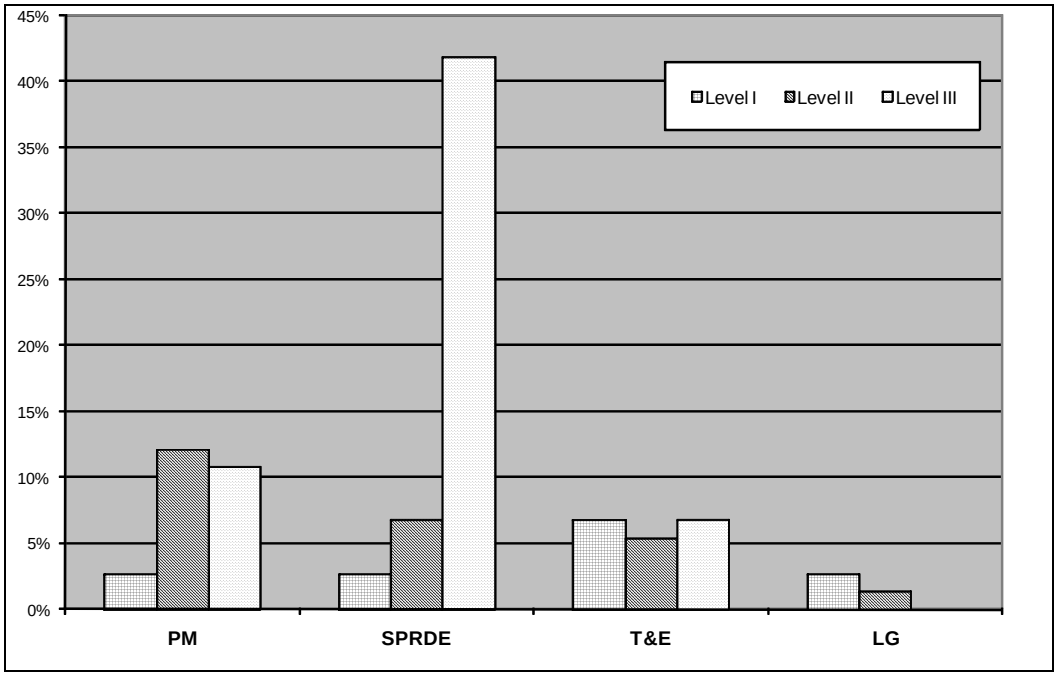


Figure 3: APDP Certifications

Of the 41 SMEs, 20 (49%) held certifications in more than one APDP area; however, 38 (93%) held Systems Planning, Research, Development and Engineering (SPRDE) -- Systems Engineering certifications, but only 19 (46%) held some level of Program Management certification. The specific numbers and percentages for each level are broken out by APDP types in Table 5. This current workforce composition suggests SPRDE technical development supersedes that of program management development for this AFRL sample group.

Table 5: APDP Levels

APDP Type	Level I	Level II	Level III
Program Management	5% (2)	22% (9)	22% (9)
SPRDE – SE	5% (2)	12% (5)	76% (31)
Test & Evaluation	12% (5)	10% (4)	15% (6)
Life Cycle Logistics	5% (2)	2% (1)	0% (0)

Another observation particular to the AFRL S&T program manager model is that the SPRDE certifications are aligned with the Systems Engineering subcategory rather than the Science & Technology Manager (STM) subcategory of the AT&L functional groups. Therefore, participants were asked to self-identify their STM levels according to the STM course competencies outlined in the *DoD Acquisition Career Management: Mandatory Course Fulfillment Program and Competency Standards* (Appendix C) and certification level descriptions in the 2007 *Federal Acquisition Certification for Program and Project Managers* (Federal Acquisition Institute, 2007:5). The results, as presented in Table 6, suggest that of the 41 AFRL SMEs, 76% are considered to be at the Expert Level, 24% at the Journeyman Level, and 0% at the Entry Level. Once again, the disproportionate representation is recognized as a natural factor of purposive SME sampling, but able to be mitigated through the use of a final validation survey.

Table 6: STM Levels

APDP Type	Entry / Beginner	Journeyman / Intermediate	Expert / Advanced
S&T Management	0% (0)	24% (10)	76% (31)

Academic Degrees.

The last type of demographic data collected includes the types of academic degrees held by the Subject Matter Experts interviewed. The respondents were asked the number of engineering, science (chemistry, physics, biology), math, or "other" degrees held, and to specify degrees in the "other" category. The results are detailed in Figure 4. Academic degrees are critical qualifiers for each of the AT&L functional career fields.

The current standard for hiring and certifying an S&T Program Manager requires a technical degree: engineering, science, or math. However, PMs in other phases of the AT&L lifecycle do not always have technical degrees; rather, they usually hold business or management degrees. Due to the fluid crossflow of military assignments, active duty PMs might find themselves assigned to S&T programs with or without a technical degree. However, current hiring restrictions prevent even the most superior-performing civilian or contracted PMs from crossflowing over to S&T programs without a technical degree.

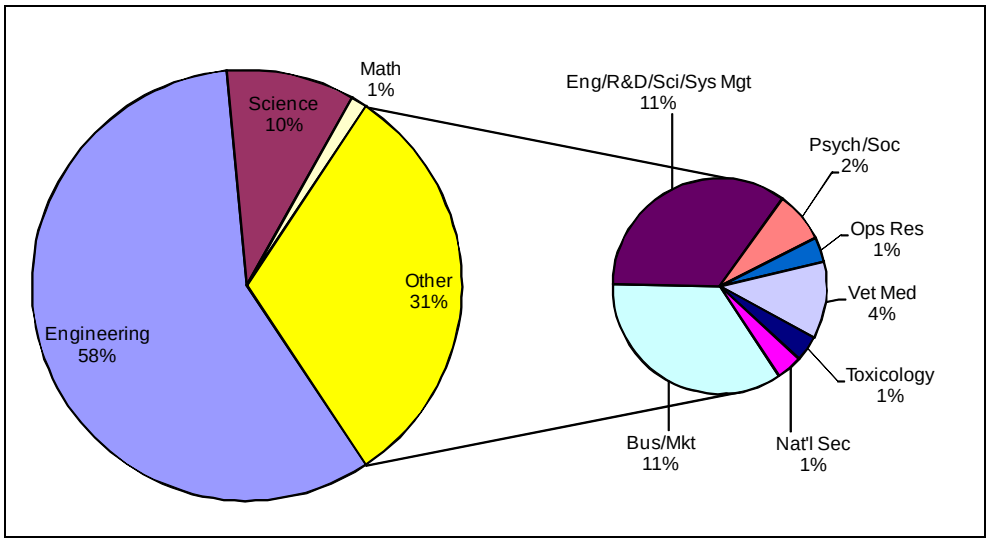


Figure 4: Academic Degrees

Part II: Technical Competencies

The second part of this study examines technical competencies, addressing the research question of whether certain competencies are more or less critical to different

program manager groups. In the study, the S&T PMs were asked to review the AT&L PM competencies and their definitions, then provide responses to the same questions about each of the competencies (Appendix B). The first question asked the respondents to rate the degree of impact—in terms of importance—each competency has on job performance, using a 5-point Likert scale. The second question asked the respondents to rate how often each competency is used in performing work in terms of frequency, also using a 5-point Likert scale. The average of these two means was computed into a "criticality score" for each competency, enabling a rank ordering of prioritized competencies according to each sample group as shown in Table 7: Comparison of Technical Competencies. Although beyond the scope of this research study, the underlying assumption of the ranked competencies is that the higher a competency is ranked, the greater effect it has on PM performance which would theoretically show up in an empirical study as having the largest/larger regression coefficient (β) than lower ranked competencies.

Table 7: Comparison of Technical Competencies

TECHNICAL COMPENTENCY TITLES		S&T Results				AT&L Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
TC 8	Communications Management & IPT/IPPT Process	41	0.79	4.34	1	1	4.39	0.71	69	.74814
TC20	Transition Techniques	41	0.83	**3.88**	2	33	3.04	0.94	68	.00000**
TC28	Contract Approach, Requirements & Supporting Documents, Prepare & Issue Solicitation	41	1.01	3.80	3	7	4.08	0.75	68	.13427
TC13	Technical Management Process	41	0.86	3.79	4	5	4.13	0.64	68	.03305*
TC29	Source Selection, Contract Award, Contract Administration, & Contract Closeout	41	0.84	3.73	5	9	3.99	0.79	69	.11626
TC14	Technical Process	41	1.03	3.61	6	12	3.95	0.71	68	.06772
TC 1	Requirements Process	41	0.88	3.55	7	3	4.28	0.64	68	.00002**
TC19	S&T Goal, Program Considerations, & Technology Engineering	41	1.08	**3.55**	7	31	3.13	0.88	68	.03908*
TC33	Financial Reporting & Oversight, Dpt/Agency Programming, Planning, & Budgeting System	41	1.04	3.55	7	9	3.99	0.78	68	.02202*
TC 5	Risk Management	41	0.86	3.44	10	4	4.17	0.75	69	.00002**
TC 3	Core Management Skills & Processes	41	1.07	3.43	11	1	4.39	0.6	70	.00000**
TC21	Identify & Protect Promising Technologies	41	1.01	3.33	12	34	2.94	0.96	67	.05105
TC 2	Technology Development Strategy/Acquisition Strategy	41	1.00	3.28	13	11	3.96	0.78	70	.00039**
TC22	T&E Integration, Strategy, & Planning	41	1.10	3.07	14	8	4.06	0.67	67	.00000**
TC23	Development Test & Evaluation (DT&E)	41	1.17	3.04	15	16	3.84	0.75	67	.00023**
TC12	System Integration	41	1.30	2.94	16	23	3.32	0.88	68	.10273
TC 9	Configuration Management, Data Management, and Information Management	41	0.87	2.93	17	19	3.46	0.88	68	.00274**
TC15	Systems Engineering Plan (SEP)	41	1.03	2.80	18	27	3.19	0.82	67	.04593*
TC16	Software Developmnet, Acquisition Management Technical Fundamentals, Quality & Measurement	41	1.17	2.78	19	20	3.45	0.83	67	.00208**
TC31	Business Financial Planning & Mngt; Cost Estimating	41	1.08	2.74	20	5	4.13	0.76	68	.00000**
TC24	Operational Test & Evaluation (OT&E) and Vulnerability Testing	41	1.26	2.49	21	18	3.66	0.75	67	.00000**
TC 6	Joint/Cross Agency/International Progrma Magamenet by U.S. Executive Agency	41	0.98	2.43	22	35	2.92	0.89	65	.01099*
TC32	Earned Value Management (EVM)	41	1.07	2.40	23	14	3.90	0.88	69	.00000**
TC30	Performance-based Service Agreements	41	1.09	2.39	24	21	3.37	0.8	69	.00000**
TC25	Life-Cycle Logistic Management, Product Support, and Interoperabililty	41	1.12	2.37	25	15	3.89	0.83	67	.00000**
TC11	Information Systems: Network Security/Assurance, Architecture, Performance, Infrastructure Design, & System Mngt	41	1.05	2.35	26	24	3.30	1.01	68	.00001**
TC17	Sofware Process Maturity, Critical Requirements, Data Management, Software Support & Safety	41	1.00	2.33	27	21	3.37	0.83	68	.00000**
TC26	Life-cycle Cost Optimization, Data Management, & Integrated Supply Chain Management	41	1.00	2.29	28	17	3.73	0.91	68	.00000**
TC27	Logistics Footprint Minimization Life-cycle Assessment, & Disposal	41	0.88	2.29	28	30	3.15	0.85	67	.00000**
TC34	Industrial Base Assessment	41	0.88	2.29	28	32	3.09	0.92	66	.00002**
TC 4	Life-Cycle Cost (Total Ownership Cost) Management	41	0.94	2.28	31	13	3.91	0.72	69	.00000**
TC18	Software Reliability, Reuse and SIS Independent Expert Reviews	41	1.04	2.22	32	27	3.19	0.81	67	.00000**
TC 7	Market Research	41	0.83	2.18	33	36	2.80	0.7	68	.00015**
TC35	Plan Production	41	1.03	2.10	34	26	3.29	0.81	66	.00000**
TC36	Produce Product	41	1.13	1.96	35	24	3.30	0.82	65	.00000**
TC10	Information Resource Strategy and Planning, System Lifecycle, and Management/Technology Awareness	41	0.76	1.88	36	29	3.18	0.87	68	.00000**

* p < .05

** p < .01

Competencies rated "more critical" by S&T PMs; all other rated "less critical"

Descriptive Statistics.

