# Systems Planning, Research, Development and Engineering (SPRDE) Workforce Competency Assessment Report

Brooke Lasley-Hunter • Alan Preston

Contributions by Molly McIntosh

CRM D0025191.A2/Final
August 2011

CNA
ANALYSIS & SOLUTIONS

Approved for distribution: August 2011

Henry S. Griffis
Director, Defense Workforce Analyses
Resource Analysis Division

This document represents the best opinion of CNA at the time of issue.
It does not necessarily represent the opinion of the Department of the Navy.

Distribution limited to DOD agencies. Specific authority: N00014-11-D-0323.
Copies of this document can be obtained through the Defense Technical Information Center at www.dtic.mil
Or contact CNA Document Control and Distribution Section at 703-824-2123.

**Copyright © 2011 CNA**
This work was created in the performance of Federal Government Contract Number N00014-11-D-0323. Any copyright in this work is subject to the Government's Unlimited Rights license as defined in DFARS 252.227-7013 and/or DFARS 252.227-7014. The reproduction of this work for commercial purposes is strictly prohibited. Nongovernmental users may copy and distribute this document in any medium, either commercially or noncommercially, provided that this copyright notice is reproduced in all copies. Nongovernmental users may not use technical measures to obstruct or control the reading or further copying of the copies they make or distribute. Nongovernmental users may not accept compensation of any manner in exchange for copies. All other rights reserved.

# Contents

Contents ..... i
Executive Summary ..... 1
Section 1: Background and model overview ..... 7
Research objectives ..... 8
Model components ..... 9
Model development ..... 10
Survey approval ..... 12
Section summary ..... 12
Section 2: Rating and analysis methodology ..... 13
Participation rates ..... 13
Methodology changes driven by participation rates ..... 14
Competency ratings ..... 16
Career level ..... 17
Analysis of importance ..... 19
Analysis of proficiency ..... 20
Analysis of retirement impact ..... 21
Analysis of employee intentions ..... 21
Data used for analysis ..... 21
Section summary ..... 23
Section 3: Workforce demographics ..... 25
Experience ..... 25
Military vs. civilian status ..... 27
Certification level ..... 30
Education ..... 31

Workforce community ..... 32
Other demographic and intentions data ..... 33
Section summary ..... 33
Section 4: Relative importance of competencies ..... 35
Important competencies by workforce community ..... 35
High importance competencies by workforce community ..... 40
Applicability of competencies to Systems Engineering and Program Management respondents ..... 42
Relative importance of competencies by certification level within the Systems Engineering and Program Management communities ..... 42
Section summary ..... 45
Section 5: Proficiency ratings ..... 47
Proficiency ratings of Systems Engineering respondents ..... 47
Proficiency ratings of Program Management respondents ..... 53
Frequency distribution of proficiency rating responses for Systems Engineering and Program Management respondents, by certification level ..... 59
Section summary ..... 59
Section 6: Retirement impact ..... 63
Predicted employee losses ..... 64
Predicted effects on proficiency ..... 65
Section summary ..... 72
Section 7: Intentions analysis ..... 73
Competency boost ..... 73
Advancement and mentoring intentions ..... 76
Section summary ..... 77
Section 8: Conclusion and next steps ..... 79
Appendix A: SPRDE Workforce Competency Model ..... 83
Appendix B: Responses related to career level ..... 89
Appendix C: Difference between employee and supervisor proficiency responses 91

Appendix D: SPRDE demographic and intentions questions ..... 93
Appendix E: Workforce demographic analysis continued ..... 99
Appendix F: Frequency distribution of proficiency ratings for the Systems Engineering and Program Management respondents, by certification level ..... 105
Systems Engineering: Level 1 ..... 105
Systems Engineering: Level 2 ..... 106
Systems Engineering: Level 3 ..... 107
Program Management: Level 1 ..... 108
Program Management: Level 2 ..... 109
Program Management: Level 3 ..... 110
Appendix G: Retirement analysis ..... 111
SPRDE and Navy civilian personnel data ..... 112
Estimating the probability of being eligible to retire ..... 113
Estimating the probability of retirement ..... 115
Appendix H: Intentions data ..... 119
List of Figures ..... 121
List of Tables ..... 123

This page intentionally left blank

# Executive Summary

The Director of Human Capital Initiatives (HCI) for the Department of Defense's (DoD) Acquisition, Technology, and Logistics (AT&L) workforce, supports the development of acquisition personnel and leaders, enabling them to make important business decisions that provide the best dollar value while supporting DoD agencies' missions. HCI initiatives include programs such as competency development and assessment. HCI's goals include improving acquisition workforce performance, making necessary investments in training, conducting trend analysis, and emphasizing the criticality of the acquisition workforce to DoD mission success.

HCI works in conjunction with the Defense Acquisition University (DAU) which supports the Department of Defense (DoD) and other Federal Agencies in the certification, training, and development of the acquisition workforce. This focus has become the impetus for a competency-based approach to optimize workforce effectiveness. In response to HCI's request, CNA is working with HCI and workforce representatives to develop competency models for each of the major career fields within the AT&L workforce. This report focuses on the competencies identified for the Systems Planning, Research Development, and Engineering (SPRDE) career field, which includes respondents in the Departments of Air Force, Army, and Navy as well as eleven 4th Estate agencies.

Together, HCI, SPRDE leadership and subject matter experts (SMEs), with guidance from CNA, developed and validated a model of performance consisting of competencies determined to be necessary to meet SPRDE's mission goals (presented in Appendix A). We used the model to create a competency assessment, in which we invited all SPRDE respondents (and their supervisors) to participate. Respondents reported on their (the employee's) proficiency on each competency element.

They also indicated how critical each competency element was to their job. Employees (not supervisors) indicated how frequently they perform each competency element and responded to 28 demographic and intentions questions.

The analyses in this report use data collected via the competency assessment to address five research goals: (1) to assess the current Systems Engineering capability of the SPRDE workforce, (2) to describe how those capabilities are distributed across DoD organizations and programs, (3) to project how those capabilities will be affected by departures, (4) to determine the potential of the current SPRDE workforce to boost the DoD's Systems Engineering capability, and (5) to develop a profile of the SPRDE workforce.

**Participation rates**

The SPRDE population consists of approximately 38,000 employees. Slightly more than 10,000 employees participated in the competency assessment across all workforce segments (services and 4th Estate agencies), which represents 27 percent of the SPRDE population. Fourteen percent of supervisors assessed employees, but only six percent of those assessments were of employees who also participated in the assessment.

**Workforce demographics**

We present the responses to demographic and intentions questions for the workforce segments relative to the SPRDE workforce as a whole. We found that the data we collected is highly representative of the SPRDE workforce. Our results closely match demographic data published in the AT&L Workforce Strategy:[1]

- We found the military (and civilian) percentages to be 94 percent (and 6 percent) which is the precise percentage found by AT&L in the population.

[1] https://acc.dau.mil/CommunityBrowser.aspx?id=360658

- We found that 57 percent of respondents were Level 3 certified which is similar to the 64 percent found by AT&L in the population.

- While we cannot calculate average years of service, averaging our responses using the mid-point years in the response categories provided, we found an average years of service of respondents consistent with the 15.9 reported in the 2009 AT&L data.

We need the 27 percent of the workforce that responded to be a random sample in order to extrapolate to the workforce as a whole. In the few demographic dimensions that we were able to explore, we found no major evidence that the sample is not random. However, caution should still be exercised in extrapolating these results to represent the entire workforce. These results **do** represent the 27 percent of the workforce who responded to the survey.

**Competency analyses**

In previous reports, we averaged employee and supervisor ratings and performed the competency analyses using the composite ratings. However, because of the low percentage of paired employee-supervisor responses we only analyzed employee responses in this report.

Analysis of employee responses suggests that the SPRDE competency model captures the competencies most pertinent to the Systems Engineering and the Program Management workforce communities. These two communities combined represent 63 percent of the SPRDE workforce. Hence, our importance and proficiency analyses focus on these two communities.

We found that the relative importance of competencies increases with increasing certification level for Systems Engineering and Program Management respondents. However, the number of competencies in each importance category does not necessarily increase with increasing certification level.

Competencies determined to be highly important to each community by certification level are presented in Figure 1.

Figure 1. Most important competencies for Systems Engineering and Program Management respondents

| | Level 1 | Level 2 | Level 3 |
|---|---|---|---|
| Systems Engineering | Requirements Analysis<br>Communication<br>Problem Solving<br>Professional Ethics | Requirements Analysis<br>Communication<br>Problem Solving<br>Professional Ethics | Requirements Analysis<br>Communication<br>Problem Solving<br>Professional Ethics<br>Validation<br>SE Leadership |
| | Level 1 | Level 2 | Level 3 |
| Program Management | SE Leadership<br>Communication<br>Problem Solving<br>Strategic Thinking<br>Professional Ethics<br>Technical Basis for Cost<br>Requirements Analysis | SE Leadership<br>Communication<br>Problem Solving<br>Strategic Thinking<br>Professional Ethics | SE Leadership<br>Communication<br>Problem Solving<br>Strategic Thinking<br>Professional Ethics<br>Technical Basis for Cost<br>Requirements Analysis<br>Stakeholder Requirements Definition<br>Implementation<br>Integration<br>Technical Assessment<br>Configuration Management<br>Risk Management<br>System of Systems |

Results indicate that Systems Engineering and Program Management respondents possess *intermediate* to *advanced* proficiency in all competencies of high importance and *intermediate* proficiency in most other competencies on average. However, individually, there are large groups of respondents that report lower than *intermediate* proficiency ratings in some competencies. Small percentages of respondents report *expert* proficiency at all levels of certification within both workforce communities. Mean proficiency values increase with increasing certification level and are highest for professional competencies.

Our retirement analysis predicts that at least 11 percent of the SPRDE workforce will retire over the next five years.[2] This loss will reduce average proficiencies in several highly important competencies. The top three high importance competencies that will be affected by the retirement of federal civilians are:

- Systems Engineering
    - Systems Engineering Leadership (~16 percent)
    - Problem Solving (~12 percent)
    - Professional Ethics (~11 percent).
- Program Management
    - Strategic Thinking (~14 percent)
    - Systems Engineering Leadership (~14 percent)
    - Professional Ethics (~12 percent).

Many respondents expressed intent to boost their proficiency in Systems Engineering Leadership. However, interest in other high importance competencies is low. For example, Systems Engineering respondents rated Problem Solving and Professional Ethics 22nd and 29th, respectively. Skill development should be focused in these areas. Program Management respondents ranked Professional Ethics 28th, another potential area for skill development.

These findings, in conjunction with our importance, proficiency, and retirement findings suggest that SPRDE management should place the development of professional competencies at a high priority.

---

[2] Our retirement estimates apply to federal civilian employees who participated in the assessment and who participate in either the Civil Service Retirement System (CSRS) or the Federal Employees Retirement System (FERS) retirement plan

In presenting our extensive analysis of competency data we did not explicitly identify proficiency gaps based on a standard. We present and discuss the data in ways intended to help leadership think about the current state of the SPRDE workforce. Given that no proficiency standards currently exist, we strongly encourage SPRDE leadership to set proficiency standards based on this baseline for future investments in gap closure strategies. Once standards have been set, results such as these can be used to discover existing or potential gaps at an individual and organizational level.

# Section 1: Background and model overview

Personnel challenges within the AT&L community must be addressed in order for the DoD to effectively perform its mission. As part of the AT&L workforce, the SPRDE Career Field is responsible for the application of interdisciplinary systems engineering principles to ensure that federal acquisition programs, supplies, and services are delivered on time, within cost, and meet performance requirements in support of U.S. war fighters and our allies.

*Systems engineering is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and total life-cycle balanced set of system, people, and process solutions that satisfy customer needs. Systems engineering is the integrating mechanism across the technical efforts related to the development, manufacturing, verification, deployment, operations, support, disposal of, and user training for systems and their life cycle processes. Systems engineering develops technical information to support the program management decision-making process.*[3]

Rapid changes in the acquisition environment, retirement eligibility of baby boomers, and potential talent shortages threaten the strength and stability of AT&L to meet its mission goals. Acquisition personnel are a key focus of government-wide initiatives to enhance recruiting, training, and retention.[4]

---

[3] ANSI/EIA-632-1999, Processes for Engineering a System & Defense Acquisition Guidebook, Feb. 19, 2010, 158-159

[4] Department of Defense, Acquisition, Technology & Logistics, *AT&L Human Capital Strategic Plan v3.0,* 2007.

This report presents the most recent assessment of the competencies of the AT&L SPRDE-SE/PSE career field (henceforth referred to as the SPRDE workforce), which consists of two closely related career paths: the Systems Engineer (SE) and Program Systems Engineer (PSE) career paths.

The Office of Personnel Management (OPM) describes a competency as "an observable, measurable pattern of skills, knowledge, abilities, behaviors and other characteristics that an individual needs to perform work roles or occupational functions successfully." OPM's definition of a competency is the foundation on which AT&L workforce competency models are built. The SPRDE workforce competency-based assessment described here aligns with the AT&L Human Capital Strategic Plan and is one element of an approach by the Human Capital Initiatives (HCI) Office to prepare the AT&L workforce for the future.[5]

The SPRDE workforce assessment is part of a larger competency assessment program addressing all career fields within the AT&L community.

## Research objectives

The research goals for the overall AT&L Competency Program are[6]:

- AT&L Goal-1: Define the competencies required to deliver (needed) capabilities.
- AT&L Goal-2: Assess the workforce to identify current and future gaps.

---

[5] Ken Krieg, Under Secretary of Defense for Acquisition, Technology & Logistics, *AT&L Human Capital Strategic Plan v3.0,* 2007.

[6] Department of Defense, Acquisition, Technology & Logistics, *AT&L Human Capital Strategic Plan v3.0,* 2007.

The SPRDE expert panel provided additional guidance on specific goals for the SPRDE workforce. The SPRDE-specific research goals are:

- SPRDE Goal-1: Assess the current Systems Engineering capability of the SPRDE workforce.
- SPRDE Goal-2: Describe how those capabilities are distributed across DoD organizations and programs.
- SPRDE Goal-3: Project how those capabilities will be affected by departures.
- SPRDE Goal-4: Determine the potential of the current SPRDE workforce to boost the DoD's Systems Engineering capability.
- SPRDE Goal-5: Develop a profile of the SPRDE workforce.

The competency model used for this assessment satisfies the first AT&L goal. The first three SPRDE-specific goals are detailed elaborations of AT&L Goal-2: current competency gaps are covered in SPRDE Goal-1, the distribution of competency gaps are covered in SPRDE Goal-2, and future gaps are covered in SPRDE Goal-3. SPRDE Goal-4 and Goal-5 are unique requirements for the SPRDE workforce. Each of the SPRDE-specific research goals is addressed in subsequent chapters of this report.

## Model components

AT&L competency models have both a technical and a professional component. Technical competencies are functional-specific competencies associated with a career field (e.g., Technical Basis for Cost). Professional competencies are leadership, relational, cognitive, and management-focused and can be applied to all career fields (e.g., Communication). Competency models contain high-level units of competence that hold more descriptive competencies with concise descriptions of

behaviors and the associated goal of the behavior needed to demonstrate the competency (referred to as competency elements). In addition, competencies often include short statements about the knowledge required to perform the behaviors (referred to as knowledge items).