The first observation of the criticality rankings involves analyzing just the S&T PM's own rankings of technical competencies. In instances where the means are equal, the rankings reflect tie scores. For example, three technical competencies all share a common criticality score (mean of 3.55), and therefore are all ranked 7th, with the next competency criticality score (mean of 3.44) ranked 10th. This ranking methodology is applied consistently to both studies through the 36 technical competencies and 27 professional competencies.

The second observation involves analyzing the differences of the technical competency rankings—or criticalities—between the two sample groups. It is important to note that although the differences in rankings might initially appear to suggest significant difference in the perceived criticality of certain competencies between the two PM groups, the true test of significance must be statistically computed based on the actual difference in their means (the results of which are presented and analyzed under the *Inferential Statistics* subheading.) For example, TC21—Identify & Protect Promising Technologies—indicates its criticality ranking by the S&T PMs as 12th compared with 34th by the AT&L PMs. However, the true difference in the criticality scores (based on testing the difference between the mean values) is not statistically significant. The criticality rankings must be analyzed in the context of each sample group's overall spread of scores, theoretically ranging from a minimum value of 1 (least critical) up to a maximum value of 5 (most critical). Figure 5 shows this difference across all 36

technical competencies based on the means of the two sample groups and their actual minimum and maximum values.

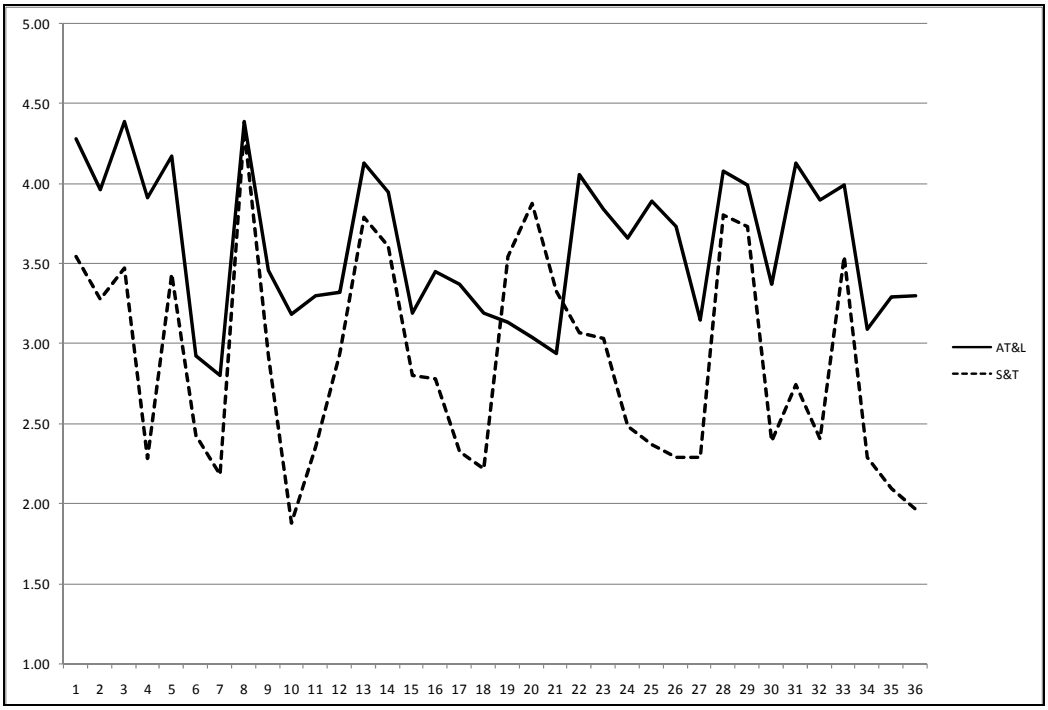


Figure 5: Technical Competency Response Ranges

In all but two cases, the AT&L PMs had higher criticality scores for the technical competencies in the model, and their spread across all 36 competencies ranged from 2.8 up to 4.39. The S&T PMs had a much larger spread across the competencies, ranging in criticality scores from 1.88 up to 4.34. Table 7 also presents the standard deviations (sd) for each of the competency criticality scores, providing insight into the amount by which participants within each study group vary or differ in opinion regarding the criticality of each competence. From these descriptive statistics, the research can use inferential

statistics to explore the investigative research question of whether the differences between the AT&L PM opinions and the S&T PM opinions are statistically significant.

Inferential Statistics.

A statistical hypothesis test was used to analyze the significance in the difference between the means of each competency's criticality scores. As explained in the methodology section of Chapter 3, before proceeding with a significance test, four conditions had to be assessed (McClave, Benson, Sincich, 2005:486):

- independence or dependence of the samples
- random or not random selection of the samples
- normal or abnormal distribution of the data
- equality or inequality of the variances

The study samples were independent and addressed the purposive lack of random sampling, but the normality of the distributions and equality of the variances needed further analysis. Original data was not available to test these conditions for the AT&L samples, but because the sample sizes are considered 'large' [(n_1=65-69) $\geq$ 30] the research can proceed based on the Central Limit Theorem which "guarantees that the sampling distribution of ($\overline{X}_1$ - $\overline{X}_2$) will be approximately normal regardless of the shapes of the underlying probability distributions of the populations (McClave, Benson, and Sincich, 2005:483). Although the S&T sample size is also considered 'large' [(n_2=41) $\geq$ 30], the conservative approach is to still test for normality with data available.

Testing normality of the S&T sample distributions using mathematical analysis, specifically the Shapiro-Wilk test, resulted in *p*-values < .05 (rejection region) for 32 of

the 36 technical competencies, with 20 of those resulting in *p*-values < .01. However, a drawback to the Shapiro-Wilk test when sample sizes are larger is the "tendency to get significant results from small deviations in normality—thus masking whether the deviation from normality is enough to bias statistical procedures (Field, 2005:93). Therefore, balancing mathematical analysis with graphical analysis is useful. From analyzing histograms, stem-and-leaf, and Q-Q Plot displays of the distributions, some of the frequency distributions suggest slight to strong skew: 16 skewing right—or positive, and 5 skewing left—or negative; with 3 suggesting possible bi-modal distributions. However, in most of these graphical displays, the Q-Q Plots appeared approximately normal. Thus, it is worth noting the distributions are not all consistently normal and therefore might benefit from additional exploration as to why not; however, by applying the standards of the Central Limit Theorem based on the large sample size, the data can meet the assumption of approximate normality for purposes of applying the t-test for statistical significance.

The final condition for using statistical significance tests was the assumption of equality or inequality of the two variances. Looking at the results in Table 7, the variances were obviously not equal. However, the 2-tailed F-distribution test, based on the ratio of the two variances, was necessary to determine which formula to apply for degrees of freedom (v) to use in combination with the test-statistic for analyzing the probability (*p*-value) of statistical significance between each competency's criticality scores.

Therefore, once all four of the conditions were addressed for use of the t-test, the *p*-value was computed using a 2-tail test as shown in Table 7, with 30 of the 36 having statistically significant difference in their means: 5 having statistical significance at the .05 level, and 25 having statistical significance at the .01 level. The competencies without any statistical difference in the criticality scores between the two sample groups are presented in Table 8. Communications Management & IPT/IPPT Process scored the highest in both sample groups. The next three competencies—two Contracting-related competencies and Technical Process—were within the top third tier of both sample groups. The last two—Systems Integration and Identify & Protect Promising Technologies—were ranked very differently, but did not have statistically significant differences between their mean criticality scores.

Table 8: Technical Competencies without Statistical Significance

TECHNICAL COMPENTENCY TITLES		S&T Results				AT&L Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p*-value)
TC 8	Communications Management & IPT/IPPT Process	41	0.79	4.34	1	1	4.39	0.71	69	.74814
TC28	Contract Approach, Requirements & Supporting Documents, Prepare & Issue Solicitation	41	1.01	3.80	3	7	4.08	0.75	68	.13427
TC29	Source Selection, Contract Award, Contract Administration, & Contract Closeout	41	0.84	3.73	5	9	3.99	0.79	69	.11626
TC14	Technical Process	41	1.03	3.61	6	12	3.95	0.71	68	.06772
TC21	Identify & Protect Promising Technologies	41	1.01	3.33	12	34	2.94	0.96	67	.05105
TC12	System Integration	41	1.30	2.94	16	23	3.32	0.88	68	.10273

The next set of technical competencies (five total) did have statistically significant differences at the .05 level between their mean criticality scores, as shown in Table 9:

Technical Competencies with Statistical Significance at the .05 Level. One of the technical competencies in this set—S&T Goal, Program Considerations, & Technology Engineering—was rated "more critical" by S&T program managers than traditional acquisition program managers. The five others were rated "less critical" by the S&T program managers, the most surprising of which was Technical Management Process. However, across the total ratings by the S&T group it ranked 4th out of 36, further demonstrating how the S&T group generally gave lower ratings across the whole set of competencies.

Table 9: Technical Competencies with Statistical Significance at the .05 Level

TECHNICAL COMPENTENCY TITLES		S&T Results				AT&L Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
TC13	Technical Management Process	41	0.86	3.79	4	5	4.13	0.6	68	.03305*
TC19	S&T Goal, Program Considerations, & Technology Engineering	41	1.08	**3.55**	7	31	3.13	0.9	68	.03908*
TC33	Financial Reporting & Oversight, Dpt/Agency Programming, Planning, & Budgeting System	41	1.04	3.55	7	9	3.99	0.8	68	.02202*
TC15	Systems Engineering Plan (SEP)	41	1.03	2.80	18	27	3.19	0.8	67	.04593*
TC 6	Joint/Cross Agency/International Progrma Magamenet by U.S. Executive Agency	41	0.98	2.43	22	35	2.92	0.9	65	.01099*

* p < .05

Competencies rated "more critical" by S&T PMs; all other rated "less critical"

The differences in criticality scores for the remaining 25 competencies were statistically significant at the .01 level, all rated by S&T PMs as "less critical" except for Transition Techniques which they rated as "more critical" and ranked 2nd (see Table 10).