## Model development

The SPRDE competency model was developed and validated in four phases. In **Phase I,** the competency assessment model development phase, career field leadership served as an expert panel (EP). They identified the behaviors, skills, characteristics, and knowledge they believe are required to be a successful SPRDE employee. Through successive discussions between SPRDE leadership and CNA, this information was developed into a competency model framework, which was then used to solicit more detailed competency information from a larger group of subject matter experts (SMEs).

At the end of Phase I, expert panel members identified successful SPRDE employees from all representative DoD services and agencies to serve as SMEs and to support development of a model from the framework. Criteria to serve as an SME ensured that participants represented the entire SPRDE workforce population and that they were experienced, superior employees. This ensured that the final competency model would accurately reflect successful performance criteria.

In **Phase II**, SMEs were asked to provide data about what makes them successful in their jobs. The CNA research team devised a multifaceted approach to collecting the data. Use of CNA's online data collection tool facilitated collection of demographic information, framework validation, and descriptions of key situations. SPRDE SMEs were first asked to provide demographic information. SMEs were also asked to add or suggest removal of competencies, elements, and knowledge items. Finally, a structured set of questions asked SMEs to compare their job responsibilities with the framework of competencies and provide examples from their own experiences of successful job

performance. This process allowed CNA to collect both qualitative and quantitative data needed to validate competencies required for superior performance. Feedback was collected from 219 SPRDE SMEs.

In **Phase III,** CNA worked with SPRDE leadership and workforce experts to decide how to use the information provided by the SMEs to refine the SPRDE competency framework developed by the expert panel. CNA used this resulting competency model to build a web-based assessment tool to capture workforce-wide assessment data.

The SPRDE competency model consists of 45 elements and 29 competencies, all organized into three units of competence. Figure 2, below, shows the final SPRDE competency model and the detailed elements are listed in Appendix A. The Phase IV assessment of the SPRDE workforce used this competency model.

Figure 2. SPRDE Competency Model

| Competencies in the Analytical Unit of Competence | | Competencies in the Technical Management Unit of Competence | | Competencies in the Professional Unit of Competence | |
|---|---|---|---|---|---|
| 1 | Technical Basis for Cost | 14 | Decision Analysis | 26 | Communications |
| 2 | Modeling and Simulation | 15 | Technical Planning | 27 | Problem Solving |
| 3 | Safety Assurance | 16 | Technical Assessment | 28 | Strategic Thinking |
| 4 | Stakeholder Requirements Definition (Requirements Development) | 17 | Configuration Management | 29 | Professional Ethics |
| 5 | Requirements Analysis (Logical Analysis) | 18 | Requirements Management | | |
| 6 | Architectural Design (Design Solution) | 19 | Risk Management | | |
| 7 | Implementation | 20 | Technical Data Management | | |
| 8 | Integration | 21 | Interface Management | | |
| 9 | Verification | 22 | Software Engineering | | |
| 10 | Validation | 23 | Acquisition | | |
| 11 | Transition | 24 | System Engineering Leadership | | |
| 12 | System Assurance | 25 | System of Systems | | |
| 13 | Reliability, Availability, and Maintainability (RAM) | | | | |

**Phase IV** of the SPRDE competency assessment process began in December 2010. At that time, CNA administered the assessment to approximately 38,000 SPRDE employees. Employees had 15 weeks to complete the assessment before the assessment closed March 14, 2011. The analysis of employee-provided proficiency and importance ratings are described in this report.

## Survey approval

Defense Acquisition University (DAU) submitted the SPRDE assessment survey to the Defense Manpower Data Center (DMDC) and Washington Headquarters Services (WHS) for survey approval in late 2009. The SPRDE survey was the model for all subsequent surveys of Acquisition workforce segments. We received survey approval in July 2010, under WHS survey license number DD-AT&L (AR) 2431.

## Section summary

We developed the Competency Model for the SPRDE workforce using the same process used for each other DoD Acquisition workforce. This process starts with a small group of Expert Panel members who develop a framework for the model. The process then expands the audience to a larger group of SMEs from across the workforce, who validate the content in the framework to produce the recommended model. Finally, we assess the still broader workforce population against this model. This final assessment provides further validation of the model, as well as demographic, proficiency, and importance ratings. The assessment survey was approved, prior to the launch of the assessment, by both DMDC and WHS.

# Section 2: Rating and analysis methodology

The intent for this assessment of SPRDE employees was to conduct as close to a workforce census as possible rather than a sampling of employees. Although we received over 10,000 assessment responses, the response rate did not achieve a census-level. This was especially true for supervisors. The response rate forced changes in our planned methodology, in order to understand the degree to which the participants are reflective of the population. Therefore, our discussion of methodology starts with a discussion of the observed participation rates.

## Participation rates

Overall, 27 percent of the SPRDE workforce contributed in some way to the assessment. Across all services and agencies, employees completed 10,173 self-assessments and supervisors assessed 5,357 employees, not all of whom participated in the assessment. The SPRDE workforce has employees in all three service departments (Air Force, Army, and Navy) as well as eleven 4th Estate agencies: the Business Transformation Agency (BTA), the Defense Acquisition University (DAU), the Defense Contract Management Agency (DCMA), the Defense Information Systems Agency (DISA), the Defense Logistics Agency (DLA), the Defense MicroElectronics Activity (DMEA), the Defense Threat Reduction Agency (DTRA), the Missile Defense Agency (MDA), the Defense Systems Management College (DSMC), the TRICARE Management Activity, and the Undersecretary of Defense for AT&L. Participation rates for the overall SPRDE workforce and for each of the four segments of the workforce; Air Force, Army, Navy, and 4th Estate, are shown in Table 1.

As we previously mentioned, the 27 percent of the workforce that responded needs to be a random sample in order to

extrapolate to the workforce as a whole. In the few demographic dimensions that we were able to explore, we found no major evidence that our sample is not random. However, caution should still be exercised in extrapolating these results to represent the entire workforce. These results **do** represent the 27 percent of the workforce who responded to the survey.

Table 1. Participation rates by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Final Assessment Status | Count of Participants | % | Count of Participants | % | Count of Participants | % | Count of Participants | % | Count of Participants | % |
| Number of people invited | 37,968 | 100 | 8,311 | 100 | 10,048 | 100 | 17,763 | 100 | 1,846 | 100 |
| Completed or Partially Completed Employee Assessments | 10,173 | 27 | 2,038 | 25 | 2,380 | 24 | 4,597 | 26 | 1,158 | 63 |
| Completed or Partially Completed Supervisory Assessments | 5,357 | 14 | 889 | 11 | 1,183 | 12 | 2,514 | 14 | 771 | 42 |
| Completed or Partially Completed Employee and Supervisory Assessments | 2,137 | 6 | 291 | 4 | 387 | 4 | 853 | 5 | 606 | 33 |

# Methodology changes driven by participation rates

## Changes in the data used for analysis

We have used a multi-rater approach for prior DoD Acquisition workforce assessments, by capturing criticality and proficiency ratings for each employee from both the employee and his or her supervisor. The response rate for paired SPRDE employee-supervisor assessments was, however, too low to provide sufficient data for analysis. Therefore, we modified our methodology to use only employee responses. This approach provides the largest consistent set of responses for our analysis. The number of employee responses is highly representative of the overall SPRDE workforce population. The results are,

however, less verifiable than employee-supervisor paired responses, because the employee proficiency and criticality responses have not been validated against supervisor responses. See the section on ***Data used for analysis*** for a further discussion of this topic.

## Changes to career level identification

CNA planned to report results based on three separate career level segments; entry-level, journey-level, and senior-level, to be consistent with the analytical methodology used with prior Acquisition workforces. Career level groupings typically highlight different characteristics and results at each level, because the levels are most often relatively homogenous, while an analysis based on the workforce, as a whole, will mask these patterns. Our assessment asked supervisors to provide the career level designation for each employee, again consistent with our approach for prior census assessments. The low participation rate by supervisors precluded using the collected data to specify career-level designations. Therefore, we used certification level as a proxy, in place of career level. The section titled ***Career Level*** describes the alternate approach used, and the implications of the data analysis of supplied career-level designations.

## Changes to how data is aggregated and reported

In this report, we provide results at the overall SPRDE workforce level. We will include separate report breakdowns at the component and 4th Estate levels where the findings may be unique from what is in this overall SPRDE report. This methodology for data aggregation and reporting eliminates most of the problems associated with low response analysis

which require masking of responses due to privacy and confidentiality issues.[7]

This report has been expanded to include the results of the four separate services/agencies (Air Force, Army, Navy, and 4th Estate). In addition, we will prepare four separate reports, one for each of the services/agencies, to address the unique and reportable findings of that service/agency. We have put the majority of the quantitative and analytical content into this report allowing the service and agency reports to focus on unique findings and special analysis, with reference to the data in this SPRDE report.

## Competency ratings

Employees rated their own proficiency for each element of the competency model, how critical they believed the competency element to be in performing their current job, and how frequently they use that competency element. Each employee's supervisor was also asked to rate the proficiency of the employee for each element in the competency model and the criticality of the element to the employee's job. Behavioral descriptions for each competency element assisted the participant in selecting the most appropriate rating for each element. Each rating scale contained five usable ratings, enumerated one through five, and one rating of zero, which indicated that the employee or supervisor could not respond for this element and for this rating category (proficiency, criticality, or frequency). We excluded all zero ratings in calculating average response rates. The rating scales used are below:

[7] The lower than anticipated response rates created a situation whereby we cannot present all the data at the service or agency level (or below) with the same levels of confidence that we can at the aggregate SPRDE-Overall level. We would also be forced to mask substantial portions of any report that focuses on individual components or 4th Estate agencies due to privacy and confidentiality restrictions.

***Criticality:*** How critical is this activity in your job? (Employee) / How critical is this behavior to the employee whom you are rating? (Supervisor)

0. N/A: Not needed in my job
1. Not Critical
2. Somewhat Critical
3. Fairly Critical
4. Very Critical
5. Extremely Critical

***Proficiency:*** How proficient are you at the competency element behaviors? (Employee) / How proficient is the employee whom you are rating? (Supervisor)

0. No Exposure to or awareness of this competency
1. Awareness: Applies the competency in the simplest situations
2. Basic: Applies the competency in *somewhat complex* situations
3. Intermediate: Applies the competency in *complex* situations
4. Advanced: Applies the competency in *considerably complex* situations
5. Expert: Applies the competency in *exceptionally complex* situations

***Frequency:*** How often do you do this activity in your job? (Employee only)

0. Never: Not needed in my job
1. Almost Never
2. Rarely
3. Occasionally
4. Frequently
5. Very Frequently

## Career level

As previously described in the section titled ***Methodology changes driven by low participation rates***, we did not obtain sufficient supervisor-supplied career-level designations to allow us to analyze employee responses by the planned entry-level, journey-level, and senior-level groupings. Instead, we

chose to use certification level as a substitute for career level.[8] The advantages of using certification level include:

- Employees provided the certification level responses, so we have responses for almost every participating employee.
- Certification level parallels the construct of career level. Specifically, both are a simple three-step gradation, which roughly designates employee capability levels. In fact, we found that certification level was the single most highly correlated demographic factor for career level.
- Certification level shows similar homogenous groupings of characteristics, as expected with career level designations.

Overall, we obtained 2,141 supervisory assessments that contained an employee career-level designation. We attempted to use this data to develop a methodology to predict career levels, based on the available demographic data. There were only six demographic responses in the assessment that were analyzed because they could potentially be related to career level:

- Systems engineering experience
- Non-systems engineering experience
- Federal-civilian experience
- Position pay grade
- Certification level
- Age.

[8] Some would argue that certification level represents the employee's efforts to complete required training, and not performance. However, our data show that it was the best alternative available to use as a proxy for career level (see Appendix B).

First, we confirmed that the supervisor responses were representative of the overall workforce. The effort to correlate demographic factors with supervisor designations of career level did not yield high-confidence results. We were able to predict an entry-level employee, with about an 11 percent error rate, but we could only predict a senior-level employee with an error rate in excess of 25 percent. Certification level was the demographic factor with the highest correlation to career level, with a correlation coefficient of .540, where a correlation coefficient of 1.0 means perfect correlation and a correlation coefficient of 0.0 means no correlation. The correlation coefficients for the six considered demographic factors that could potentially be related to career level varied from .282 to .540, as shown in Appendix B.

## Analysis of importance

We asked employees to rate the criticality and frequency of use of each competency element against a standard five-point scale. We computed the mean of both ratings, by competency, for SPRDE'S three largest workforce communities—Systems Engineering, Science & Other Engineering, and Program Management—in order to assign relative importance. These communities represent approximately 87 percent of the SPRDE workforce. We categorized competencies as high, medium, or low based on their mean criticality and frequency values. We also computed mean criticality and frequency ratings by certification level within each workforce community and grouped them according to relative importance.

In order to determine how many competencies lie within each importance category (high, medium, or low) by workforce community, we plotted mean criticality against mean frequency ratings for the three workforce communities of interest. Comparing high importance competencies across the three workforce communities allowed us to identify similarities and differences between them. Comparing mean criticality and frequency ratings across certification levels within each

workforce community revealed the relative importance of competencies to each certification grouping.

Prior to analyzing importance data, we eliminated any responses that did not include a value of one through five for both criticality and frequency of use and calculated the sample sizes for importance of each competency by counting respondents who provided reliable frequency and criticality responses at the competency element level. Eliminating responses using our validation criteria (outlined separately) changed the sample sizes for each question in the assessment.

## Analysis of proficiency

We analyzed proficiency data received from respondents in the Systems Engineering and Program Management workforce communities.[9] First, we computed mean and mode proficiency values for each competency by workforce community and certification level. Next, we plotted these values in order to get a sense of the proficiency status for each grouping of respondents. We compared the mean and mode values for each competency in order to ensure that the mean is representative of the respondent population.

Finally, we compared mean proficiency levels across certification levels to determine the reported proficiency status for each. We used the same process to remove incomplete/invalid data from our proficiency data set as we did for our importance analysis.

[9] During the course of our importance analyses, we determined that most of the competencies of importance to the Science & Other Engineering community are fundamentally different than those important to the Systems Engineering and Program Management communities. These results suggest that either Science & Other Engineering competencies are not well represented in the SPRDE competency model assessed here or that this community needs to be further broken down into smaller groupings and reassessed.

## Analysis of retirement impact

Based on the demographic data provided by the assessment respondents, we estimate the percent of federal civilians who either are currently eligible for retirement or will become eligible in the next five years. Then, conditional on being eligible for retirement, we estimate the percent who will retire over the next five years.

## Analysis of employee intentions

Assessment participants provided responses to questions related to their professional growth and continued work intentions. One question also probed their inclination to be a mentor to others. We present the responses to these questions in this report and we discuss the implications of the responses relative to predicted near-term retirement losses.

## Data used for analysis

We obtained only 2,137 sets of paired responses from an employee and his or her supervisor, across the entire 37,968 SPRDE workforce. If we were to perform our analysis using the multi-rater approach, this low level of response would be insufficient for the level and types of analysis expected by SPRDE workforce management and would force us to mask substantial portions of any report, due to privacy and confidentiality restrictions. It also precludes any separate reporting for the Air Force, Army, 4th Estate, agencies within the 4th Estate, or across any collected demographic responses, for the same reasons.

We analyzed the average differences between the supervisor and employee responses in the paired employee-supervisor response sets that we captured during the assessment. We expected to see low difference measures between responses, based on the results from the three prior workforce segments, (Contracting, Logistics, and Program Management).

The results of this analysis also found small differences, but there were some statistically significant differences between responses. Running a paired t-test there were 30 elements rated by employees and supervisors as statistically different from each other, although the average differences were all less than .28. The overall average difference was .02 between employee and supervisor responses. Further, supervisors provided statistically different proficiency ratings that were lower than the employee ratings for only 8 elements. All-in-all, only one competency element had an average difference between the responses of greater than .25. The detailed element averages for proficiency ratings between employee and supervisor responses are in Appendix C.

As a result, while there are some minor differences, we are confident with using only individual employee responses from this assessment, without averaging in the supervisor responses. These independent employee responses do lack the multi-view validation for each respondent, but are still highly representative of the SPRDE workforce. We collected 10,173 individual employee responses, with sufficient distribution across the services and agencies, to allow us to report for each of these segments, in addition to the SPRDE-overall workforce.

To ensure that the data set contained reliable data for analysis, we validated the data set and excluded the following scenarios from the analysis:

- *If the employee selected 0: (Not needed in my job) in the frequency or criticality rating for an element.*
- *If the employee selected 0: (No Exposure to or awareness of this competency) in the proficiency rating for an element.*
- *If the criticality, proficiency, or frequency ratings were blank for an element.*

- *If the responding employee was identified as a contractor by ".ctr" in their email address.*

- *If a systematic response pattern was identified (i.e., AAA, ABA, ABB, etc).*

## Section summary

Overall, 27 percent of the SPRDE workforce contributed to the assessment, completing 10,173 self-assessments, with consistent response rates across the service departments and slightly higher response rates among the agencies. The lower than expected response rates, especially from supervisors, dictated several methodological changes, including:

- Only employee responses were used for analysis,

- Certification level was used instead of career level, and

- Results were aggregated at a higher level than planned and consolidated into one SPRDE-Overall report.

The methodologies for analysis of importance and proficiency, and their distribution across services and agencies were consistent with the other DoD Acquisition workforces, and the rating scales were identical.

This page intentionally left blank.

# Section 3: Workforce demographics

Respondents were asked 28 demographic and intentions questions. These questions and the selections available to each respondent are shown in Appendix D. Supervisors were presented the same demographic questions when they responded as an employee, but provided no demographic input in their supervisory responses.

What follows helps create a profile of the SPRDE workforce obtained from the demographic responses.

## Experience

**Most SPRDE respondents have less than 10 years of systems engineering experience.**

Results presented in Table 2 are derived from the following demographic question: *How many years of experience have you had as a Systems Engineer?*

The majority of the SPRDE respondents have less than 10 years of systems engineering experience (59 percent). The Air Force segment has the largest percentage of respondents with less than 10 years of experience (66 percent). Approximately 10 percent of SPRDE respondents have more than 25 years of systems engineering experience (for SPRDE respondents as a whole and across the segments).

Table 2. Systems Engineering experience responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Years of Experience | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Less than 5 | 3,786 | 37 | 922 | 45 | 786 | 33 | 1714 | 37 | 364 | 31 |
| 5 to 10 | 2,245 | 22 | 429 | 21 | 596 | 25 | 958 | 21 | 262 | 23 |
| 11 to 15 | 1,340 | 13 | 228 | 11 | 315 | 13 | 614 | 13 | 183 | 16 |
| 16 to 25 | 1,774 | 17 | 287 | 14 | 423 | 18 | 830 | 18 | 234 | 20 |
| More than 25 | 977 | 10 | 161 | 8 | 246 | 10 | 462 | 10 | 108 | 9 |
| Unknown | 51 | 1 | 11 | 1 | 14 | 1 | 19 | 0 | 7 | 1 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,150 | 100 |

**Most SPRDE respondents have less than 10 years experience as a scientist or other type of engineer.**

Results presented in Table 3 are derived from the following demographic question: *How many years of experience have you had as an engineer or scientist other than as a Systems Engineer?*

As was found with systems engineering experience, the majority of SPRDE respondents have less than 10 years of other science or engineering experience (59 percent). The Air Force segment has the largest percentage of respondents in this category, as well (65 percent). The remaining groupings of respondents by years of experience are comparable across segments.

Table 3. Other experience as a scientist or engineer responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Years of Experience | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Less than 5 | 3,638 | 36 | 855 | 42 | 777 | 33 | 1,610 | 35 | 396 | 34 |
| 5 to 10 | 2,316 | 23 | 460 | 23 | 568 | 24 | 1,040 | 23 | 248 | 21 |
| 11 to 15 | 1,322 | 13 | 228 | 11 | 312 | 13 | 600 | 13 | 182 | 16 |
| 16 to 25 | 1,589 | 16 | 293 | 14 | 374 | 16 | 725 | 16 | 197 | 17 |
| More than 25 | 1,282 | 13 | 200 | 10 | 339 | 14 | 609 | 13 | 134 | 12 |
| Unknown | 26 | 0 | 2 | 0 | 10 | 0 | 13 | 0 | 1 | 0 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

**Most SPRDE respondents have no manufacturing engineering experience.**

Results presented in Table 4 are derived from the following demographic question: *Do you have manufacturing experience?*

Most of SPRDE respondents have no manufacturing experience (62 percent). The 4th Estate segment has the largest percentage of respondents with manufacturing experience (46 percent).

Table 4. Manufacturing experience responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Manufacturing Experience | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Yes | 3,887 | 38 | 682 | 33 | 1,028 | 43 | 1,553 | 34 | 624 | 46 |
| No | 6,284 | 62 | 1,355 | 67 | 1,352 | 57 | 3,043 | 66 | 534 | 54 |
| Unknown | 2 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

## Military vs. civilian status

**Most SPRDE respondents are federal civilians with no prior military experience.**

Results presented in Table 5 are derived from the following demographic question: *What is your current status?*

Most of the SPRDE respondents consist of federal civilians (94 percent) and most civilian respondents have no prior military experience. The Air Force segment has the lowest percentage of civilian respondents of all of the segments (76 percent).

Slightly more than one-fourth (27 percent) of the SPRDE respondents has military experience. Most respondents with military experience are civilians while the remaining respondents are active duty military. The Air Force segment has the largest percentage of respondents with military experience (47 percent).

Table 5. Military versus civilian responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Military/Civilian Status | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Active Duty Military | 572 | 6 | 495 | 24 | 29 | 1 | 47 | 1 | 1 | 0 |
| Federal Civilian, No Prior Military Service | 7,440 | 73 | 1,081 | 53 | 1,942 | 82 | 3,593 | 78 | 824 | 71 |
| Federal Civilian, Prior Military Service | 2,145 | 21 | 459 | 23 | 401 | 17 | 953 | 21 | 332 | 29 |
| Unknown | 16 | 0 | 3 | 0 | 8 | 0 | 4 | 0 | 1 | 0 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

**Most civilians in the SPRDE respondents are paid according to the GS-Level pay scale and reside in the GS-11 to GS-13 grade level range.**

Results presented in Table 6 are derived from the following demographic question: *If you are in the civil service (or NSPS) system, what is your current grade level (or pay-band)?*

Most SPRDE civilian respondents are paid according to the GS-Level pay scale (5,739 respondents which is 60 percent of the civilian workforce). Within the GS-Level pay scale system, most civilian respondents fall in the GS-11 to GS-13 range.

Twenty-four percent of civilian respondents categorized themselves in the National Security Personnel System (NSPS) pay scale system. Within the NSPS pay scale system, most civilian respondents categorized themselves in Band 3. Fifteen percent of civilian respondents categorized themselves in the *Other Pay Band* category. Most of the civilians in this category work within one of the service segments.

Table 6. Civilian grade level/pay band responses by SPRDE segment

| | SPRDE-All | | | Air Force | | | Army | | | Navy | | | 4th Estate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Grade Level/ Pay Band | # | % Civ | % All | # | % Civ | % All | # | % Civ | % All | # | % Civ | % All | # | % Civ | % All |
| GS-10 or below | 210 | 2 | 2 | 41 | 3 | 2 | 32 | 1 | 1 | 85 | 2 | 2 | 52 | 5 | 5 |
| GS-11 to GS-13 | 4,282 | 45 | 42 | 1,058 | 67 | 52 | 1,070 | 45 | 45 | 1,597 | 35 | 35 | 557 | 48 | 48 |
| GS-14 or higher | 1,247 | 13 | 12 | 312 | 20 | 15 | 368 | 16 | 16 | 449 | 10 | 10 | 118 | 10 | 10 |
| NSPS Pay Band 1 | 224 | 2 | 2 | 1 | 0 | 0 | 7 | 0 | 0 | 130 | 3 | 3 | 86 | 7 | 7 |
| NSPS Pay Band 2 | 847 | 9 | 8 | 9 | 1 | 0 | 146 | 6 | 6 | 657 | 14 | 14 | 35 | 3 | 3 |
| NSPS Pay Band 3 | 1,216 | 13 | 12 | 7 | 1 | 0 | 305 | 13 | 13 | 628 | 14 | 14 | 276 | 24 | 24 |
| Other Pay Band | 1,476 | 15 | 15 | 108 | 7 | 5 | 389 | 17 | 16 | 956 | 21 | 21 | 23 | 2 | 2 |
| Unknown/N/A | 103 | 1 | 1 | 7 | 1 | 0 | 38 | 2 | 2 | 48 | 1 | 1 | 10 | 1 | 1 |
| All Civilian Respondents | 9605 | 100 | 94 | 1543 | 100 | 75 | 2355 | 100 | 99 | 4,550 | 100 | 99 | 1157 | 100 | 100 |

**Most active duty military SPRDE respondents rank between O-1 and O-3.**

Results presented in Table 7 are derived from the following demographic question: *If you are active-duty military, what is your current rank?*

Most active-duty military respondents in the SPRDE workforce categorized themselves in the O-1 to O-3 range (308 respondents, which is 54 percent of the military population). Almost all respondents in this category are in the Air Force segment (305 respondents). The remaining active duty military respondents categorized themselves in the O-4 or higher range (260 respondents). The Air Force segment has the most respondents in this category (190 respondents), followed by the Navy segment (94 respondents).

Table 7. Military rank responses by SPRDE segment

| | SPRDE-All | | | Air Force | | | Army | | | Navy | | | 4th Estate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Military Rank | # | % Mil | % All | # | % Mil | % All | # | % Mil | % All | # | % Mil | % All | # | % Mil | % All |
| E-1 to E-5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| E-6 to E-9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| O-1 to O-3 | 308 | 54 | 3 | 305 | 62 | 15 | 0 | 0 | 0 | 3 | 6 | 0 | 0 | 0 | 0 |
| O-4 or higher | 260 | 46 | 3 | 190 | 38 | 9 | 25 | 100 | 1 | 44 | 94 | 1 | 1 | 100 | 0 |
| All Military Respondents | 568 | 100 | 6 | 495 | 100 | 25 | 25 | 100 | 1 | 47 | 100 | 1 | 1 | 100 | 0 |

# Certification level

**Most SPRDE respondents are Level 3 certified.**

Results presented in Table 8 are derived from the following demographic question: *What is your current certification level?*

Most of the SPRDE respondents is Level 3 certified (57 percent). Over half of the respondents in both the Army and the Navy segments are Level 3 certified (73 percent and 62 percent, respectively). Thus most SPRDE respondents have already attained the highest certification level possible. SPRDE management should consider creating an additional certification level in order to encourage employees to stay motivated and competitive.

The number of respondents within the Air Force and 4th Estate segments are more evenly distributed between the three certification levels. Assessment results indicate that 9 percent of SPRDE respondents do not know their certification level.

Table 8. Certification level responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Level | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| One | 1,697 | 17 | 570 | 28 | 216 | 9 | 672 | 15 | 239 | 21 |
| Two | 1,834 | 18 | 446 | 22 | 360 | 15 | 690 | 15 | 338 | 29 |
| Three | 5,777 | 57 | 727 | 36 | 1,727 | 73 | 2,837 | 62 | 486 | 42 |
| Unknown | 865 | 9 | 295 | 14 | 77 | 3 | 398 | 9 | 95 | 8 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

# Education

**About half of SPRDE respondents have achieved a master's degree or higher.**

Results presented in Table 9 are derived from the following demographic questions: *What is your highest level of educational attainment?* and *Is your highest-level degree in science, technology, engineering, or math (STEM)?*

The highest level of educational achievement by most of SPRDE respondents is either bachelor's degree (48 percent) or master's degree (47 percent). The Navy and 4th Estate segments have the largest percentages of respondents with a bachelor's degree (both 53 percent) and the Air Force segment has the largest percentage of respondents holding a master's degree or higher (60 percent) followed closely by the Army segment (57 percent).

Approximately 90 percent of the respondents across the services report that their highest degree is in science, technology, engineering, or math. Fourth Estate respondents report the opposite (only 12 percent of respondents hold their highest degree in one of these four disciplines).

Table 9. Education levels and focus responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Highest Level of Educational Achievement | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| High School | 27 | 0 | 1 | 0 | 4 | 0 | 20 | 0 | 2 | 0 |
| Associate Degree | 35 | 0 | 2 | 0 | 4 | 0 | 26 | 1 | 3 | 0 |
| Bachelor's Degree | 4,889 | 48 | 813 | 40 | 1,014 | 43 | 2,454 | 53 | 608 | 53 |
| Master's Degree | 4,751 | 47 | 1,099 | 54 | 1,239 | 52 | 1,912 | 42 | 501 | 43 |
| Doctoral Degree | 451 | 4 | 120 | 6 | 114 | 5 | 175 | 4 | 42 | 4 |
| Other | 18 | 0 | 3 | 0 | 5 | 0 | 8 | 0 | 2 | 0 |
| Unknown | 2 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |
| Highest Degree in science, technology engineering or math (STEM)? | 9,095 | 87 | 1,772 | 88 | 2,096 | 88 | 4,204 | 92 | 133 | 12 |

## Workforce community

**Most respondents identify themselves with the Systems Engineering, Science & Other Engineering, and Program Management Workforce communities.**

Results presented in Table 10 are derived from the following demographic question: *Please identify the workforce community with which you are most closely associated?*

As one might expect, Systems Engineering is the most highly populated workforce community in SPRDE (56 percent), followed by the Science & Other Engineering community (24 percent) and Program Management (7 percent). The remaining respondents (13 percent) classified themselves as one of 21 named workforce community categories or as one of an unknown number of other unnamed communities. We group these respondents as "Other/None."

Systems Engineering, Science & Other Engineering, and Program Management are the three most populated workforce communities (respectively) across the segments as well. However, the 4th Estate segment has a higher percentage of System Engineering respondents (75 percent) than the services

and a lower percentage of respondents in the Science & Other Engineering community (8 percent).

Table 10. Workforce community responses by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Workforce Community | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Systems Engineering | 5,735 | 56 | 1,039 | 51 | 1,205 | 51 | 2,620 | 57 | 871 | 75 |
| Science & Other Engineering | 2,431 | 24 | 526 | 26 | 615 | 26 | 1,200 | 26 | 90 | 8 |
| Program Management | 711 | 7 | 179 | 9 | 220 | 9 | 252 | 6 | 60 | 5 |
| Other/None | 1296 | 13 | 294 | 14 | 340 | 14 | 525 | 11 | 137 | 12 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

Respondents were asked to identify themselves with one of 24 workforce communities. The category labeled "Other/None" represents all respondents that associate themselves with one of the remaining 21 workforce community options not listed here **and** those respondents who chose the "Other/None" option in response to the assessment question.