Table 10: Technical Competencies with Statistical Significance at the .01 Level

TECHNICAL COMPENTENCY TITLES		S&T Results				AT&L Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
TC20	Transition Techniques	41	0.83	**3.88**	2	33	3.04	0.94	68	.00000**
TC 1	Requirements Process	41	0.88	3.55	7	3	4.28	0.64	68	.00002**
TC 5	Risk Management	41	0.86	3.44	10	4	4.17	0.75	69	.00002**
TC 3	Core Management Skills & Processes	41	1.07	3.43	11	1	4.39	0.6	70	.00000**
TC 2	Technology Development Strategy/Acquisition Strategy	41	1.00	3.28	13	11	3.96	0.78	70	.00039**
TC22	T&E Integration, Strategy, & Planning	41	1.10	3.07	14	8	4.06	0.67	67	.00000**
TC23	Development Test & Evaluation (DT&E)	41	1.17	3.04	15	16	3.84	0.75	67	.00023**
TC9	Configuration Management, Data Management, and Information Management	41	0.87	2.93	17	19	3.46	0.88	68	.00274**
TC16	Software Developmnet, Acquisition Management Technical Fundamentals, Quality & Measurement	41	1.17	2.78	19	20	3.45	0.83	67	.00208**
TC31	Business Financial Planning & Mngt; Cost Estimating	41	1.08	2.74	20	5	4.13	0.76	68	.00000**
TC24	Operational Test & Evaluation (OT&E) and Vulnerability Testing	41	1.26	2.49	21	18	3.66	0.75	67	.00000**
TC32	Earned Value Management (EVM)	41	1.07	2.40	23	14	3.90	0.88	69	.00000**
TC30	Performance-based Service Agreements	41	1.09	2.39	24	21	3.37	0.8	69	.00000**
TC25	Life-Cycle Logistic Management, Product Support, and Interoperabililty	41	1.12	2.37	25	15	3.89	0.83	67	.00000**
TC11	Information Systems: Network Security/Assurance, Architecture, Performance, Infrastructure Design, & System Mngt	41	1.05	2.35	26	24	3.30	1.01	68	.00001**
TC17	Sofware Process Maturity, Critical Requirements, Data Management, Software Support & Safety	41	1.00	2.33	27	21	3.37	0.83	68	.00000**
TC26	Life-cycle Cost Optimization, Data Management, & Integrated Supply Chain Management	41	1.00	2.29	28	17	3.73	0.91	68	.00000**
TC27	Logistics Footprint Minimization Life-cycle Assessment, & Disposal	41	0.88	2.29	28	30	3.15	0.85	67	.00000**
TC34	Industrial Base Assessment	41	0.88	2.29	28	32	3.09	0.92	66	.00002**
TC 4	Life-Cycle Cost (Total Ownership Cost) Management	41	0.94	2.28	31	13	3.91	0.72	69	.00000**
TC18	Software Reliability, Reuse and SIS Independent Expert Reviews	41	1.04	2.22	32	27	3.19	0.81	67	.00000**
TC 7	Market Research	41	0.83	2.18	33	36	2.80	0.7	68	.00015**
TC35	Plan Production	41	1.03	2.10	34	26	3.29	0.81	66	.00000**
TC36	Produce Product	41	1.13	1.96	35	24	3.30	0.82	65	.00000**
TC10	Information Resource Strategy and Planning, System Lifecycle, and Management/Technology Awareness	41	0.76	1.88	36	29	3.18	0.87	68	.00000**

** p < .01

Competencies rated "more critical" by S&T PMs; all other rated "less critical"

Overall Analysis.

The results and analysis show that the perceived criticality of certain program management competencies differs—at least between the traditional acquisition PMs from the AT&L study and the S&T PMs interviewed in this study. Of the 36 technical competencies from the AT&L study, 30 had statistically significant differences between the criticality ratings: S&T PMs rated two of those as "more critical" and the other 28 as "less critical." The two "more critical" competencies—Transition Techniques and S&T Goal, Program Considerations, & Technology Engineering—ranked 2nd and 7th respectively for S&T PMs; however, those happened to be two of the "least critical" and lowest ranked in the AT&L study—33rd and 31st respectively. Perhaps even more noteworthy than the individual scores, was the much lower spread of rankings for the 28 "less critical" competencies by the S&T PMs.

Two important observations emerged through the interview process potentially related to the 28 low-rated competencies. The first observation pertained to the respondents' selection of importance and frequency ratings: in several cases, respondents struggled with their selection based on lack of total agreement with the definitions and behaviors described under each competency heading. For example, references to "acquisition strategy," "milestone approval authority," or "earned value management" often elicited responses such as "we don't do that" or "that's only in the product centers." Thus, most respondents would automatically rate the competency much lower in importance and with either a "never" or "sometimes" frequency rating. In some cases, however, the respondents indicated they recognized that although the exact wording of

the descriptions consisted of more traditional acquisition terminology, the theory or intent was important and applied within S&T program management, albeit "by another name." Thus, their ratings for importance and frequency shifted upward.

The second observation that emerged through the SME interview process was the struggle that several of the S&T PMs seemed to have with the second question pertaining to frequency: "How often is this competency used in performing work?" Several of the interviewees sought clarification whether their responses should reflect "ideally" or "in reality." This implied disconnect was more directly stated by respondents who made comments such as "we really *should* be doing this more often in S&T but we don't." Comments such as this suggest an opportunity for examination or clarification with organizational leadership regarding the linkage between strategic vision and S&T program management performance expectations.

It is not known precisely how much influence the perceived ambiguities, alternate perspectives, or individual uncertainties could have shaped all the SME's ratings, especially without interviewer insight to the SMEs responding through asynchronous online interviews. However, the insights that were gained could possibly help explain the consistently lower 28 criticality ratings and/or the 16 positively skewed distributions. Lower importance and frequency ratings are not problems by themselves; the important question that needs addressing is "why?" If indeed certain competencies are less critical to S&T program managers, then that is very useful data to know when developing a competency model by which workforce management initiatives are shaped. However, if competencies are ranked lower due to construct validity issues—either by the definitions

themselves, ambiguity in the phrasing of the questions, or a disconnect in the "reality" of competency expectations versus application—then the reliability of the results becomes questionable.

Part III: Professional Competencies

The third part of this research study examines perceptions about the criticality of professional competencies to successful program management. The data collected were based on the same set of questions as the technical competencies—5-point Likert scales about the importance and frequency for each competency. The average of these two means computed the overall criticality score (mean) as shown and ranked in Table 11.

Table 11: Comparison of Professional Competencies

PROFESSIONAL COMPENTENCY TITLES		S&T PM Results				AT&L PM Results				Level of Signif.
		N	SD	Mean	Rank	Rank	Mean	SD	N	(*p* -value)
PC16	Oral Communication	41	0.59	4.48	1	1	4.51	0.90	69	.80955
PC27	Written Communication	41	0.81	4.38	2	17	4.10	1.09	69	.13074
PC 1	Accountability	41	0.70	4.37	3	10	4.30	1.02	69	.68927
PC19	Problem Solving	41	0.64	4.33	4	9	4.39	0.79	69	.66037
PC14	Interpersonal Skills	41	0.73	4.27	5	3	4.45	0.99	69	.27442
PC23	Team Building	41	0.76	4.09	6	2	4.46	0.78	69	.01507*
PC 5	Customer Service	41	0.91	4.02	7	15	4.14	0.97	69	.53258
PC10	Financial Management	41	0.77	**3.98**	8	20	3.46	1.38	69	.01359*
PC24	Technical Credibility	41	0.83	3.93	9	14	4.16	0.98	69	.18757
PC13	Influencing & Negotiating	41	0.87	3.91	10	3	4.45	0.74	69	.00145**
PC 6	Decisiveness	41	0.78	3.90	11	6	4.43	0.96	69	.00217**
PC11	Flexibility	41	0.85	3.90	11	3	4.45	0.92	69	.00205**
PC17	Partnering	41	0.85	3.88	13	6	4.43	0.74	69	.00091**
PC 4	Creativity & Innovation	41	0.87	3.87	14	16	4.12	1.16	69	.19590
PC21	Resilience	41	0.80	3.79	15	8	4.41	0.81	69	.00019**
PC 7	Developing Others	41	0.95	3.74	16	21	3.41	1.34	69	.13058
PC22	Strategic Thinking	41	0.92	3.72	17	11	4.25	0.96	69	.00513**
PC25	Technology Mngt	41	0.98	**3.61**	18	27	3.03	1.31	69	.00979**
PC 3	Continual Learning	41	0.84	3.59	19	22	3.35	1.37	69	.26567
PC 2	Conflict Management	41	0.91	3.57	20	17	4.10	1.09	69	.00775**
PC12	Human Capital Mngt	41	1.12	3.57	20	25	3.12	1.44	69	.06885
PC26	Vision	41	1.05	3.50	22	11	4.25	0.98	69	.00039**
PC 9	External Awareness	41	0.94	3.41	23	19	3.84	1.38	69	.05791
PC 8	Entrepreneurship	41	0.98	3.38	24	23	3.32	1.22	69	.78489
PC18	Political Savvy	41	0.98	3.37	25	13	4.23	1.00	69	.00003**
PC15	Leveraging Diversity	41	1.02	3.28	26	24	3.22	1.32	69	.78912
PC20	Public Service Motivation	41	1.09	2.73	27	26	3.07	1.31	69	.14821

* p < .05
** p < .01
Competencies rated "more critical" by S&T PMs; all other rated "less critical"

Descriptive Statistics.

The resulting rankings of the mean criticality scores according to SMEs from S&T program management are compared in Table 11 with those from the AT&L study group comprised of predominantly traditional acquisition program managers. The same underlying assumption applies regarding the prioritized rankings: the highest professional

competency presumably has the greatest affect on PM performance, theoretically appearing in an empirical study as having the largest regression coefficient (β).

The first observation about the descriptive statistics examines the means of the S&T PM criticality scores in relation to themselves. Again, in instances where the means are equal, the rankings reflect tie scores. The second observation compares the difference in the rank ordering of the means between the two groups. It should be reemphasized that the difference in the rankings of the means alone cannot determine statistical significance (such inferential statistical analysis follows under the next subheading.) For example, the 2nd highest ranked professional competency according to S&T PMs is "Written Communication." Despite its rank order only being 17th according to AT&L respondents, this difference is not statistically significant when the value of the two means—4.28 and 4.10, respectively—are tested.

Like the technical competencies, the research can benefit from additional insights to be gained by graphically analyzing the difference in the range of responses between the two sample groups, as shown in Figure 6. Unlike the stark differences that exist regarding the technical competencies, the professional competencies tend to align closer between the two sample groups. The next comparison to make between the sample groups is whether any differences between these mean scores are statistically significant, as determined through inferential statistics.