## Other demographic and intentions data

Additional data were collected about assessment respondents. Some of these were used to inform our retirement and intentions analyses and will be discussed later. The remaining data—the respondent's use of the Defense Acquisition Guidebook (DAG), respondent support to SPRDE acquisition organizations, and the effect of the latest BRAC changes on respondents—are presented in Appendix E.

## Section summary

The responses we received to the demographic portion of the competency assessment provide insight into the composition of the SPRDE workforce.

Results indicate that most respondents have less than 10 years of systems engineering experience and less than 10 years of science or other engineering experience. The majority of respondents have no manufacturing experience. The respondents primarily consist of federal civilians with no prior military experience. Most civilian respondents are within the GS-Level pay scale and reside in the GS-11 to GS-13 grade level range. For those civilian

respondents within the NSPS pay scale system, most are in Band 3. Active duty military respondents primarily rank between O-1 and O-3. Most SPRDE respondents (approximately 57 percent) are Level 3 certified considering both civilian and military respondents. This finding can be used to inform SPRDE management's potential decision to create an additional certification level.

We found that about half of respondents in the SPRDE workforce have a master's degree or higher and most respondents supporting a service segment have earned their highest degree in a science- or math-related field. Finally, the top three workforce communities within SPRDE for which we received responses are the Systems Engineering, Science & Other Engineering, and Program Management communities.

# Section 4: Relative importance of competencies

Each assessment participant ranked the criticality and frequency of use for each of the 45 competency elements. We computed the mean criticality and the mean frequency of each competency, which we then used to assign relative importance. We categorize competencies in terms of importance as follows:

- Competencies that have **both a mean criticality rating AND a mean frequency rating of 3.0 or above** have ***high importance.***
- Competencies that have **either a mean criticality rating OR a mean frequency rating of 3.0 or above** have ***medium importance.***
- Competencies that have **both a mean criticality rating AND a mean frequency rating** **below 3.0** have ***lower importance.***

In this section we discuss the relative importance of competencies for the three SPRDE workforce communities that have the greatest number of responses. Next, we discuss the relative importance of competencies within each workforce community by certification level, highlighting the high and medium importance competencies.

## Important competencies by workforce community

As determined in our workforce demographic analysis, the Systems Engineering, Science & Other Engineering, and Program Management workforce communities represent 87 percent of SPRDE respondents. The remaining 21 workforce communities contain relatively small percentages of respondents. Therefore, we focus the remainder of our analyses on the top three communities.

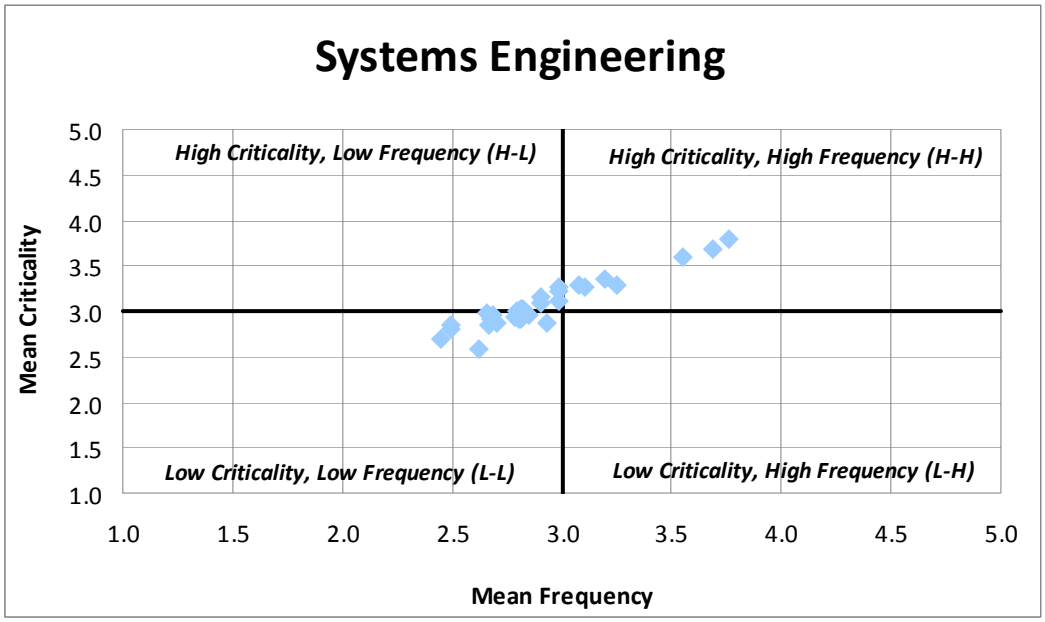
## Systems Engineering

Our analysis suggests that respondents who associated themselves with the Systems Engineering community in the assessment consider approximately one fourth (24 percent) of the competencies as highly important. They consider slightly more than one fourth (28 percent) of the competencies to be of medium importance based on their criticality to their jobs. No competencies are considered to be important solely based on their frequency. The remaining competencies (48 percent) are considered to be of lower importance to Systems Engineering respondents (Figure 3).

Competencies identified as highly important to Systems Engineering respondents are:

- Competency 5: Requirements Analysis
- Competency 7: Implementation
- Competency 8: Integration
- Competency 24: Systems Engineering Leadership
- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 29: Professional Ethics.

Figure 3. Mean criticality versus mean frequency plot of competencies rated by Systems Engineering community respondents



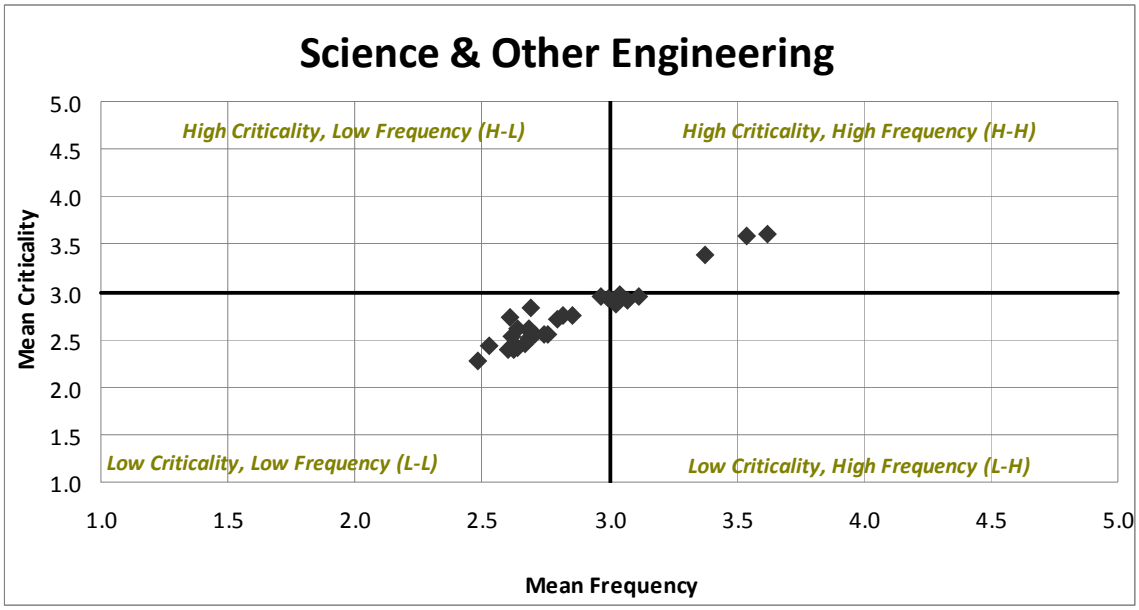

## Science & Other Engineering

Our analysis suggests that three competencies (10 percent) are of high importance to respondents who associated themselves with the Science & Other Engineering community. A greater number of competencies (28 percent) are considered to be of medium importance to this group of respondents based on mean frequency ratings, but most competencies (62 percent) rank at the lower end of the importance spectrum (Figure 4).

Competencies identified as highly important to Science & Other Engineering respondents are:

- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 29: Professional Ethics.

Figure 4. Mean criticality versus mean frequency plot of competencies rated by Science & Other Engineering community respondents



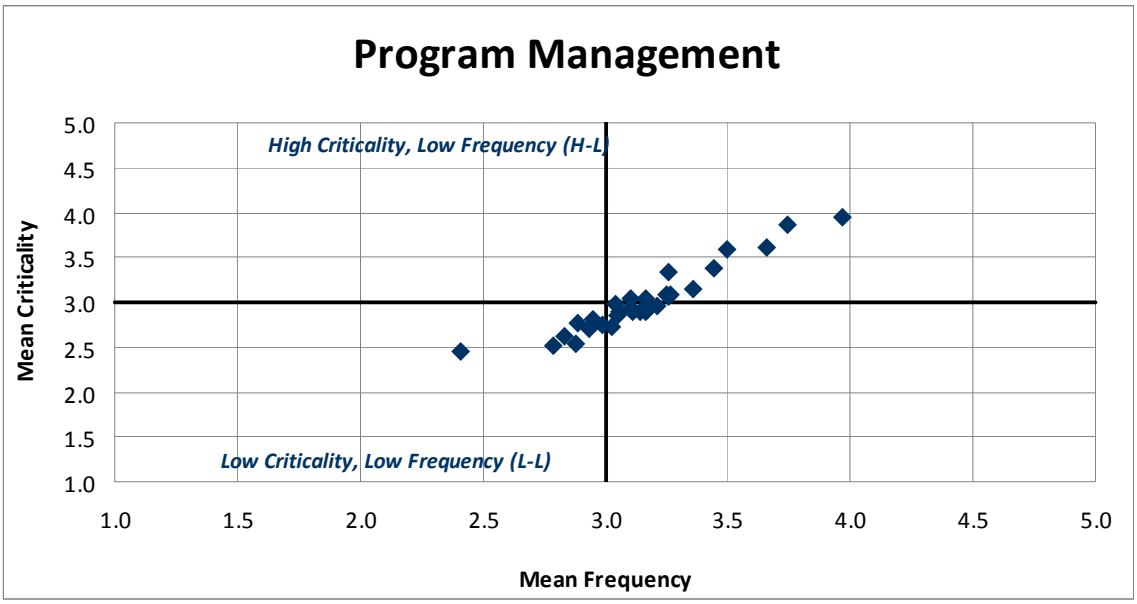

## Program Management

Nearly half (41 percent) of the competencies in the SPRDE competency model are considered to be of high importance to Program Management respondents. Approximately one third (31 percent) of the competencies are considered to be of medium importance to this community; however, they are considered important because activities associated with these competencies are performed frequently (unlike competencies determined to be of medium importance to Systems Engineering respondents). Nearly one third (28 percent) of the competencies are considered to be of lower importance to Program Management respondents (Figure 5).

Competencies identified as highly important to Program Management respondents are:

- Competency 1: Technical Basis for Cost
- Competency 4: Stakeholder Requirements Definition
- Competency 5: Requirement Analysis
- Competency 7: Implementation
- Competency 8: Integration
- Competency 17: Configuration Management
- Competency 19: Risk Management
- Competency 24: Systems Engineering Leadership
- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 28: Strategic Thinking
- Competency 29: Professional Ethics.

Figure 5. Mean criticality versus mean frequency plot of competencies rated by Program Management community respondents




## High importance competencies by workforce community

When comparing importance across workforce communities we find that three competencies are rated as highly important across all three communities (ranked in order of greatest importance):

- Competency 29: Professional Ethics
- Competency 26: Communication
- Competency 27: Problem Solving.

All three competencies belong to the Professional Unit of Competence.

We also find that competencies identified as highly important to Systems Engineering respondents are a subset of the competencies identified as highly important to Program Management respondents.

No competencies other than professional competencies were identified as highly important to the Science & Other Engineering community. This suggests that the competency model developed for SPRDE overall fails to capture the competencies pertinent to the Science and Other Engineering workforce. For this reason, the remainder of our analysis focuses only on Systems Engineering and Program Management responses (Table 11).

Table 11. Comparison of high importance competencies across workforce communities

| Unit of Competence | Competency Name | SE | S&OE | PM |
|---|---|---|---|---|
| Analytical | 1. Technical Basis for Cost | | | X |
| | 2. Modeling and Simulation | | | |
| | 3. Safety Assurance | | | |
| | 4. Stakeholder Requirements Definition (Requirements Development) | | | X |
| | 5. Requirements Analysis (Logical Analysis) | X | | X |
| | 6. Architecture Design (Design Solution) | | | |
| | 7. Implementation | X | | X |
| | 8. Integration | X | | X |
| | 9. Verification | | | |
| | 10. Validation | | | |
| | 11. Transition | | | |
| | 12. System Assurance | | | |
| | 13. Reliability, Availability & Maintainability (RAM) | | | |
| Technical Management | 14. Decision Analysis | | | |
| | 15. Technical Planning | | | |
| | 16. Technical Assessment | | | |
| | 17. Configuration Management | | | X |
| | 18. Requirements Management | | | |
| | 19 .Risk Management | | | X |
| | 20. Technical Data Management | | | |
| | 21. Interface Management | | | |
| | 22. Software Engineering | | | |
| | 23. Acquisition | | | |
| | 24. Systems Engineering Leadership | X | | X |
| | 25. System of Systems | | | |
| Professional | 26. Communication | X | X | X |
| | 27. Problem Solving | X | X | X |
| | 28. Strategic Thinking | | | X |
| | 29. Professional Ethics | X | X | X |

SE = Systems Engineering, S&OE = Science & Other Engineering, PM = Program Management

## Applicability of competencies to Systems Engineering and Program Management respondents

We investigated the relative percentage of assessment respondents who reported that a competency was not needed in their job (scale rating of 0 for frequency or criticality) as well as those who reported that they were unaware of or had no exposure to a competency (scale rating of 0 for proficiency) in the SPRDE competency model. We found that all competencies received some percentage of “N/A” responses. For Systems Engineering, “N/A” responses ranged from 1 to 38 percent, and for Program Management, “N/A” responses ranged from 1 to 31 percent, depending on the competency element. Elements of the competencies Acquisition and Software Development received the highest percentage of "N/A" responses, for both Systems Engineering and Program Management. In general, Systems Engineering and Program Management respondents were more likely to provide an “N/A” response to a competency because it was not needed as opposed to not being aware of or being exposed to the competency.

## Relative importance of competencies by certification level within the Systems Engineering and Program Management communities

In this section we discuss competency importance within the Systems Engineering and Program Management communities relative to respondent-supplied certification levels.

**The relative importance of competencies increases with increasing certification level among Systems Engineering respondents.**

The same four competencies were determined to be highly important to Level 1 and Level 2 certified Systems Engineering respondents. However, Level 3 certified respondents find several additional competencies to be highly important to their job.

Competencies of medium importance to Level 1 respondents are a subset of those identified by Level 2 respondents. Most competencies of medium importance to Level 3 respondents were not identified by Level 1 or Level 2 certified respondents to be of high or medium importance. Most of the Level 2 medium importance competencies are considered highly important to Level 3 certified respondents (Table 12).

Table 12. Importance ratings for the Systems Engineering community, by competency and certification level

| # | Competency Name | Level 1 | | Level 2 | | Level 3 | |
|---|---|---|---|---|---|---|---|
| | | Mean Crit | Mean Freq | Mean Crit | Mean Freq | Mean Crit | Mean Freq |
| 1 | Technical Basis for Cost | 2.60 | 2.64 | 2.81 | 2.86 | 2.96 | 3.03 |
| 2 | Modeling and Simulation | 2.58 | 2.63 | 2.54 | 2.56 | 2.62 | 2.64 |
| 3 | Safety Assurance | 2.55 | 2.37 | 2.81 | 2.59 | 2.96 | 2.77 |
| 4 | Stakeholder Requirements Definition (Requirements Development) | 2.91 | 2.73 | 2.95 | 2.78 | 3.19 | 2.99 |
| 5 | Requirements Analysis (Logical Analysis) | 3.16 | 3.02 | 3.25 | 3.09 | 3.44 | 3.28 |
| 6 | Architecture Design (Design Solution) | 2.81 | 2.60 | 2.90 | 2.69 | 3.12 | 2.91 |
| 7 | Implementation | 3.08 | 2.93 | 3.18 | 2.95 | 3.36 | 3.15 |
| 8 | Integration | 2.99 | 2.86 | 3.10 | 2.93 | 3.38 | 3.22 |
| 9 | Verification | 3.05 | 2.79 | 3.20 | 2.91 | 3.33 | 3.06 |
| 10 | Validation | 2.98 | 2.82 | 3.05 | 2.80 | 3.33 | 3.08 |
| 11 | Transition | 2.67 | 2.38 | 2.84 | 2.55 | 3.06 | 2.79 |
| 12 | System Assurance | 2.96 | 2.74 | 3.03 | 2.75 | 3.23 | 2.98 |
| 13 | Reliability, Availability & Maintainability (RAM) | 2.45 | 2.27 | 2.63 | 2.42 | 2.79 | 2.50 |
| 14 | Decision Analysis | 2.74 | 2.57 | 2.82 | 2.67 | 3.03 | 2.89 |
| 15 | Technical Planning | 2.66 | 2.47 | 2.78 | 2.60 | 2.95 | 2.80 |
| 16 | Technical Assessment | 2.67 | 2.52 | 2.83 | 2.74 | 3.01 | 2.91 |
| 17 | Configuration Management | 2.69 | 2.59 | 2.91 | 2.77 | 3.06 | 2.94 |
| 18 | Requirements Management | 2.77 | 2.59 | 2.95 | 2.74 | 3.10 | 2.89 |
| 19 | Risk Management | 2.78 | 2.56 | 2.96 | 2.74 | 3.07 | 2.87 |
| 20 | Technical Data Management | 2.73 | 2.61 | 2.88 | 2.76 | 2.99 | 2.87 |
| 21 | Interface Management | 2.71 | 2.40 | 2.90 | 2.56 | 3.07 | 2.75 |
| 22 | Software Engineering | 2.67 | 2.43 | 2.79 | 2.43 | 2.89 | 2.52 |
| 23 | Acquisition | 2.53 | 2.25 | 2.75 | 2.42 | 2.87 | 2.57 |
| 24 | Systems Engineering Leadership | 2.93 | 2.79 | 3.06 | 2.98 | 3.46 | 3.45 |
| 25 | System of Systems | 2.69 | 2.45 | 2.75 | 2.48 | 3.02 | 2.78 |
| 26 | Communication | 3.46 | 3.43 | 3.53 | 3.54 | 3.79 | 3.82 |
| 27 | Problem Solving | 3.36 | 3.27 | 3.46 | 3.41 | 3.72 | 3.68 |
| 28 | Strategic Thinking | 2.89 | 2.76 | 2.97 | 2.80 | 3.23 | 3.10 |
| 29 | Professional Ethics | 3.65 | 3.58 | 3.71 | 3.67 | 3.87 | 3.86 |

Shading indicates relative importance of each competency according to Systems Engineering respondents: green = high importance; yellow = medium importance; no shading = lower importance.

**All professional competencies and the Systems Engineering Leadership competency were identified as highly important to all certification levels among Program Management respondents; however, the relative importance varies for all other analytical and technical management competencies by certification level.**

Based on the Program Management responses, all professional competencies as well as Systems Engineering Leadership are highly important to the job at each level of certification. Level 2 certified respondents find only those five competencies to be highly important to their job. Level 1 certified respondents find two other competencies to be highly important while Level 3 certified respondents find nine other competencies to be of high importance.

Competencies identified as having medium importance also vary by certification level. Most competencies are of medium importance to at least one certification level. Only five competencies are of low importance across all three certification levels (Table 13).

Table 13. Importance ratings for the Program Management community, by competency and certification level

| # | Competency Name | Level 1 | | Level 2 | | Level 3 | |
|---|---|---|---|---|---|---|---|
| | | Mean Crit | Mean Freq | Mean Crit | Mean Freq | Mean Crit | Mean Freq |
| 1 | Technical Basis for Cost | 3.24 | 3.07 | 2.99 | 3.14 | 3.33 | 3.44 |
| 2 | Modeling and Simulation | 2.46 | 2.28 | 2.15 | 2.18 | 2.42 | 2.49 |
| 3 | Safety Assurance | 2.55 | 2.14 | 2.58 | 2.46 | 2.92 | 2.73 |
| 4 | Stakeholder Requirements Definition (Requirements Development) | 3.22 | 2.97 | 3.04 | 2.80 | 3.30 | 3.16 |
| 5 | Requirements Analysis(Logical Analysis) | 3.38 | 3.00 | 3.16 | 2.94 | 3.40 | 3.20 |
| 6 | Architecture Design (Design Solution) | 2.85 | 2.54 | 2.95 | 2.73 | 3.10 | 2.90 |
| 7 | Implementation | 3.15 | 2.81 | 3.05 | 2.79 | 3.31 | 3.12 |
| 8 | Integration | 3.08 | 2.82 | 2.87 | 2.68 | 3.35 | 3.19 |
| 9 | Verification | 3.09 | 2.72 | 3.03 | 2.83 | 3.25 | 2.98 |
| 10 | Validation | 3.06 | 2.57 | 2.93 | 2.66 | 3.21 | 2.96 |
| 11 | Transition | 2.77 | 2.35 | 2.71 | 2.54 | 3.06 | 2.85 |
| 12 | System Assurance | 2.90 | 2.55 | 3.03 | 2.84 | 3.21 | 2.96 |
| 13 | Reliability, Availability & Maintainability (RAM) | 2.49 | 2.18 | 2.86 | 2.63 | 2.83 | 2.55 |
| 14 | Decision Analysis | 3.05 | 2.78 | 2.93 | 2.78 | 3.10 | 2.94 |
| 15 | Technical Planning | 2.69 | 2.47 | 2.76 | 2.62 | 2.96 | 2.82 |
| 16 | Technical Assessment | 2.87 | 2.72 | 2.87 | 2.75 | 3.12 | 3.06 |
| 17 | Configuration Management | 2.81 | 2.50 | 2.94 | 3.06 | 3.19 | 3.13 |
| 18 | Requirements Management | 3.11 | 2.78 | 2.92 | 2.92 | 3.15 | 2.97 |
| 19 | Risk Management | 3.05 | 2.71 | 2.98 | 2.85 | 3.22 | 3.12 |
| 20 | Technical Data Management | 2.76 | 2.44 | 2.75 | 2.56 | 3.03 | 2.90 |
| 21 | Interface Management | 2.80 | 2.24 | 2.81 | 2.46 | 3.09 | 2.81 |
| 22 | Software Engineering | 2.80 | 2.23 | 2.69 | 2.50 | 2.94 | 2.60 |
| 23 | Acquisition | 2.65 | 2.27 | 2.75 | 2.58 | 3.02 | 2.78 |
| 24 | Systems Engineering Leadership | 3.27 | 3.05 | 3.22 | 3.41 | 3.60 | 3.69 |
| 25 | System of Systems | 2.94 | 2.47 | 2.82 | 2.65 | 3.20 | 3.02 |
| 26 | Communication | 3.59 | 3.43 | 3.67 | 3.87 | 3.78 | 3.94 |
| 27 | Problem Solving | 3.48 | 3.18 | 3.65 | 3.63 | 3.71 | 3.70 |
| 28 | Strategic Thinking | 3.22 | 3.00 | 3.41 | 3.30 | 3.52 | 3.47 |
| 29 | Professional Ethics | 3.79 | 3.48 | 3.76 | 3.69 | 4.03 | 4.07 |

Shading indicates relative importance of each competency according to Program Management respondents: green = high importance; yellow = medium importance; no shading = lower importance.

## Section summary

We classified competencies by their relative importance to the top three largest SPRDE workforce communities: Systems Engineering, Science & Other Engineering, and Program Management. Through this analysis, we found that the Systems Engineering and Program Management responses closely align to the SPRDE competency model; the Science & Other

Engineering community does not. We also found that competencies identified as highly important to Systems Engineering respondents are a subset of the competencies identified as highly important to Program Management respondents. The relative importance of each competency varies among certification levels within each community.

Professional competencies were consistently determined to be highly important to the respondents within the three workforce communities we analyzed and across all certification levels within those communities. They also have the highest mean criticality and frequency ratings of all competencies. This finding could indicate that the entire workforce shares a common regard for professionalism or it could be an acknowledgement by the workforce that SPRDE management places high value on professional competencies.

# Section 5: Proficiency ratings

In this section we present the average and most common proficiency ratings provided by assessment participants for all competencies in the SPRDE competency model. We display our results by workforce community and certification level at the competency level. We finish our discussion by highlighting the proficiency of the highly important competencies.

## Proficiency ratings of Systems Engineering respondents

**Most Level 1 certified Systems Engineering respondents report having the ability to apply most competencies in somewhat complex situations.**

Most Level 1 Systems Engineering assessment participants responded that they apply most competencies in *somewhat complex* situations (scale rating of 2). Mean proficiency values for most competencies rated by Level 1 certified Systems Engineering respondents are between 2.0 and 3.0.

Responses indicate that most Level 1 respondents apply the following 10 competencies in *complex* situations (scale rating of 3):

- Competency 5: Requirements Analysis
- Competency 6: Architecture Design
- Competency 7: Implementation
- Competency 9: Verification
- Competency 10: Validation
- Competency 24: Systems Engineering Leadership
- Competency 26: Communication

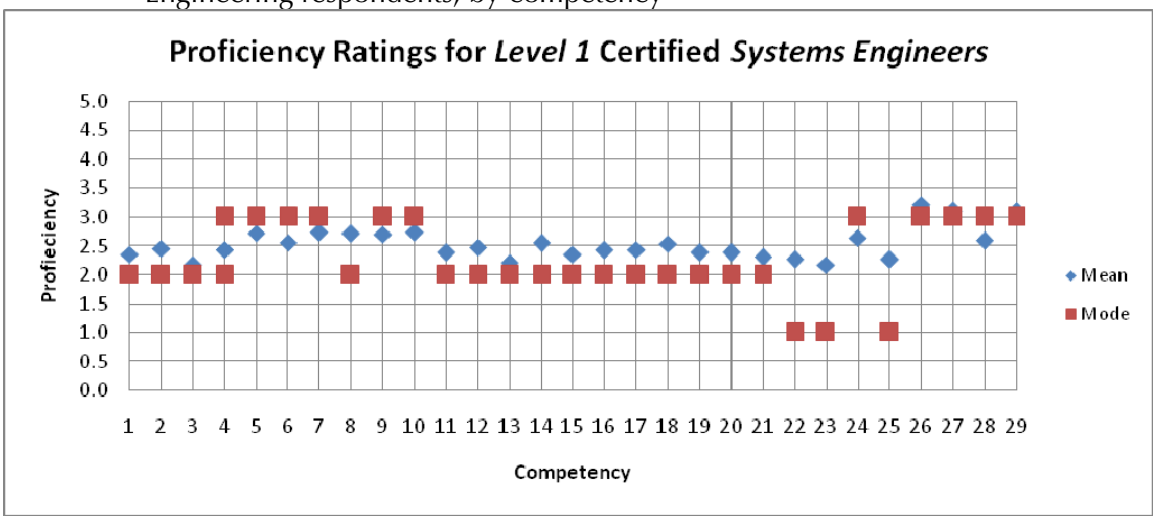
- Competency 27: Problem Solving
- Competency 28: Strategic Thinking
- Competency 29: Professional Ethics.

For three competencies, most Level 1 respondents reported applying the competency in *simple* situations (scale rating of 1). The three competencies are:

- Competency 22: Software Engineering
- Competency 23: Acquisition
- Competency 25: System of Systems.

However, for one competency—Competency 4: Stakeholder Requirements Definition—respondents most often rated proficiency as *basic* as well as *intermediate*. These results are presented in Figure 6.

Figure 6. Average and common proficiency ratings for Level 1 certified Systems Engineering respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Most Level 2 certified Systems Engineering respondents report having intermediate proficiency in most competencies.**

Most Level 2 Systems Engineering respondents indicated that they apply most competencies in *complex* situations (scale rating

of 3). Mean proficiency values for most competencies rated by Level 2 certified Systems Engineering respondents are between 2.5 and 3.0.

Responses indicate that most Level 2 respondents apply two competencies in *considerably complex* situations (scale rating of 4):

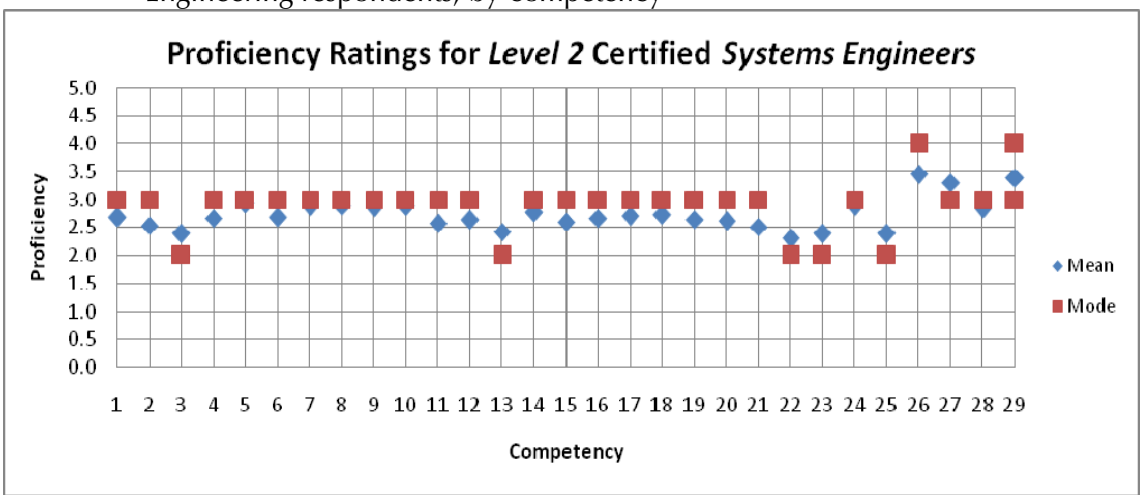
- Competency 26: Communication
- Competency 29: Professional Ethics.