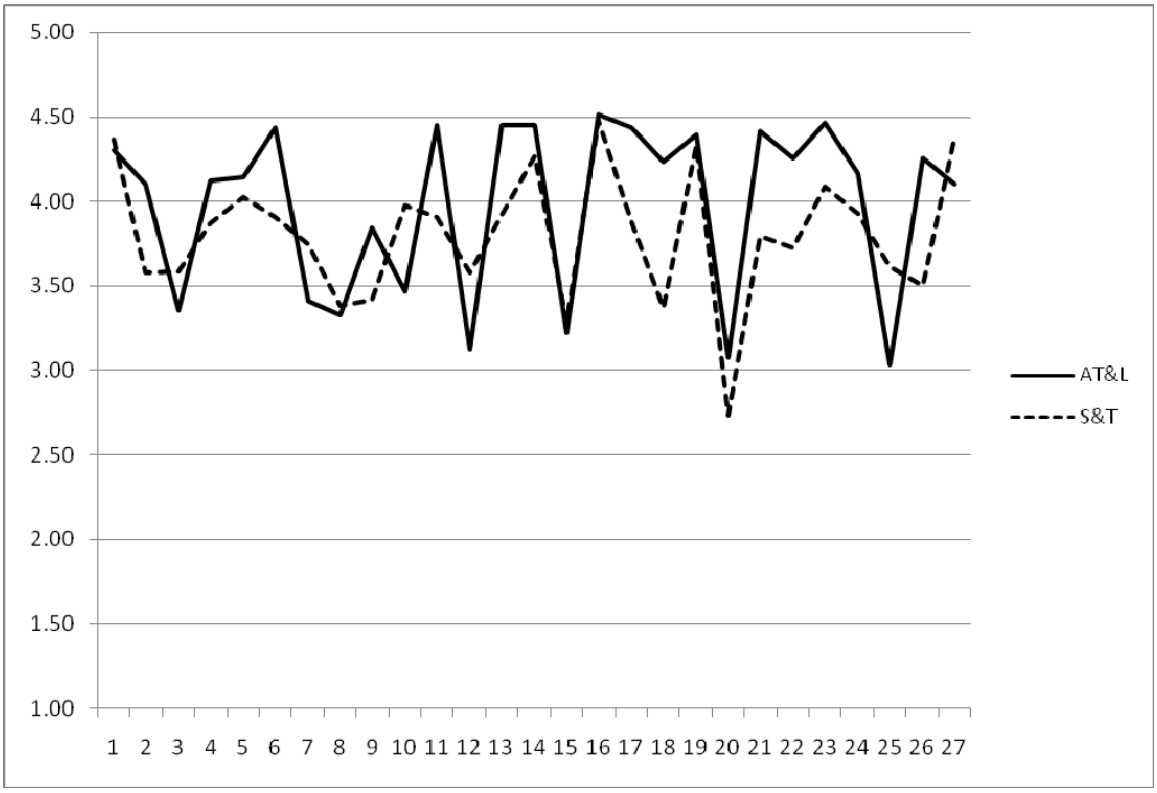


Figure 6: Professional Competency Response Ranges

Inferential Statistics.

The same statistical hypothesis test applied for the technical competencies was also used to test the professional competencies. In order to use the more conservative t-test, the four assumptions—independence, randomness, normality, and equality of variances—were addressed through the same analysis processes explained in Part II. With the proper degrees of freedom determined for use with the computed test statistic, the resulting probability (p-value) of statistical significance could be analyzed.

Of the 27 professional competencies, 15 had no statistical significance in the different ratings by the two sample groups, as shown in Table 12.

Table 12: Professional Competencies without Statistical Significance

PROFESSIONAL COMPENTENCY TITLES		S&T PM Results				AT&L PM Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
PC16	Oral Communication	41	0.59	4.48	1	1	4.51	0.90	69	.80955
PC27	Written Communication	41	0.81	4.38	2	17	4.10	1.09	69	.13074
PC 1	Accountability	41	0.70	4.37	3	10	4.30	1.02	69	.68927
PC19	Problem Solving	41	0.64	4.33	4	9	4.39	0.79	69	.66037
PC14	Interpersonal Skills	41	0.73	4.27	5	3	4.45	0.99	69	.27442
PC 5	Customer Service	41	0.91	4.02	7	15	4.14	0.97	69	.53258
PC24	Technical Credibility	41	0.83	3.93	9	14	4.16	0.98	69	.18757
PC 4	Creativity & Innovation	41	0.87	3.87	14	16	4.12	1.16	69	.19590
PC 7	Developing Others	41	0.95	3.74	16	21	3.41	1.34	69	.13058
PC 3	Continual Learning	41	0.84	3.59	19	22	3.35	1.37	69	.26567
PC12	Human Capital Mngt	41	1.12	3.57	20	25	3.12	1.44	69	.06885
PC 9	External Awareness	41	0.94	3.41	23	19	3.84	1.38	69	.05791
PC 8	Entrepreneurship	41	0.98	3.38	24	23	3.32	1.22	69	.78489
PC15	Leveraging Diversity	41	1.02	3.28	26	24	3.22	1.32	69	.78912
PC20	Public Service Motivation	41	1.09	2.73	27	26	3.07	1.31	69	.14821

The remaining 12 professional competencies did have statistical significance in the differences between their means, or criticality ratings, with 2 having statistical significance at the .05 level: Team Building which was rated "less critical" by the S&T PMs, and Financial Management which was rated "more critical" by the S&T PMs, as shown in Table 13. The increase in the Financial Management professional competency might be surprising to some researchers, considering the much higher-dollar program costs and high-visibility budget reviews required in traditional acquisition program management. However, one hypothesis for this result is that traditional acquisition PMs have strict oversight and guidelines limiting their actual control over funding decisions,

whereas S&T PMs have much broader latitude and thus individual accountability for their investment portfolio decisions.

Table 13: Professional Competencies with Statistical Significance at the .05 Level

PROFESSIONAL COMPENTENCY TITLES		S&T PM Results				AT&L PM Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
PC23	Team Building	41	0.76	4.09	6	2	4.46	0.78	69	.01507*
PC10	Financial Management	41	0.77	**3.98**	8	20	3.46	1.38	69	.01359*

* p < .05

Competencies rated "more critical" by S&T PMs; all other rated "less critical"

The remaining 10 professional competencies were found to be significantly different at the .01 level between S&T PMS and the AT&L PMs, as shown in Table 14. Technology Management was the only professional competency rated as "more critical" by S&T PMs, with the other nine rated as "less critical" by S&T PMs.

Table 14: Professional Competencies with Statistical Significance at the .01 Level

PROFESSIONAL COMPENTENCY TITLES		S&T PM Results				AT&L PM Results				Level of Signif.
		n	sd	mean	rank	rank	mean	sd	n	(*p* -value)
PC13	Influencing & Negotiating	41	0.87	3.91	10	3	4.45	0.74	69	.00145**
PC 6	Decisiveness	41	0.78	3.90	11	6	4.43	0.96	69	.00217**
PC11	Flexibility	41	0.85	3.90	11	3	4.45	0.92	69	.00205**
PC17	Partnering	41	0.85	3.88	13	6	4.43	0.74	69	.00091**
PC21	Resilience	41	0.80	3.79	15	8	4.41	0.81	69	.00019**
PC22	Strategic Thinking	41	0.92	3.72	17	11	4.25	0.96	69	.00513**
PC25	Technology Mngt	41	0.98	**3.61**	18	27	3.03	1.31	69	.00979**
PC 2	Conflict Management	41	0.91	3.57	20	17	4.10	1.09	69	.00775**
PC26	Vision	41	1.05	3.50	22	11	4.25	0.98	69	.00039**
PC18	Political Savvy	41	0.98	3.37	25	13	4.23	1.00	69	.00003**

** p < .01

Competencies rated "more critical" by S&T PMs; all other rated "less critical"

Part IV: Open-Ended Questions

The final part of the study involves a qualitative analysis of the responses to the three open-ended questions based on a grounded theory approach. Grounded theory is an inductive method of analysis, leading to the emergence of theories through consideration and analysis of the data (Patten, 2005:153). For this research, the goal of the three open-ended questions was to identify themes or issues which might further elucidate the S&T program management environment regarding the applications of competency modeling and its potential impact on future human resource management decisions. The results and analysis of the data are segmented by each open-ended question below.

Question 1.

The first open-ended question asked the respondents whether any competencies were missing from the current AT&L PM model that they considered to be critical to managing S&T programs. Of the 41 respondents, 24 (56%) indicated there were no additional competencies needing to be added; however, 17 (42%) made suggestions about elements they thought were missing from the model. The suggestions as originally worded by the respondents are provided in Appendix C: Comments to Open-Ended Question #1, with the attempt to group them by technical competencies and professional competencies.

Some of the respondents suggested additions that are already included in the AT&L competency model—either explicitly by the same name or implicitly by another name. For example, the suggestion to include a technical competency related to the development and use of architectures is already specifically addressed within four of the

technical competency definitions (TC1, TC11, TC14, and TC16). Redundant recommendations like this could be attributed to oversight or memory lapse—especially during an on-the-spot 30-minute interview. However, redundant recommendations should not be dismissed; rather, their inclusion amplifies the perceived importance or relevance of that particular competency. Such instances become important when fine-tuning a competency model for a specific target group.

Several of the other recommendations emphasize particular aspects of competencies that might be more important to S&T PMs. Whether analysis techniques, process controls, tech reports, or designs—the emphasis seems to be on demonstrating competencies in S&T-unique contexts. The terms "knowledge of" and "understanding of" specific subject areas were often mentioned. An important progression in incorporating such suggestions into an S&T PM model would be to translate them into actual behaviors or tasks required by the PM which outwardly demonstrate the intrinsic knowledge or understanding. In other words, what decisions or actions must an S&T program manager make that is critically dependent on a specific knowledge or understanding? Questions such as this are at the core of a "critical incident technique" interview, in which SMEs help define core competencies in terms of specific behaviors resulting in superior performance. Thus, initial results such as this underscore the importance of one respondent's overarching comment: "the formal definitions in the model are not right for S&T program managers; the concepts behind the competencies are okay" but they need specific refinement in the context of the S&T environment.

Question 2.

The second open-ended question asked of the respondents was whether they thought demonstrated proficiency in a set of S&T program manager competencies could serve as hiring and/or evaluation criteria. The intent behind this question was to extract opinions which might provide insights into the current environment affecting future implementation challenges. Currently, the application of competency modeling—at least within government—is primarily focused on workforce development initiatives. The three other uses for integrating competency models into workforce management—selection (hiring), performance appraisal, and succession planning—are just now being tested in pilot studies like the examples mentioned in Chapter II.

Of the 41 respondents, 37 (90%) expressed overall support towards a specialized set of competencies for S&T program management; however, their responses often contained qualifiers or caveats. Four respondents (10%) were definitely opposed to the idea. The individual responses are listed in Appendix D: Comments to Open-Ended Question #2, with an attempt to sort them by supportive or not-supportive categories:

Themes that emerged from the *supportive category* include:

- useful if tailored to the specific job:
  - by levels (entry, journeyman, advanced)
  - by technology programs (basic, applied, or advanced)

- useful as an augmentation—not an absolute or stand-alone
  - to help guide the process for better matching
  - to aid the decision-maker's judgment—not replace it

Themes that emerged from the *not-supportive category* include:

- difficulty in measuring / evaluating competencies
- lack of standardized or consistent application

An overwhelming majority recognized value in having a well-defined and specialized set of competencies unique to their profession. The greatest uncertainties remain in the challenge of quantifying and standardizing them consistently across the workforce.