The ability to apply competencies in *somewhat complex* situations (scale rating of 2) was the most commonly provided response by Level 2 respondents for five competencies:

- Competency 3: Safety Assurance
- Competency 13: Reliability, Availability, & Maintainability (RAM)
- Competency 22: Software Engineering
- Competency 23: Acquisition
- Competency 25: System of Systems.

Level 2 Systems Engineering respondents were split in how they reported one competency, applying Competency 29: Professional Ethics, in both *intermediate* and *advanced* situations. These results are presented in Figure 7.

Figure 7. Average and common proficiency ratings for Level 2 certified Systems Engineering respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Most Level 3 certified Systems Engineering respondents report having intermediate proficiency in most competencies.**

Level 3 Systems Engineering respondents most often reported that they apply most competencies in *complex* situations (scale rating of 3). Mean proficiency values for most competencies rated by Level 3 certified Systems Engineering respondents are between 3.0 and 3.5.

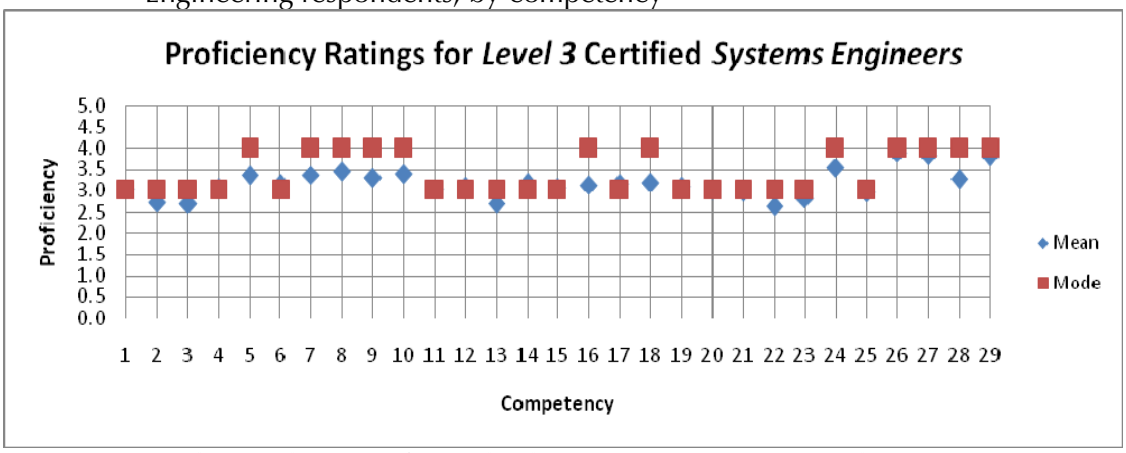
Level 3 respondents most often reported applying 12 competencies in *considerably complex* situations (scale rating of 4):

- Competency 5: Requirements Analysis
- Competency 7: Implementation
- Competency 8: Integration
- Competency 9: Verification
- Competency 10: Validation
- Competency 16: Technical Assistance
- Competency 18: Requirements Management

- Competency 24: Systems Engineering Leadership
- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 28: Strategic Thinking
- Competency 29: Professional Ethics.

These results are presented in Figure 8.

Figure 8. Average and common proficiency ratings for Level 3 certified Systems Engineering respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Mean proficiency ratings of Systems Engineering respondents for most competencies identified as highly important are above 3.0.**

We summarize the mean proficiency results of high importance competencies as rated by Systems Engineering respondents:

- *Level 1* - Mean proficiency ratings are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>three of four</u> high importance competencies**.

- *Level 2* - Mean proficiency ratings are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>three of four</u> high importance competencies.**

- *Level 3* - Mean proficiency levels are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>all</u> nine high importance competencies.**

The mean proficiency ratings of Level 1 and Level 2 certified Systems Engineering respondents for Competency 5, Requirements Analysis fall below *intermediate*. Our results are presented in Table 14.

Table 14. Mean proficiency ratings for the Systems Engineering community, by competency and certification level

| # | Competency | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| 1 | Technical Basis for Cost | 2.36 | 2.68 | 3.05 |
| 2 | Modeling and Simulation | 2.46 | 2.54 | 2.72 |
| 3 | Safety Assurance | 2.16 | 2.39 | 2.68 |
| 4 | Stakeholder Requirements Definition (Requirements Development) | 2.44 | 2.67 | 3.06 |
| 5 | Requirements Analysis (Logical Analysis) | 2.72 | 2.92 | 3.35 |
| 6 | Architecture Design (Design Solution) | 2.56 | 2.68 | 3.16 |
| 7 | Implementation | 2.73 | 2.88 | 3.37 |
| 8 | Integration | 2.71 | 2.89 | 3.44 |
| 9 | Verification | 2.70 | 2.85 | 3.29 |
| 10 | Validation | 2.73 | 2.88 | 3.38 |
| 11 | Transition | 2.38 | 2.57 | 3.05 |
| 12 | System Assurance | 2.48 | 2.63 | 3.10 |
| 13 | Reliability, Availability & Maintainability (RAM) | 2.21 | 2.42 | 2.69 |
| 14 | Decision Analysis | 2.55 | 2.76 | 3.18 |
| 15 | Technical Planning | 2.36 | 2.61 | 3.07 |
| 16 | Technical Assessment | 2.43 | 2.67 | 3.13 |
| 17 | Configuration Management | 2.43 | 2.70 | 3.15 |
| 18 | Requirements Management | 2.53 | 2.73 | 3.18 |
| 19 | Risk Management | 2.38 | 2.64 | 3.09 |
| 20 | Technical Data Management | 2.38 | 2.61 | 3.01 |
| 21 | Interface Management | 2.31 | 2.51 | 2.96 |
| 22 | Software Engineering | 2.26 | 2.31 | 2.63 |
| 23 | Acquisition | 2.17 | 2.40 | 2.82 |
| 24 | Systems Engineering Leadership | 2.64 | 2.88 | 3.53 |
| 25 | System of Systems | 2.26 | 2.40 | 2.96 |
| 26 | Communication | 3.21 | 3.44 | 3.88 |
| 27 | Problem Solving | 3.09 | 3.31 | 3.82 |
| 28 | Strategic Thinking | 2.58 | 2.83 | 3.27 |
| 29 | Professional Ethics | 3.11 | 3.39 | 3.80 |

Shading indicates relative importance of each competency according to the Systems Engineering community: green = high importance; yellow = medium importance; no shading = least important.

## Proficiency ratings of Program Management respondents

**Most Level 1 certified Program Management respondents report having intermediate proficiency in most competencies.**

Most Level 1 Program Management respondents report applying most competencies in *complex* situations (scale rating of 3). Mean proficiency values for most competencies rated by Level 1 certified Program Management respondents are between 2.5 and 3.0.

Level 1 respondents report applying two competencies in *considerably complex* situations (scale rating of 4):

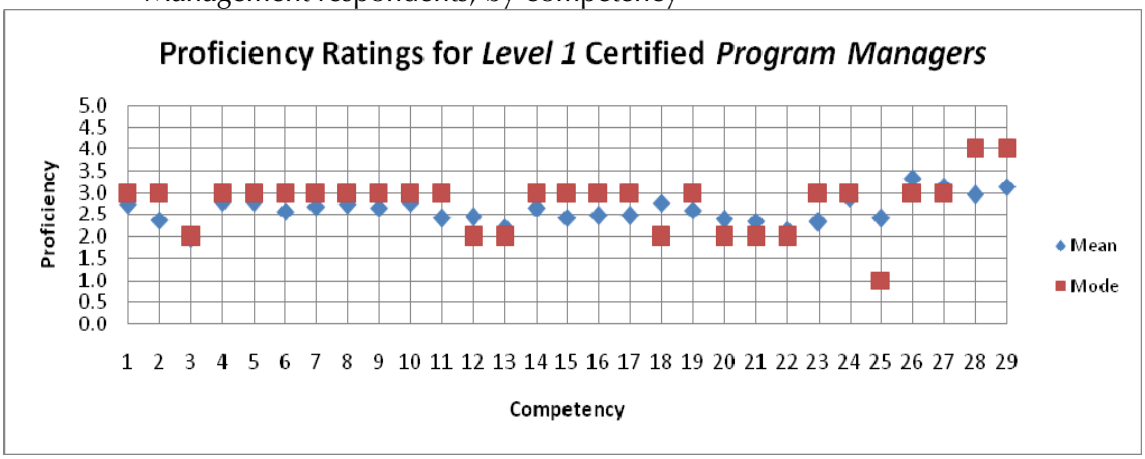
- Competency 28: Strategic Thinking
- Competency 29: Professional Ethics.

Level 1 respondents often rated several competencies below the intermediate proficiency rating (scale rating of 3). These responses suggest that most Level 1 Program Management respondents apply seven competencies in *somewhat complex* situations (scale rating of 2):

- Competency 3: Safety Assurance
- Competency 12: System Assurance
- Competency 13: Reliability, Availability, & Maintainability (RAM)
- Competency 18: Requirements Management
- Competency 20: Technical Data Management
- Competency 21: Interface Management
- Competency 22: Software Engineering.

Proficiency responses also suggest that most Level 1 respondents apply Competency 25, System of Systems, in *simple* situations (scale rating of 1). These results are presented in Figure 9.

Figure 9. Average and common proficiency ratings for Level 1 certified Program Management respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Most Level 2 certified Program Management respondents report having intermediate proficiency in most competencies.**

Most Level 2 Program Management respondents indicated that they can apply most competencies in *complex* situations (scale rating of 3). Mean proficiency values for most competencies rated by Level 2 certified Program Management respondents are between 2.5 and 3.0.

Responses suggest that Level 2 respondents most often apply three competencies in *considerably complex* situations (scale rating of 4):

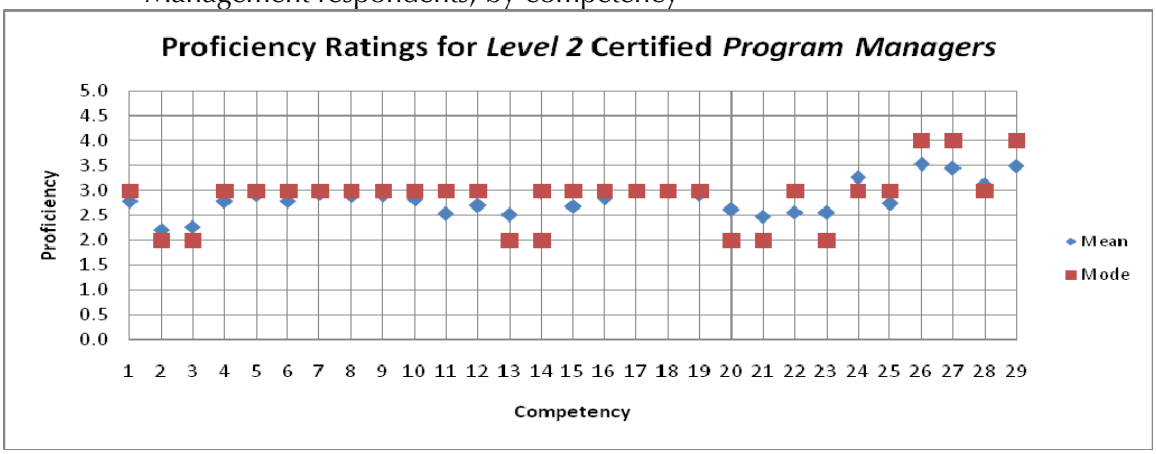
- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 29: Professional Ethics.

Level 2 respondents most often apply six competencies in *somewhat complex* situations (scale ratings of 2):

- Competency 2: Modeling and Simulation
- Competency 3: Safety Assurance
- Competency 13: Reliability, Availability, & Maintainability (RAM)
- Competency 20: Technical Data Management
- Competency 21: Interface Management
- Competency 23: Acquisition.

Level 2 respondents were split in how they reported one competency, applying Competency 14: Decision Analysis, in both *basic* and *intermediate* situations. These results are presented in Figure 10.

Figure 10. Average and common proficiency ratings for Level 2 certified Program Management respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Most Level 3 certified Program Management respondents report having intermediate proficiency in most competencies.**

Level 3 Program Management respondents most often reported that they apply competencies in *complex* situations (scale rating of 3). Mean proficiency values for most competencies rated by

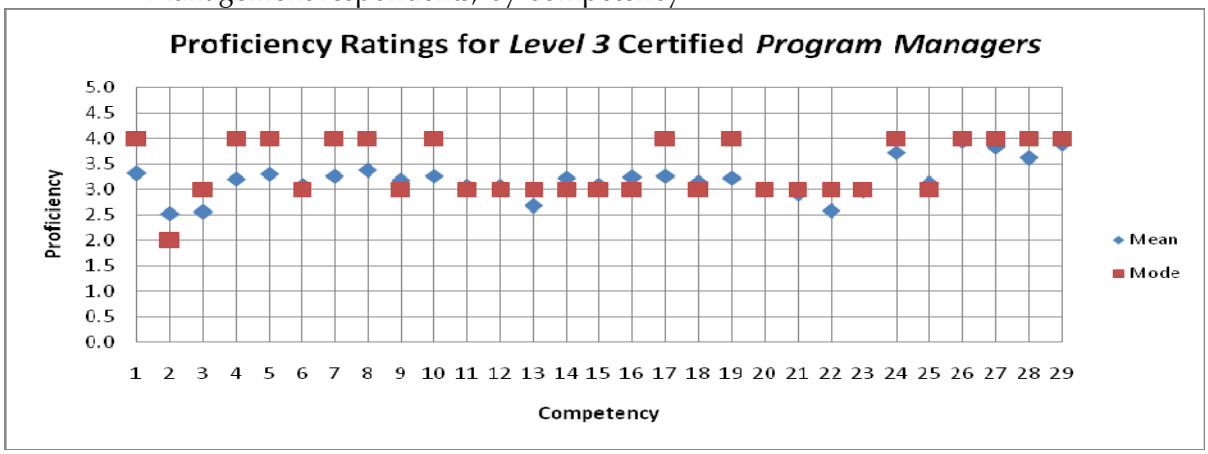
Level 3 certified Program Management respondents are between 3.0 and 3.5.

Level 3 respondents reported applying 13 competencies in *considerably complex* situations (scale rating of 4):

- Competency 1: Technical Basis for Cost
- Competency 4: Stakeholder Requirements Definition
- Competency 5: Requirements Analysis
- Competency 7: Implementation
- Competency 8: Integration
- Competency 10: Validation
- Competency 17: Configuration Management
- Competency 19: Risk Management
- Competency 24: Systems Engineering Leadership
- Competency 26: Communication
- Competency 27: Problem Solving
- Competency 28: Strategic Thinking
- Competency 29: Professional Ethics.

Level 3 respondents most often apply one competency—Competency 2: Modeling and Simulation—in *somewhat complex* situations (scale rating of 2). These results are presented in Figure 11.

Figure 11. Average and common proficiency ratings for Level 3 certified Program Management respondents, by competency




Competency numbers can be cross-referenced with competency names in Appendix A.

**Mean proficiency ratings of Program Management respondents for most competencies identified as highly important are above 3.0.**

The mean proficiency results of high importance competencies as rated by Program Management respondents are as follows:

- *Level 1* - Mean proficiency levels are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>three of seven</u> high importance competencies.**
- *Level 2* - Mean proficiency levels are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>all</u> five high importance competencies**.
- *Level 3* - Mean proficiency levels are **between 3.0 (*intermediate*) and 4.0 (*advanced*) for <u>all</u> 14 high importance competencies**.

The four competencies of high importance to Level 1 certified Program Management respondents whose mean proficiency ratings are below 3.0 are:

- Competency 1: Technical Basis for Cost
- Competency 5: Requirements Analysis
- Competency 24: Systems Engineering Leadership
- Competency 28: Strategic Thinking.

We present our results in Table 15.

Table 15. Mean proficiency ratings for the Program Management community, by competency and certification level

| # | Competency | Level 1 | Level 2 | Level 3 |
|---|---|---|---|---|
| 1 | Technical Basis for Cost | 2.73 | 2.77 | 3.32 |
| 2 | Modeling and Simulation | 2.37 | 2.21 | 2.52 |
| 3 | Safety Assurance | 1.97 | 2.27 | 2.56 |
| 4 | Stakeholder Requirements Definition (Requirements Development) | 2.79 | 2.77 | 3.20 |
| 5 | Requirements Analysis (Logical Analysis) | 2.79 | 2.92 | 3.31 |
| 6 | Architecture Design (Design Solution) | 2.58 | 2.78 | 3.09 |
| 7 | Implementation | 2.69 | 2.94 | 3.27 |
| 8 | Integration | 2.74 | 2.89 | 3.37 |
| 9 | Verification | 2.67 | 2.90 | 3.17 |
| 10 | Validation | 2.78 | 2.83 | 3.26 |
| 11 | Transition | 2.43 | 2.53 | 3.05 |
| 12 | System Assurance | 2.44 | 2.69 | 3.05 |
| 13 | Reliability, Availability & Maintainability (RAM) | 2.21 | 2.51 | 2.68 |
| 14 | Decision Analysis | 2.65 | 2.97 | 3.22 |
| 15 | Technical Planning | 2.44 | 2.68 | 3.08 |
| 16 | Technical Assessment | 2.49 | 2.84 | 3.23 |
| 17 | Configuration Management | 2.47 | 2.99 | 3.26 |
| 18 | Requirements Management | 2.78 | 2.99 | 3.14 |
| 19 | Risk Management | 2.61 | 2.92 | 3.22 |
| 20 | Technical Data Management | 2.40 | 2.62 | 3.00 |
| 21 | Interface Management | 2.34 | 2.48 | 2.91 |
| 22 | Software Engineering | 2.16 | 2.56 | 2.58 |
| 23 | Acquisition | 2.34 | 2.55 | 2.97 |
| 24 | Systems Engineering Leadership | 2.88 | 3.25 | 3.71 |
| 25 | System of Systems | 2.42 | 2.74 | 3.12 |
| 26 | Communication | 3.33 | 3.52 | 3.95 |
| 27 | Problem Solving | 3.13 | 3.44 | 3.83 |
| 28 | Strategic Thinking | 2.96 | 3.12 | 3.61 |
| 29 | Professional Ethics | 3.14 | 3.49 | 3.89 |

Shading indicates relative importance of each competency according to the Program Management community: green = high importance; yellow = medium importance; no shading = least important.

## Frequency distribution of proficiency rating responses for Systems Engineering and Program Management respondents, by certification level

We also investigated the frequency distribution of proficiency responses to each competency by certification level for the Systems Engineering and Program Management communities. In most cases we observed, for a given competency, a somewhat even distribution of responses across two or three ratings with a much smaller number of responses for the remaining ratings. We also observed that the center of the proficiency distribution shifts to the right (toward higher ratings) with increasing certification level, which is consistent with our average analysis findings. Finally, although none of the findings discussed thus far in the report indicate that respondents are able to apply competencies in *exceptionally complex* situations (expert: scale rating of 5), we found that a cadre of these employees resides within each certification level. Our analysis suggests that the percentage of *experts* in each grouping increases with increasing certification level and the largest percentage of experts are Level 3 certified Program Management respondents. We present the full set of frequency distributions in Appendix F.

## Section summary

Analysis of proficiency responses by competency suggests that most Systems Engineering and Program Management respondents are applying most competencies in *complex* situations (scale rating of 3). However, Level 1 certified Systems Engineering respondents perceive themselves as the exception, reporting the ability to apply most competencies in *somewhat complex* situations (scale rating of 2).

For both the Systems Engineering and Program Management workforce communities, mean proficiency ratings increase with increasing certification level. Respondents in both groupings and across all certification levels (except Level 1 certified Systems Engineering respondents) often report being able to

apply two or more Professional competencies in *considerably complex* situations. Level 3 respondents often report being able to apply several Analytic and Technical Management competencies in *considerably complex* situations, as well. Level 3 certified Program Management respondents often rated themselves as being able to apply more competencies in *considerably complex* situations than Level 3 Systems Engineering respondents.

Mean proficiency ratings for all highly important Professional competencies in both communities and at all certification levels are above 3.0 (*intermediate).* Mean proficiency ratings fall slightly below 3.0 for Level 1 and Level 2 certified Systems Engineering respondents in the one Analytical and Technical Management competency identified as highly important to their jobs. Some Analytical and Technical Management competencies determined as highly important to Level 1 Program Management respondents also fall slightly below 3.0. For all other highly important competencies mean proficiency ratings are 3.0 and above.

The results of our proficiency analyses should not be used to judge whether adequate levels of proficiency have been achieved for each grouping we investigated for two main reasons:

- Although our mean and mode proficiency analyses suggest that most assessment respondents are *intermediately* proficient (scale rating of 3) in most competencies, in many cases our frequency distribution analysis indicates that other respondents feel that they are more or less proficient than the averages.

- Given that no proficiency standards exist for the SPRDE workforce, a lower than *intermediate* proficiency rating does not necessarily indicate a deficiency. Likewise, one grouping of the workforce may have consistently rated itself above *intermediate* proficiency in a given competency, but the proficiency rating might fall well short of what is actually needed to get the job done. Alternately, it may not be necessary for employees at

certain certification levels and/or in certain communities to be proficient in some competencies.

Therefore, SPRDE leadership should consider using the proficiency analyses in this report as the impetus for developing proficiency standards. Once standards are set, results such as these can be used to discover if and where deficiencies exist in the SPRDE workforce.

This page intentionally left blank.

# Section 6: Retirement impact

In this section we discuss our predictions concerning the effect of near-term retirement (five years) on the SPRDE workforce as a whole, the workforce segments as well as the Systems Engineering and Program Management communities. These predictions only apply to federal civilian respondents. However, the majority of the SPRDE workforce is federal civilian.

We base our estimates of retirement behavior on the recent retirement behavior of Navy civilian personnel, which was separately analyzed in Koopman, McIntosh, and McHugh (2010).[10]The method we use to apply these estimates to the SPRDE sample is captured in Appendix G.

Across the sample of 9,642 SPRDE personnel, we estimate approximately 24 percent will be eligible to retire in the next five years and, among those who are eligible to retire, approximately 44 percent will retire in that timeframe. Therefore, among all SPRDE individuals (both eligible and ineligible to retire in the next five years), we estimate that 11 percent will retire in the next five years (Table 16).

Table 16. Estimated five-year probabilities: eligibility and retirement

| | N | Average | Standard deviation |
|---|---|---|---|
| Pr(eligible) | 9,642 | 0.24 | 0.37 |
| Pr(retire \| Pr(eligible)>0) | 3,106 | 0.44 | 0.13 |
| Pr(retire) | 9,642 | 0.11 | 0.17 |

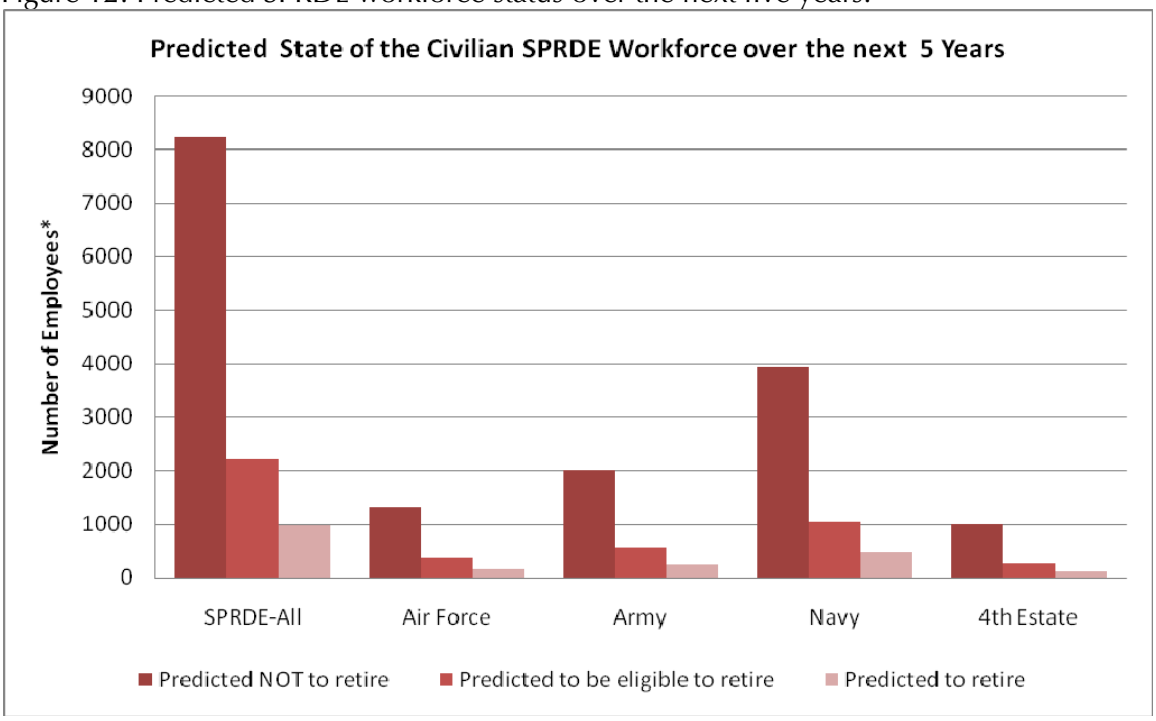
[10] Martha Koopman et al. *Causes and Consequences of Navy Civilians' Retirement Behavior,* Jan 2010 (CNA Research Memorandum D0022018.A1/Final)

We use these retirement estimates to predict the impact of near-term retirement on the SPRDE workforce as a whole, on each workforce segment, and on the Systems Engineering and Program Management workforce communities in terms of numbers of respondents. We then examine the impact of near-term retirement on mean proficiency levels for the workforce communities. We present the values for all competencies, noting the relative importance of each.

## Predicted employee losses

Our analysis of respondent-provided demographic data suggests that slightly more than 2,000 SPRDE respondents will be eligible to retire over the next five years, but we predict that only about 1,000 will actually retire. The percentages of respondents predicted NOT to retire, respondents predicted to be eligible to retire, and respondents predicted to retire are comparable across all SPRDE segments (Figure 12). Approximately 500 of the respondents predicted to retire are in Systems Engineering and about 74 of them are in Program Management (Table 17).

Figure 12. Predicted SPRDE workforce status over the next five years.




This graph reflects retirement prediction data for federal civilians who participated in the assessment and who participate in either the Civil Service Retirement System (CSRS) f or the Federal Employees Retirement System (FERS) retirement plan.

Table 17. Number of respondents predicted NOT to retire from the Systems Engineering and Program Management workforce communities over the next five years relative to current numbers

| Number of respondents | Systems Engineering | Program Management |
|---|---|---|
| Total no. of respondents considered* | 5293 | 561 |
| No. of respondents predicted NOT to retire over the next five years | 4791 | 486 |

*Federal civilians who participated in the assessment and who participate in either the CSRS or the FERS retirement plan.

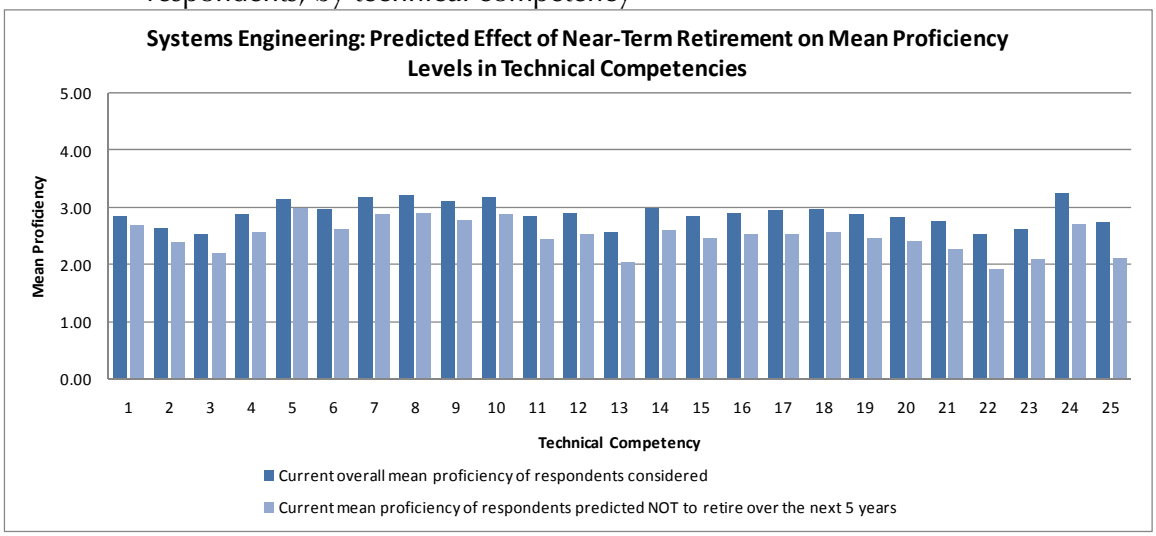
# Predicted effects on proficiency

## Systems Engineering

In Figures 13 and 14 we present current overall mean proficiency levels for federal civilian Systems Engineering respondents versus the current mean proficiency levels of

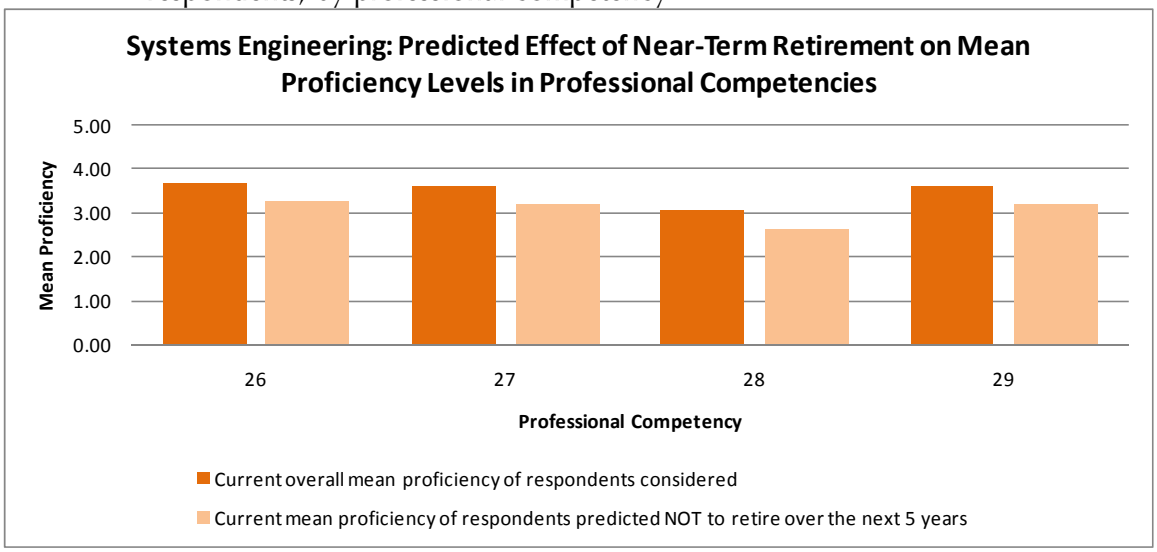
federal civilian respondents predicted not to retire over the next five years. Our retirement predictions show that the respondents predicted not to retire have lower proficiency in all competencies, and the difference is largest for several technical competencies (e.g., 13, 21, 22, 23, 24, and 25) and all professional competencies.