Question 3.

The third open-ended question asked the respondents whether a technical degree (science, engineering, mathematics) is critical to proficient S&T management. The intent of this question was to assess opinions—based on past precedent and current culture—regarding the necessity and expectation for S&T managers to have technical degrees.

This topic generated a lot of discussion, often with the same respondent describing examples of successes and failures from both scenarios. However, when asked for a definitive "yes" or "no" response, 26 (65%) of the 40 SMEs (one did not commit to an answer) maintained that having a degree was important enough to the success of an S&T program manager to deem it a "critical" requirement. The general themes of concern from this group of respondents included: lack of understanding and insight to technical implications affecting programmatic decisions; over-reliance on contractor technical expertise; and lack of credibility—and thus impact—with the technical people being managed. However, 14 (35%) suggested it was not critical, although most agreed it would definitely be a benefit to the PM. Themes expressed from this group of respondents include: technical understanding could be gained through experience—not just a degree; the business manager with critical thinking and analysis skills could excel in S&T program management; a balanced team of expertise—the program manager with an engineering tech advisor—is a successful model. The specific

responses around this topic are presented in Appendix E: Comments to Open-Ended Question #3.

Currently a technical degree is a hiring and certification restriction—certified program managers cannot cross over to S&T program management without a technical degree (although military PMs can get assigned with or without technical degrees.) Thus, the development model is dependent on first recruiting scientists and engineers (S&Es), then training them to become program managers. These current practices align with documented success stories and related studies, such as the 1997 report on "The Perceived Importance of Technical Competence to Project Managers in the Defense Acquisition Community" which concluded that (technology-based) technical competence was "extremely important or absolutely essential" especially for projects in earlier acquisition phases "demonstrating and validating technology" (Grant, Baumgardner, and Shane, 1997:17). The long-term strategic concern over this paradigm centers on the projected diminishing pool of S&E candidates. Can the DoD afford to compete in the future for high-demand, limited-supply S&Es to manage its programs, or could / should the paradigm shift to hire from more abundant management pools to then train in technology-focused competencies?

V. Conclusions & Recommendations

The purpose of this exploratory research was to analyze competencies of program managers across the Department of Defense (DoD) Acquisition, Technology, and Logistics (AT&L) spectrum, specifically those that might be unique to Science and Technology (S&T) program management. Ongoing emphasis on the importance of developing the workforce for successful performance through competency-based initiatives is the number one goal in AT&L's 2007 Strategic Goals Implementation Plan. Thus, an overarching question of this research was whether program management competencies differ across AT&L, and if so, in which areas? To scope the research effort, an AT&L interim competency model became the measure by which to compare competencies for program managers (PMs) in traditional acquisition programs with PMs in S&T programs. The investigative questions guiding the research methodology were whether certain competencies were more or less critical for different types of program manager positions, and if so, were the differences statistically significant enough to warrant additional resources towards a specialized S&T PM competency model.

The results of the data collection and analysis using the AT&L interim PM competency model clearly show subject matter experts from traditional acquisition program management and those from S&T program management do rate the criticality of certain competencies differently. In 42 out of 63 instances (67%) the criticality scores of S&T PMs had statistically significant differences. Only four of those 42 competencies were rated "more critical" by S&T PMs: Transition Techniques; S&T Goal, Program Considerations, & Technology Engineering; Financial Management; and Technology

Management. The other 38 of the 42 (90%), were rated "less critical" with statistically significant lower scores than those of their acquisition PM counterparts. The qualitative analysis of the open-ended interview questions suggest that although the AT&L PM competency model may seem to have face validity, the definitions currently defining the competencies may not have adequate content validity for S&T program management. In other words, the competencies defined with the current behavior-based tasks do not represent the S&T program management context to elicit reliable results when applying the competency model to shape successful performance. Although there are inherent sampling biases within this study which limit the generalization of these results to the population at large, the results suggest that enough statistically significant differences exist to warrant further research into a specialized S&T PM competency model.

Whether under the direction of current federal mandates or by motivation to reap the best return on human capital investment, the DoD cannot afford *not* to ensure the accuracy and reliability of the competency models by which it will recruit, develop, and retain its workforce. The process for developing the competency models aligns with best practices across literature; applying the resources to ensure the validity of individual competencies within those frameworks will rely on the commitment of each AT&L functional leadership. According to Michael Ayers, 3M workforce management consultant and CEO of The Commonwealth Practice, "getting a firm grip on competencies will permit your organization to have richer conversations about the demands it is facing in a changing environment…but doing it effectively requires the courage to look at the current situation honestly and the courage to own the responsibility for creating the future that the organization wants" (Ayers, 2001:2).

Appendix A: Structured Interview

Analysis of Competencies for Managing Science & Technology (S&T) Programs

Introduction

Thank you in advance for volunteering to share your expertise based on your personal experience of having managed DoD S&T (aka R&D) programs, or having supervised STMs who do. Participation criteria: recognized by your organization as a "superior-performer" subject matter expert and have at least two years of experience. No personally identifiable data will be collected, the nature of the research is non-controversial, and your inputs will only be disclosed in a consolidated format. You have the option to discontinue participation at any time without any adverse action. It should take 30 minutes or less.

This research is based on the 2006-2007 Competency Model developed for the Office of the Under Secretary of Defense Acquisition, Technology, and Logistics (OSD(AT&L)); sponsored by HQ Air Force Material Command (AFMC/A5S) in alignment with ongoing Strategic Workforce Management Initiatives; and endorsed by AFRL/DP. The results are broadly relevant to workforce development & certification, education & training curriculum, and assignment considerations; they are specifically relevant to the Individual Development Plans (IDPs) of S&T employees and their supervisors.

Instructions

Please complete the experience data in Part I. In Parts II & III you will be asked to review the definitions/behaviors for each technical competency (36) and professional competency (27) and then select a response to the three same questions about each competency. Part IV includes three open-ended questions; you may use as much space as necessary to explain your responses.

I. TOTAL EXPERIENCE in **DoD S&T** (mark all that apply; **highlight most recent status held**)

As a Military Member

Years Experience	< 2 Years	3-6 Years	7-12 Years	> 12 Years
Managing S&T/Supervising STMs	_____	_____	_____	_____

As a Government Civilian

Years Experience	< 2 Years	3-6 Years	7-12 Years	> 12 Years
Managing S&T/Supervising STMs	_____	_____	_____	_____

As a Government Contractor

Years Experience	< 2 Years	3-6 Years	7-12 Years	> 12 Years
Managing S&T/Supervising STMs	_____	_____	_____	_____

APDP Certifications: (indicate all areas that apply)

Level I: _____

Level II: _____

Level III: _____

In S&T management, I'm considered:

_____ Entry Level (Beginner)

_____ Journeyman Level (Intermediate)

_____ Expert Level (Senior)

Degree(s): Engineering_____ Science_____ Mathematics_____

Other(s)_____

Years in AFRL Orgs (mark all that apply; **highlight most recent**): RD_____; RH_____; RI_____; RX_____; RW_____; RZ_____; RY_____; RB_____; RV_____; AFOSR_____; HQ_____

Other S&T-affiliated Org(s): _____

COMPETENCY QUESTIONS 1/20

II. TECHNICAL COMPETENCIES

1. **Requirements Process**: (a.) identify / analyze / prioritize needs: prepare a Functional Needs Analysis to compare alternatives, identify capability gaps & redundancies, reflect inefficiencies, & address priorities while defining an integrated architecture of multiple views which facilitate integration and promote interoperability across capabilities and among related integrated architectures; (b.) define user needs and constraints: to include performance parameters, objectives, & thresholds; affordability, scheduling, & technical constraints; and environmental issues while performing tradeoffs

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

2. **Technology Development Strategy / Acquisition Strategy**: (a.) technology development, acquisition, & management strategies: prepare a Technology Development Strategy for milestone approval authority no later than the completion of a Concept Refinement Phase; prepare an Acquisition Strategy for milestone approval authority no later than the completion of a Technology Development Phase to include a plan for total life-cycle system management, contracting, and sustainment; (b.) conduct project/program coordination with users, MDAs, industry, etc.; (c.) track development of AoA exploring numerous conceptual solutions towards concept refinement phase and technology development strategy with justification for formal initiation of acquisition program; (d.) ensure development of business partnerships between PM and PCO built on a successful acquisition strategy

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

3. **Core Management Skills & Processes**: (a.) Phase Inputs/Outputs; Management Reviews: plan program scope, security measures, total Life-cycle system management addressing scheduled "Inputs" and "Outputs" for each phase to include internal & external project/program management reviews; (b.) Project Management Master Schedule: prepare/document program schedule via technology/methods using portfolio & project management software; (c.) WBS: prepare program & contract Work Breakdown Structures (WBS) and integrate with other processes/documents; (d.) Technical Reviews & Tradeoffs: conduct technical reviews and perform trade-offs; (e.) EVM Baseline, Six Sigma, Lean: oversee & coordinate Earned Value Management (EVM) baseline review processes, strategies, negotiations, while applying "lean" and "six sigma" skills as appropriate

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

4. **Life-Cycle Cost (Total Ownership Cost) Management**: (a.) prepare an estimate of TOC applying basic cost-estimating techniques/tools regarding management decisions; (b). develop/submit out-year financial plans & budget estimated in DoD format based on EVM processes

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

5. **Risk Management**: (a.) conduct risk assessments, identify risk events, perform risk analysis; monitor/report risk status; integrate risk management into routine management practices (b.) apply decision analysis in selecting/prioritizing risk handling options folded into a detailed Integrated Master Plan (IMP); (c.) employ risk management software for tracking, rating, & handling risk events, identifying critical paths, and determining probabilities of program completion dates and costs

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

6. **Joint/Cross Agency/International Program Management by single U.S. Executive Agency**: formulate, plan, implement, manage, track and evaluate joint, interagency acquisition projects/programs

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

7. **Market Research**: develop a market research strategy per Federal Acquisition Regulation (FAR) Part 10 and extends to dual-use technologies as applicable

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

8. **Communications Management and the IPT/IPPT Process**: (a.) Effective Communications & Media: employ oral/written skills for all internal/external briefings, communicating lessons learns, and application of public affairs policies; (b.) employ IPPD & IPT Process: maintaining open communication processes with staff, contractors, & supporting agencies while reinforcing team building, leadership, and empowerment; apply metrics principles of change management

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

9. **Configuration Management, Data Management and Information Management**: utilize knowledge of (a.) principles/methods for planning/managing the implementation, update, & integration of information system components; (b.) data management tools such as modeling, backup, recovery, warehousing, mining, disposal, and data standardization processes; (c.) where/how to gather, organize, & maintain information management systems

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

10. **Information Resource Strategy and Planning, System Life-cycle, and Management/Technology Awareness**: utilize knowledge of (a.) Capital Planning and Investment Control including requirements of CCA, OMB A-11 / A-130 / A-300 to include systems life cycle management concepts used in planning, developing, implementing, operating, and maintaining information systems; (b.) IM/IT Methods, Assessment, Development: principles, methods, & techniques of IM/IT assessment, planning, management, monitoring, & evaluation such as baseline assessment, interagency functional analysis, contingency planning, and disaster recovery; (c.) new developments & applications of IM / IT (policies, processes, methods, hardware, software, and telecommunications)

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

11. **Information Systems: Network Security/Assurance, Architecture, Performance, Infrastructure Design and System Management**: utilize knowledge of (a.) IM / IT certification and accreditation methods, tools, & procedures for developing information security system plans to prevent system vulnerabilities and provide/restore security of information systems and network services; (b.) IM / IT systems engineering to include architecture methodologies design and development along with typology of software, hardware, & network protocols and standards integrated with one another and associated controlling software; (c.) IM / IT performance measures and service-level agreements (SLA) to assess the quality, effectiveness, & practicality of IT systems

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

12. **System Integration**: utilize knowledge of the principles, methods, and procedures for installing, integrating, & optimizing information systems components including knowledge of system test & evaluation and software verification and validation for large-scale IM / IT procurements

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

13. **Technical Management Process**: (a.) Tech Plan/Assessment, Systems Engineering Methods: prepare/apply decision analysis method, technical plans & assessment, requirements management method, and technical data management plan for selecting alternatives, applying systems engineering processes properly, conducting technical reviews, providing traceability back to user-defined capabilities, & acquiring/accessing technical data; (b.) Integrate Risk Management Plan: integrate risk management plan/methods for systems engineering context examining risks of deviating from program plan design performance requirements with respect to other lifecycle issues such as manufacturing, operations, environment, safety, occupational health considerations, & support; (c.) Apply Config Management Methods: apply configuration management methods/practices for consistency of a product's attributes, resulting in a complete audit trail of decisions and design modifications; (d.) Interface Management: prepare/apply process for interface management to ensure interface definition & compliance among system elements and other systems

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

14. **Technical Process**: (a.) Working with the User: prepare & apply a requirements development process for working with the user to establish & refine operational needs, attributes, performance parameters, & constraints that flow from needed capabilities, then ensure all relevant requirements are addressed; (b.) Developing Logical Analysis Process: prepare/apply a logical analysis process to obtain sets of logical solutions to improve understanding of the defined requirements & their relationships; prepare/apply a process for monitoring & selecting design solutions that translate outputs of the requirements development and logical analysis process into alternative design solutions; (c.) Monitoring Physical Architecture: prepare/apply process for monitoring the Implementation process that actually yields the lowest level system elements in the system hierarchy, then incorporating the lower level system elements into a higher-level system element in the physical architecture; (d). Verifying Elements Meet Specifications: prepare/apply a process to monitor the verification process to confirm systems element meets the design-to/build-to specifications, then participate in the validation process; (e). Transitioning Element to Next Level: prepare/apply a process to move the system element to the next level in the physical architecture, or for end-item system, to the user

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

15. **Systems Engineering Plan (SEP)**: prepare and maintain a Systems Engineering Plan which will describe required engineering activities and address the who, what, when, where, why, and how of the applied systems engineering approach, including security

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

16. **Software Development, Acquisition Management Technical Fundamentals, Quality and Measurement**: (a.) Software Development Plan: plan, select, apply & conduct a development process, key plans/approaches, life-cycle reviews, and development methodologies; select programming languages and interpret/apply commercial/governmental off-the-shelf methods; (b.) Software Fundamental Application: apply software engineering fundamentals in the areas of architecture, hardware, COTS/ERP management processes, communications, networking, quality assurance methods, error density methods, and integration verification/validation methods; plan, develop, & employ software performance, management, & technical measurement methods, including capability maturity models & measurement examples

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

17. **Software Process Maturity, Critical Requirements, Data Management, Software Support and Safety:** plan, select, & apply process maturity models and maturity return on investment (ROI) methods; select safety, privacy & security requirement methods; apply data & net-centric data management process; develop support characteristics, support plan, & life-cycle plan; plan & apply safety issues, procedures, & tools

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

18. **Software Reliability, Reuse, and SIS Independent Expert Reviews:** regarding software reliability, select and apply reliability measurement methods, software RAM issues, & models; develop reuse considerations and discuss repositories; organize SIS expert reviews

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

19. **S&T Goal, Program Considerations, and Technology Engineering:** (a.) S&T Future Needs: investigate & track user needs; construct & plan a broad-based program spanning all Department/Agency relevant sciences & technologies to anticipate future needs and those not being pursued by civil or commercial communities while planning to ensure the conduct of S&T activities do not preclude/facilitate future competition; (b.) S&T Transition to Operational System: develop a program of long-range research regarding the implementation and transition of S&T and new methods into operational systems; gather & assess opportunities & evaluation of technical readiness for operational application

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

20. **Transition Techniques:** (a.) Anticipate Future S&T Needs: address user needs; maintain a broad-based program spanning all relevant sciences and technologies to anticipate future needs and those not being pursued by civil or commercial communities; (b.) S&T Transition to Operational System: develop a program of long-range research, the implementation & transition of science, technology, & new methods into operational systems; gather & assess opportunities & evaluation of technical readiness for operational application

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

21. **Identify and Protect Promising Technologies:** Apply a process for reducing the security risks of introducing these technologies into the acquisition process in laboratories and research centers, academia, and foreign & domestic commercial sources

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

22. **Test & Evaluation (T&E) Integration, Strategy, and Planning:** (a.) T&E Plan: develop a robust, integrated T&E strategy for developmental test and evaluation (DT&E) and operational test and evaluation (OT&E); develop a vulnerability test to validate system performance and ensure the product provides measurable improvement to operational capabilities; (b.) Event Driven, Realistic Testing: integrate modeling and simulation (M&S) activities with government and contractor DT&E, OT&E, vulnerability, interoperability, & performance testing into an efficient continuum in concert with the user & test communities without compromising rigor; ensure testing is event driven within the program's overall acquisition strategy; prepare T&E Report preparation and document these plans (coordinating with Acquisition Strategy) in comprehensive T&E Maser Plan (TEMP), including security; (c.) Minimize Test Cost: integrate the many aspects of T&E to optimize test scope and minimize cost

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

23. **Development Test & Evaluation (DT&E):** develop test to validate systems engineering; ensure Development Test will provide verification and validation of the systems engineering process and confidence that the system design solution is on track to satisfy the desired capabilities; ensure T&E strategy/plan is consistent with and complementary to the Systems Engineering Plan

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

24. **Operational Test and Evaluation (OT&E):** achieve maturity prior to Initial OT&E: apply department/agency process for IOT&E to preclude the item/system from entering IOT&E prematurely by ensuring it has demonstrated technical maturity under the conditions expected in the IOT&E; ensure final OT tests include vulnerability testing and that the tests are conducted under realistic conditions to determine effectiveness & suitability of the item

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

25. **Life-Cycle Logistic Management, Product Support, and Interoperability:** (a.) Life-Cycle Product Support: examine & implement innovative, alternative logistics support practices, including best public sector & commercial practices and technology solutions; establish logistics support program goals for cost, customer support, and performance parameters over the program life cycle; include as part of the Acquisition Strategy a program manager developed sustainment strategy for Life-Cycle Product Support; (b). Open Systems and Cross-Servicing: develop a modular open systems approach (MOSA) where interoperability is a key LCL facilitator, allowing the program manager to take advantage of shared government-wide capabilities in designing and implementing a product support strategy; consider long-term potential of Acquisition and Cross-Servicing Agreements (ACSAs); apply logistic risk mitigation analysis early in system development to reduce required resources and overall life cycle costs

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

26. **Life-Cycle Cost Optimization, Data Management and Information Management:** (a.) Life-Cycle Logistic Cost: develop total cost to the government of acquisition and ownership over the item's useful life; include the cost of development, acquisition, support, disposal, & all program decisions (trade-offs) affecting Life-Cycle logistics; (b.) Data Management: develop & apply a program life-cycle data management method for the item/system throughout its life cycle; plan/acquire/access/manage/use data throughout total system life-cycle; (c.) Support User with Life-Cycle Logistics: design & implement an integrated, synchronized, total-system, life-cycle logistics chain to meet user requirements; promote user confidence in the logistics process by building a responsive, cost-effective capacity to ensure users get needed material when needed with complete status information

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

27. **Logistic Footprint Minimization, Life-Cycle Assessment, and Disposal:** (a.) Engineer Minimum Log Footprint: minimize the logistical burden (footprint) an item/system will place on the user; (b.) Continuous Log Assessment: develop & apply a method to carry out ongoing lifecycle assessments of the fielded item/system including assessments that identify & properly address performance, readiness, ownership cost, & support issues, including pre/post deployment evaluations to assess system performance & support strategy and support technology insertion for continuous modernization & product affordability improvements; (c.) Disposal: prepare a plan early in the program for ultimate neutralizing of any harmful aspects of item/system and disposal once no longer useful

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

28. **Contract Approach, Requirements and Supporting Documents, Prepare & Issue Solicitation:** (a.) Business Partnership & Contract Plan: apply a process by which the efforts of the PM, PCO, and all other personnel responsible for contractual matter are integrated through a comprehensive plan for fulfilling agency needs in a timely manner and at a reasonable cost; develop overall contract strategy for managing the acquisition, coordination and development of the acquisition plan, including support of the exit criteria for each acquisition phase; develop a business partnership between the PM and PCO emphasizing successful acquisition strategy leading to program success; ensure potential and actual contractors, sub-contractors, & affiliated government organizations/offices have full comprehension of program definition plus procuring agency's organizational culture and organizational structure; (b.) Plan Solicitation: apply pre-award policies in accordance with Federal Acquisition Regulation (FAR) and key contract terms & conditions for solicitation; (c.) Pre-Award, SOW, Roles & Missions: apply pre-award policies per FAR; manage preparation of comprehensive program specification and statement of work (SOW) that fully & correctly defines the program, addressing roles & missions of the government and contractor

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

29. **Source Selection, Contract Award, Contract Administration, & Contract Close-out:** (a.) Source Selection: apply/support source selection criteria per FAR Part 15; (b.) Awards Process: support contract award process per FAR Part 15 – Contracting by Negotiation / PreAward, Award, & Post Award Notifications, Protests, & Mistakes; (c.) Contract Administration: support contract administrative actions per FAR Part 42 – Contract Administration and Audit Services, while addressing "base-lining" the contract as in Research and Technology Protection (RTP) actions and outlining the contracting officer representative (COR) and PM duties for administering contract requirements—e.g. contract modifications process, receipt of contractor change proposals and contractor financing requirements; (d.) Termination: support procedures for contract closeout per FAR Part 49 – Termination of Contracts

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

30. **Performance-based Service Agreements:** establish a negotiated baseline of performance with system users, and the corresponding support necessary to achieve that performance, from both commercial and/or organic support providers; utilize the baseline performance and negotiate the required level of support with the providers to achieve the desired performance at a cost consistent with available support funding

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

31. **Business Financial Planning & Management and Cost Estimating:** (a.) Total Cost / Performance / Affordability: apply Total Life Cycle Systems Management (TLCSM) which requires the PM to base major decisions on system-wide analyses and the lifecycle consequences of those decisions and on system performance & affordability; (b.) Cost Estimating Skills: apply cost estimating processes, methods, techniques, analytical principles, data, specialized costing, reconciliation processes with other estimates, and management applications

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

32. **Earned Value Management (EVM):** (a.) Apply EVM: apply EVM management policies, methodologies, & software for performance measurement of programs including: Technical Performance Measurement selection and tracking vs. scheduled data collection events; (b.) Apply Baseline Review: apply the Integrated Baseline Review (IBR) process; (c.) Prepare Corrective Strategies: apply analytical & evaluation techniques to determine effective program strategies when EVM indicators are yellow and/or red

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

33. **Financial Reporting & Oversight and Programming, Planning, & Budgeting System:** (a.) Employ Financial Management Systems: select & employ financial information system(s) in analysis tasks & report preparation intended for collecting, processing, maintaining, transmitting, and reporting data about financial events in support of financial planning or budgeting systems/documents; report cost information or support the preparation of financial statements; (b.) Agency Financial Management System: apply department/agency's policy/instructions for financial planning, programming, budget development & execution on a managed project/program that supports the development & decision making towards meeting internal/external financial management obligations

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

34. **Industrial Base Assessment:** know manufacturing resources; analyze international and domestic sources which can meet the required need as the primary sources of supply (consistent with relevant domestic preference statutes per FAR Part 25 – Foreign Acquisition)

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

35. **Plan Production:** apply pre-production management practices that will establish if the item/system has achieved the following: acceptable performance in development; T&E and operational assessment; a mature software capability; no significant manufacturing risks; manufacturing processes under control; acceptable interoperability; acceptable operational supportability; and demonstration the system is affordable throughout the life cycle, optimally funded, and properly phased for rapid acquisition

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

36. **Produce Product:** (a.) Low-Rate Production Decision: apply management practices leading to an adequate & efficient manufacturing capability and production (if applicable) of the minimum quantity necessary to provide production or production-representative articles for IOT&E; establish an initial production base for the system; permit an orderly increase in the production rate for the system, sufficient to lead to full-rate production upon successful completion of operational and vulnerability testing, where applicable; (b.) Standards for Production: apply appropriate recognized standards to evaluate product performance, i.e. NIST, ISO, ANSI

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

II. PROFESSIONAL COMPETENCIES

1. **Accountability**: Holds self and others accountable for measurable high-quality, timely, and cost-effective results; determines objectives, sets priorities, and delegates work; accepts responsibility for mistakes; complies with established control systems and rules

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

2. **Conflict Management**: anticipates and takes steps to present counter-productive confrontations; manages and resoles conflicts and disagreements in a constructive manner

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

3. **Continual Learning**: assesses and recognizes own strengths and weaknesses; pursues self-development

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

4. **Creativity and Innovation**: develops new insights into situations; questions conventional approaches; encourages new ideas and innovations; designs and implements new or cutting edge programs/processes

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

5. **Customer Service**: anticipates and meets the needs of both internal and external customers; delivers high-quality products and services; is committed to continuous improvement

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

6. **Decisiveness**: makes well-informed, effective, and timely decisions, even when data are limited or solutions produce unpleasant consequences; perceives the impact and implications of decisions

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

7. **Developing Others**: develops the ability of others to perform and contribute to the organization by providing ongoing feedback and by providing developmental opportunities to learn through formal and informal methods

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

8. **Entrepreneurship**: positions the organization for future success by identifying new opportunities; builds the organization by developing/improving products or services; takes calculated risks to meet organizational objectives

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

9. **External Awareness**: understands and keeps up-to-date on local, national, and international policies/trends that affect the organization and shape stakeholders' views; is aware of the organization's impact on external environment

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

10. **Financial Management**: understands the organization's financial processes; prepares, justifies, and administers program budget; oversees procurement and contracting to achieve desired results; monitors expenditures and uses cost-benefit thinking to set priorities

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

11. **Flexibility**: is open to change and new information; rapidly adapts to new information, changing conditions, or unexpected obstacles

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

12. **Human Capital Management**: builds and manages workforce based on organizational goals, budget considerations, and staffing needs; ensures that employees are appropriately recruited, selected, appraised, and rewarded; takes action to address performance problems; manages a blended workforce and variety of situations

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

COMPETENCY QUESTIONS 16/20

13. **Influencing/Negotiating:** persuades others; builds consensus through give and take; gains cooperation from others to obtain information and accomplish goals

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

14. **Interpersonal Skills**: treats others with courtesy, sensitivity, and respect; considers and responds appropriately to the needs and feelings of different situations

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

15. **Leveraging Diversity**: fosters an inclusive workplace where diversity and individual differences are valued and leveraged to achieve the vision and mission of the organization

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

16. **Oral Communication**: makes clear and convincing oral presentations; listens effectively; clarifies information as needed

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

17. **Partnering**: develops networks and builds alliances; collaborates across boundaries to build strategic relationships and achieve common goals

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

18. **Political Savvy**: identifies the internal and external politics that impact the work of the organization; perceives organizational and political reality and acts accordingly

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

19. **Problem Solving**: identifies and analyzes problems; weighs relevance and accuracy of information; generates and evaluates alternative solutions; makes recommendations

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

20. **Public Service Motivation**: shows a commitment to serve the public; ensures that actions meet public needs; aligns organizational objectives and practices with public interests

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

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21. **Resilience**: deals effectively with pressure; remains optimistic and persistent, even under adversity; recovers quickly from setbacks

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

22. **Strategic Thinking**: formulates objectives, priorities, and plans consistent with the long-term business and competitive interests of the organization in a global environment; capitalizes on opportunities and manages risks

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

23. **Team Building**: inspires and fosters team commitment, spirit, pride, and trust; facilitates cooperation and motivates team members to accomplish group goals

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

24. **Technical Credibility**: understands and appropriately applies principles, procedures, requirements, regulations, and policies related to specialized expertise

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

25. **Technology Management**: keeps up-to-date on technological development; makes effective use of technology to achieve results; ensures access to and security of technology systems

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

26. **Vision**: takes a long-term view and acts as a catalyst for organizational change; builds a shared vision with others; influences others to translate vision into action

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

27. **Written Communication**: writes in a clear, concise, organized, and convincing manner for the intended audience

What is the degree of impact this competency has on job performance?

(1) Not Important; (2) Somewhat Important; (3) Important; (4) Very Important; (5) Extremely Important

How often is this competency used in performing work?

(1) Never; (2) Sometimes; (3) Often; (4) Frequently; (5) Very Frequently

At what point in your career did you FIRST use this work function to perform your job?

(1) Entry; (2) Journeyman; (3) Senior/Expert; N/A

IV. OPEN-ENDED QUESTIONS:

(1) Are there any competencies missing from this set that you think are critical to managing S&T programs? If so, what?

_____
_____
_____

(2) Could demonstrated proficiency in a set of STM competencies serve as hiring evaluation criteria? Why/Why Not?

_____
_____
_____

(3) Is a technical degree (e.g. science, engineering, mathematics) critical to proficient S&T management? Why/Why Not?

_____
_____
_____

COMPETENCY QUESTIONS 20/20

Appendix B: S&T Manager (STM) Course Competencies

STM 201 – INTERMEDIATE S&T MANAGEMENT COURSE
1. Assess the Science and Technology Manager Career Path requirements 2. Explain the Defense Systems Acquisition Framework with regard to technology transition. 3. Summarize the impact of the business environment on technology transition 4. Given specifics of critical technologies, classify them according to the nine levels defined in the Technology Readiness Levels (TRL) 5. Assess the Future Naval Capabilities process 6. Compare the various technology transition processes 7. Explain the approach used by the Army to transition technology 8. Summarize DARPA's role in technology transition 9. Analyze the benefits of the Applied Technology Council approach to technology transition 10. Discus the role of the DoD Office of Technology Transition 11. Discriminate between industry and government mechanisms to transition technology 12. Develop a technology transition checklist 13. Apply effective technology transition practices

STM 302 – ADVANCED S&T MANAGEMENT COURSE

1. Identify and explain the primary objectives of each phase and milestone of the DoD Acquisition Process Model

2. Explain the principles of Science & Technology transition, the acquisition lifecycle, total ownership costs, the S&T – acquisition interface, and S&T transition management objectives

3. Demonstrate an understanding of the technology engineering management process to create Defense Capabilities for existing and future requirements

4. Develop integrated architectures for DoD systems and understand the interoperability certification process

5. Given an acquisition scenario within the IPPD environment, the student will be able to develop and present the outputs of the systems engineering process

6. Given an acquisition scenario within the IPPD environment, the student will be able to identify the key activities necessary to implement the systems engineering process

7. Identify the benefits and pitfalls in international acquisition from an S&T manager's perspective

8. Evaluate organization, communication and teaming techniques that facilitate Integrated Product and Process Development in the Science & Technology program environment

9. Given a technology program scenario, develop requirements and metrics for managing the team, affordability, technology, cost & schedules

10. Given an overview of alternative evaluation techniques, identify their opportunities and potential value for use in Technology project management

11. Prepare for the acquisition of a Software Intensive System by understanding the lessons learned, the government regulations and guidelines, and the relevant system definitions

12. Given a notional software-intensive system, institute appropriate software management plans using the "16 Best Practices" tenets to address AT&L/S&T Software Intensive Systems (SIS) management concerns

13. Given a requirement to acquire a new start S&T software-intensive system, students will be able to determine the ability of contractors to provide on-time within budget systems containing high quality mature software

14. Given a scenario, the student will correctly distinguish the role of Test & Evaluation in the acquisition and systems engineering processes\

15. Apply the DoD Test and Evaluation process to S&T programs and contribute to the development of test and evaluation master plans in a test IPT environment

16. Identify a Test & Evaluation strategy for alternative acquisitions, such as Non-Developmental Items (NDI), Commercial Items & non-traditional acquisitions such as Advanced Concept Technology Demonstrations (ACTD)

17. Given a technology program scenario, develop requirements and metrics for managing the team, affordability, technology, cost & schedule activities

18. Analyze key issues related to transitioning technology to acquisition programs, evaluate alternative methods to address these issues and recommend steps that will lead to success

Appendix C: Comments to Open-Ended Question #1

"Are there competencies missing from this set that you think are critical to managing S&T programs?

Technical Competencies

- Analysis techniques: statistical process control, experimental design, forecasting, systems thinking—all tailored to technology-specific S&T fields
- System of systems integration and the development and use of architectures
- Reporting scientific results and applied science: turning them into peer-reviewed/DTIC reports
- Knowledge of and familiarity with computer/scientific software
- Operational understanding: development activities related to operators in the field for focusing on priorities most important to an operator
- Knowledge of how systems/technologies are used/deployed by users
- Knowledge of working with supporting functional: finance (FM), contracting (PK), and other technology directorate supporting functions
- Understanding of ethical values or implications unique to various technology areas: chemical/biological weapons, stem cell research, safety & human rights, environmental
- Technology-specific expertise unique to the S&T environment in which one is working
- Complex thinking: being able to break down a complex issue into manageable pieces

Professional Competencies:

- Marketing skills: advocate for program development and technology transition support to broad audiences
- Team integrity/trust: sharing the right information with the right people at the right times
- Follow-through: complete agreed actions and report the results back to those who need to know
- Accuracy of recommendations: knowing how to ensure guidance given is reliable
- Enthusiasm about the program being managed: caring about the success of the program with a commitment to delivering results
- Balance: self-awareness of balancing strengths and weaknesses to avoid extreme management styles
- Mentorship: how to mentor and guide others to enable them to better achieve full potentials and better contribute in areas of inexperience
- Finesse: convincing people to "do your bidding" even while they think they are working to their own advantage
- Charisma: inspiring others to follow even through undesirable situations

Appendix D: Comments to Open-Ended Question #2

"Could demonstrated proficiency in a set of STM competencies serve as hiring evaluation criteria?"

Supportive

- especially helpful for identifying the more critical factors relating to the specifics of each job
- being able to ask a candidate for an example of an experience where they have demonstrated particular desired competencies could provide good indicators of their understanding and proficiency
- very valuable inputs to improve the hiring process
- competencies could serve as a hiring criteria in order to get the right people into particular S&T management jobs
- a competency model supports a good interview process: discerning how competent an individual is in the areas expected to perform
- competencies could and should be used in the hiring process to help avoid hiring unqualified managers
- demonstrated proficiency should be considered a part of any hiring activity
- professional competencies (working with others, team player, communication skills, accountability) are just as important competencies to know about a person – just as important as technical competencies
- definitely useful, but the competencies would need to be tailored for the various S&T positions (for example, differences in basic, applied, and advanced S&T development phases)
- using a competency model could help in the "weeding out" process
- useful for identifying training & gap-filling needs
- competencies are useful for hiring and evaluations at the mid-upper levels, but would be difficult at the entry levels
- competencies could be used, but they are difficult to evaluation
- competencies could be used for hiring, but not for evaluation
- competencies could be used partly, but not exclusively
- the application of a competency model or process would be extremely helpful if able to better identify new hires who are already proficient in key areas
- it seems we're already doing it this way, aren't we?
- useful for assessing basic PM skills/tasks….something like a basic skills exam
- integrating competencies into the interview process would help gage a person's decisiveness, problem solving, flexibility, resiliency, and interpersonal skills; the technical/technology competence should be guaranteed first
- useful if tailored to fit the specific jobs being targeted
- the use of competencies for hiring / evaluation is a best practice rather than the current government standard; it would be very useful if consistently developed and applied

- integrating the professional competencies along with the technical competencies is an important hiring strategy in evaluating how well the candidate would fit into the existing team
- demonstrated competencies should be one of the various criteria to consider when hiring, since they are relevant to specific job performance
- demonstrated competencies should be a consideration, but not necessarily a firm requirement since a very capable candidate with the potential to perform well but not proven experience could be overlooked
- useful only as a decision aid to the hiring authority—not as a replacement for individual judgment
- they must be carefully tailored to the position—not a 'must have all or out' requirement
- use of particular competencies depends on the program & position: different competencies or degrees of proficiency depending on basic, applied, or advanced S&T programs
- entry levels should only focus on technical competencies; advancement into leadership positions should hone the professional competencies
- does demonstrated proficiency mean a test?
- TRL levels require different balance across technical & professional competencies
- (x5) depends on the level of hiring: entry levels probably don't have demonstrated technical competencies, perhaps professional competency

<u>Not Supportive</u>

- competencies are an overly logic-based approach lacking the humanistic dimension
- if "demonstrated proficiency" equates to "experience," then the selection process could become overly rigid, overlooking understanding acquired through academic exposure
- a "cold" criteria set could not be used to do final evaluation
- the Air Force's track record on measuring things like competencies has been very poor
- measuring competencies for use in hiring would end up motivating the wrong behavior—become a pro at gaming the "test" to show they have such competencies
- competencies are too difficult to evaluate – how would they be measured & applied consistently?
- (x3) they should not be used for evaluation due to lack of consistency
- past (and diverse) job experience is more useful

Appendix E: Comments to Open-Ended Question #3

"Is a technical degree (e.g. science, engineering, mathematics) critical to proficient S&T program management?"

"Not necessarily" category:

- need is more for technical competency – not just a degree
- managing S&T people – not really, people skills are needed
- not critical; but helpful
- some individuals have been successful in S&T management without a technical degree
- no, not with combination of operational and S&T experience/expertise
- as long as the person is technically competent, a management degree is just as effective or maybe even more so in the ability to effectively run a program, serving as the manager and not the chief engineer
- picking a solid team can overcome any perceived shortfall
- not if the individual is a critical thinker who can ask basic questions regarding purpose, logical approach, and expected results; would benefit from having a strong individual in a Tech Advisor role, who can provide technical oversight to ensure quality science is produced and especially provide staff mentoring in scientific methods, sound research, and professional association networks
- no, have known some [S&T PMs] without [technical degrees] who are very good: ability to learn, being flexible, and being persistent in finding out info are more important
- many S&Es aren't good managers; education is often theory, not the application
- no, one of the best technical managers had a history degree; he made up for his lack of technical education with decades of experience in the operational world doing operational test and tactics development, providing him with the "vision" for what was needed from the technical people in his organization.
- You still need core technical excellence in the organization, but diversity of backgrounds stimulates creativity
- the lack of a technical degree can sometimes be an advantage: a PM won't get hung up on the technical details and can instead focus on other important programmatic matters
- a "team" consisting of a strong program manager "business type" combined with a strong technical advisor can be just as good if not better
- a technical degree is not critical, but the person would have to have some knowledge and understanding of the technology being developed or they would need a strong technical lead they could trust implicitly to ensure the right technology is being developed
- no, it's more important to be able to understand how business processes work and how the technology fits

"Absolutely" category:

- candidates should be able to apply scientific methods, understand scientific and engineering documents, literature, and practical applications of engineers
- yes, in order to be viewed as competent as well as having some personal experience to make decisions
- yes, without a solid technical competency we are incapable of effectively leading the development programs and are forced to rely 100% upon the contractor for critical technical decisions which is biased to benefit the contractor's financial position
- technical knowledge of the particular competency is critical to run a good program and get beneficial results for the AF
- yes, for first and second level supervisors in order to properly find new work, allocate it efficiently, evaluate its progress, and make go/no go decisions on the direction of the effort; "senior leaders" (at the 2-ltr level) could get away with a non-technical degree, but must score well on the competencies listed and should be surrounded by expertise with higher degrees (e.g. a tech advisor)
- yes, S&T management is very related to understanding the underlying science and engineering of the program
- yes, a technical background is essential to being able to direct and lead the highly technical individuals who are usually part of an S&T program; without a fundamental technical understanding (based upon a tech degree), the S&T manager will find it difficult to communicate the technical details to non-tech folks and will find it difficult to communicate with/understand the S&Es they lead
- yes, initially to give the S&T PM credibility and some confidence in the job
- yes, you need technical experience to understand and guide the work of others all the way to the commander
- yes, it would be difficult for somebody without at least a basic working knowledge of technical terms to effectively manage an S&T program
- STMs should not rely solely on the judgment of advisors: they may need to choose between conflicting advice from different advisors or be able to devise their own best course of action; they also need to understand why something is a technical challenge or physical impossibility
- yes, a technical degree usually means that the individual will be a good problem solver and is fairly logical in their thought process
- yes, a technical degree is critical to S&T management because the S&T manager has to understand the technology being developed or risk providing ineffective management to the project.
- yes, for problem solving
- yes, absolutely in order to be technically savvy, ask technical questions and understand trades and problems within context
- yes, a technical degree is essential to advanced S&T work
- yes, provides basic core principles in science, process (design), and logical thinking
- yes, less difficult to "cross train" into various technical management and financial disciplines than vice-versa

- yes, most of what we manage in government is technical and without capacity to understand "tech," the manager is not very effective and is vulnerable
- yes, a technical degree gives a person the background to understand the technical nature of the work and visualize its impact on real world operations; someone without a technical degree would have more difficulty understanding the technical value and making decisions to continue or stop a given technology program
- yes, having a technical degree, as a minimum, gives credibility with a contractor
- yes, technical management relies on sound technical decisions; a technical manager needs the tech background to understand, lead, and represent the area
- yes, managing S&T requires basic knowledge of the management area (in this case it's managing S&T)
- yes, important to have technical background when making decisions such as funding decisions, manpower allocations, etc.
- yes, absolutely: those with said degrees won't respect or trust you; you need to be able to smell the BS

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Major Sidney Watson Goehring graduated from the United States Air Force Academy in Colorado Springs, Colorado, with a Bachelor of Science degree in English in 1993 and was commissioned into the United States Air Force.

In 1994, she was a Distinguished Graduate from the Defense Information School, Ft. Benjamin-Harrison, Indiana. Assigned to the 42nd Air Base Wing at Maxwell Air Force Base, Alabama, she served as Deputy Chief of Public Affairs for Air University. After earning a Master of Science degree in Adult Education from Troy State University Montgomery in 1996, she deployed to Saudi Arabia as Chief of Public Affairs for the 4404th Provisional Wing supporting OPERATION SOUTHERN WATCH. Stationed next at Randolph Air Force Base in San Antonio, Texas, from 1997-2000 she provided Public Affairs support for Headquarters Air Education and Training Command, also earning leadership awards while attending Squadron Officer School.

In 2000, she joined the faculty of the Department of English and Fine Arts at the United States Air Force Academy, Colorado Springs, Colorado. There she served as Assistant Professor, Course Director, Executive Officer, Honor Liaison Officer, and Assistant Director for the Department of Defense Executive Writing Program.

In 2004, Maj Goehring became an Acquisition Program Manager at the Air Force Research Laboratory, Wright Patterson Air Force Base, Ohio, serving as a Senior Strategic Planner and later the Wargaming Branch Chief. She was selected in 2006 for Professional Military Education at the Graduate School of Engineering and Management, Air Force Institute of Technology. Upon graduation, she will be awarded a Master of Science degree in Research and Development Management.

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14. ABSTRACT

The purpose of this research is to analyze competencies needed for successful program management of Research and Development (R&D) programs—also known as Science and Technology (S&T) programs within the Department of Defense (DoD). Current competency models are in development for the DoD Acquisition, Technology, and Logistics (AT&L) functional areas. Using an interim competency model developed for the Program Manager career field comprised of 36 technical competencies and 27 professional competencies, the research compares competencies' criticality scores rated by traditional acquisition program managers (PMs) with those rated by S&T program managers. In 42 out of 63 instances (67%) the criticality scores had statistically significant differences. Only four of those 42 competencies were rated "more critical" by S&T PMs; the other 38 of the 42 (90%), were rated "less critical" with statistically significant lower scores than those of their acquisition PM counterparts. The analysis of the open-ended interview questions suggests that although the AT&L PM competency model may seem to have face validity, the descriptions currently defining the PM competencies may not have adequate content validity for an S&T program management competency model, thus warranting further resources towards defining an independent competency model for S&T PM workforce management initiatives.

15. SUBJECT TERMS

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