Figure 13. Comparison of current mean proficiency ratings for civilian Systems Engineering respondents, by technical competency




Competency numbers can be cross-referenced with competency names in Appendix A.

Figure 14. Comparison of current mean proficiency ratings for civilian Systems Engineering respondents, by professional competency




Competency numbers can be cross-referenced with competency names in Appendix A.

In Table 18 we present by competency the predictions represented in Figures 13 and 14, for Systems Engineering respondents. Competencies shaded in green have high importance, those shaded in yellow have medium importance, and those with no shading have lower importance. Among highly important competencies, the greatest difference in current mean proficiency ratings is predicted to be in Systems Engineering Leadership (approximately 16 percent). The professional competencies Problem Solving, Professional Ethics and Communication are predicted to be the next most highly impacted (between 11 percent and 12 percent) by near-term retirement, in terms of proficiency.

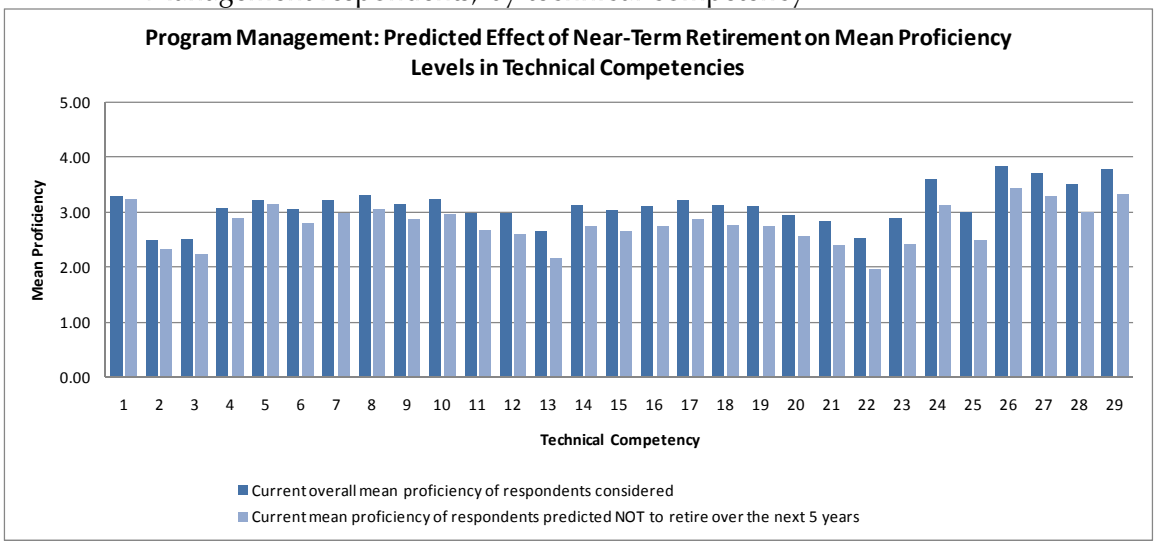
Table 18. Comparison for civilian Systems Engineering respondents of current overall mean proficiency ratings versus current mean proficiency ratings for respondents predicted NOT to retire over the next five years

| Competency Name | Current Mean Proficiency of Respondents Considered | Current Mean Proficiency of Respondents Predicted NOT to Retire Over the Next Five Years | % Difference in Proficiency |
|---|---|---|---|
| Systems Engineering Leadership | 3.26 | 2.72 | -16.37% |
| Problem Solving | 3.59 | 3.18 | -11.42% |
| Professional Ethics | 3.59 | 3.19 | -11.36% |
| Communication | 3.67 | 3.27 | -11.02% |
| Integration | 3.22 | 2.90 | -9.87% |
| Implementation | 3.18 | 2.88 | -9.44% |
| Requirements Analysis (Logical Analysis) | 3.16 | 3.00 | -5.19% |
| Strategic Thinking | 3.06 | 2.59 | -15.42% |
| Risk Management | 2.87 | 2.46 | -14.45% |
| Requirements Management | 2.98 | 2.57 | -13.63% |
| System Assurance | 2.91 | 2.53 | -13.08% |
| Architecture Design (Design Solution) | 2.98 | 2.63 | -11.59% |
| Verification | 3.12 | 2.79 | -10.49% |
| Stakeholder Requirements Definition (Requirements Development) | 2.87 | 2.58 | -10.24% |
| Validation | 3.19 | 2.88 | -9.68% |
| Software Engineering | 2.52 | 1.92 | -23.78% |
| System of Systems | 2.73 | 2.13 | -22.03% |
| Reliability, Availability & Maintainability (RAM) | 2.57 | 2.04 | -20.67% |
| Acquisition | 2.63 | 2.11 | -19.97% |
| Interface Management | 2.77 | 2.29 | -17.30% |
| Technical Data Management | 2.83 | 2.41 | -14.89% |
| Transition | 2.86 | 2.45 | -14.15% |
| Technical Planning | 2.86 | 2.46 | -13.91% |
| Configuration Management | 2.95 | 2.54 | -13.84% |
| Decision Analysis | 2.99 | 2.60 | -13.08% |
| Technical Assessment | 2.91 | 2.53 | -13.03% |
| Safety Assurance | 2.53 | 2.21 | -12.98% |
| Modeling and Simulation | 2.64 | 2.40 | -9.25% |
| Technical Basis for Cost | 2.86 | 2.69 | -6.00% |

## Program Management

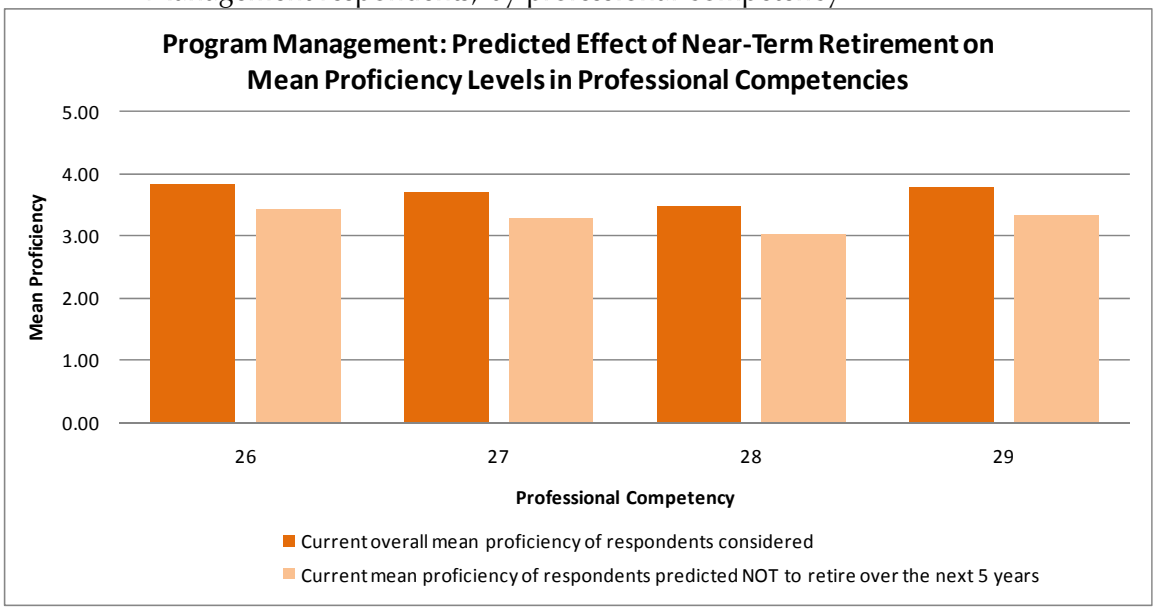
In Figures 15 and 16, we present the current overall mean proficiency levels for Program Management respondents versus the current mean proficiency levels of the respondents predicted NOT to retire over the next five years. In aggregate these results seem very similar to what we found for Systems Engineering respondents.

Figure 15. Comparison of current mean proficiency ratings for civilian Program Management respondents, by technical competency




Competency numbers can be cross-referenced with competency names in Appendix A.

Figure 16. Comparison of current mean proficiency ratings for civilian Program Management respondents, by professional competency




Competency numbers can be cross-referenced with competency names in Appendix A.

In Table 19, we present by competency the predictions represented in Figures 15 and 16, for Program Management respondents. Among highly important competencies the greatest difference in current proficiency ratings is in Strategic Thinking and in Systems Engineering Leadership (about 14 percent). Professional Ethics, Risk Management, Problem Solving, Configuration Management, and Communication are predicted to be the next most impacted (between about 11 and 12 percent) by near-term retirement, in terms of proficiency.

Table 19. Comparison for civilian Program Management respondents of current overall mean proficiency ratings versus current mean proficiency ratings for respondents predicted NOT to retire over the next five years

| Competency Name | Current Mean Proficiency of Respondents Considered | Current Mean Proficiency of Respondents Predicted NOT to Retire Over the Next Five Years | % Difference in Proficiency |
|---|---|---|---|
| Strategic Thinking | 3.49 | 3.01 | -13.60% |
| Systems Engineering Leadership | 3.60 | 3.11 | -13.60% |
| Professional Ethics | 3.78 | 3.32 | -12.10% |
| Risk Management | 3.10 | 2.74 | -11.75% |
| Problem Solving | 3.71 | 3.28 | -11.53% |
| Configuration Management | 3.22 | 2.86 | -11.04% |
| Communication | 3.83 | 3.42 | -10.89% |
| Integration | 3.31 | 3.05 | -7.63% |
| Implementation | 3.21 | 2.98 | -7.15% |
| Stakeholder Requirements Definition (Requirements Development) | 3.07 | 2.88 | -6.31% |
| Requirements Analysis (Logical Analysis) | 3.22 | 3.14 | -2.47% |
| Technical Basis for Cost | 3.29 | 3.23 | -1.83% |
| System of Systems | 3.01 | 2.47 | -17.70% |
| Interface Management | 2.84 | 2.38 | -16.18% |
| System Assurance | 2.98 | 2.61 | -12.62% |
| Decision Analysis | 3.11 | 2.75 | -11.73% |
| Technical Assessment | 3.11 | 2.75 | -11.43% |
| Requirements Management | 3.11 | 2.77 | -10.78% |
| Validation | 3.25 | 2.96 | -8.83% |
| Verification | 3.14 | 2.87 | -8.49% |
| Architecture Design (Design Solution) | 3.04 | 2.80 | -7.83% |
| Software Engineering | 2.53 | 1.97 | -21.99% |
| Reliability, Availability & Maintainability (RAM) | 2.64 | 2.16 | -18.15% |
| Acquisition | 2.89 | 2.41 | -16.66% |
| Technical Data Management | 2.92 | 2.55 | -12.86% |
| Technical Planning | 3.02 | 2.65 | -12.16% |
| Safety Assurance | 2.51 | 2.24 | -10.92% |
| Transition | 2.98 | 2.67 | -10.50% |
| Modeling and Simulation | 2.49 | 2.33 | -6.49% |

## Section summary

We calculated retirement eligibility and retirement probabilities based on several demographic items, which allowed us to estimate the impact of employee losses due to federal-civilian retirement within the next five years. Based on these probabilities we predict that approximately 1,000 respondents will retire over the next five years across all SPRDE segments. Roughly 500 of the predicted retirees are Systems Engineering respondents and about 70 are Program Management respondents.

Retirement losses are expected to impact proficiency levels; however, further analysis is required in order to determine whether the impact is normal and/or significant. Among high importance competencies, Systems Engineering Leadership and the professional competencies are predicted to be relatively more affected by retirements, both for the Systems Engineering workforce community and the Program Management workforce community. However, Program Management has three other highly important competencies that will be relatively more affected by retirements: Strategic Thinking, Risk Management, and Configuration Management.

# Section 7: Intentions analysis

In this section we present the results of our analysis of respondent-provided intentions data. Our discussion focuses on how respondent intentions relate to our retirement analyses.

## Competency boost

Results presented in Table 20 are derived from the following intentions question: *Select the top three competencies in which you plan to boost your proficiency during the next 12-month period.* The results are the tabulated responses for the Systems Engineering community ranked according to how frequently they were chosen.

Systems Engineering Leadership was the most frequently selected competency in which Systems Engineering respondents cited an intention to boost their proficiency in the next year. Of the high importance competencies, Systems Engineering Leadership is also the competency we predict will be most affected by retirements over the next five years. Although respondents did not rank them among the top five competency boost choices, many respondents did indicate that they plan to boost their proficiency in another highly important competency: Problem Solving. However, Communication and Professional Ethics, the other high importance professional competencies, ranked twenty-second and twenty-ninth, respectively.

Modeling and Simulation and Integration are the second and third most named competencies in which respondents are planning to boost their proficiency. Integration is a high importance competency, but it is one of the competencies expected to be less affected by retirements. Modeling and Simulation is considered to be a lower importance competency by Systems Engineering respondents, and is on the lower end of the retirement impact spectrum.

Table 20. Competencies in which Systems Engineering respondents intend to boost their proficiency during the next 12 months

| Competency | Total # of Times Selected | Selection Rank |
|---|---|---|
| 1. Technical Basis for Cost | 535 | 17 |
| 2. Modeling and Simulation | **918** | **2** |
| 3. Safety Assurance | 233 | 24 |
| 4. Stakeholder Requirements Definition (Requirements Development) | 600 | 9 |
| 5. Requirements Analysis (Logical Analysis) | 637 | 7 |
| 6. Architectural Design (Design Solution) | 623 | 8 |
| 7. Implementation | 362 | 20 |
| 8. Integration | **741** | **3** |
| 9. Verification | 565 | 15 |
| 10. Validation | 360 | 21 |
| 11. Transition | 140 | 28 |
| 12. System Assurance | 218 | 26 |
| 13. Reliability, Availability, and Maintainability (RAM) | 518 | 18 |
| 14. Decision Analysis | 231 | 25 |
| 15. Technical Planning | 567 | 13 |
| 16. Technical Assessment | 683 | 6 |
| 17. Configuration Management | 567 | 14 |
| 18. Requirements Management | 502 | 19 |
| 19. Risk Management | 730 | 4 |
| 20. Technical Data Management | 292 | 23 |
| 21. Interface Management | 172 | 27 |
| 22. Software Engineering | 587 | 10 |
| 23. Acquisition | 713 | 5 |
| 24. System Engineering Leadership | **1788** | **1** |
| 25. System of Systems | 541 | 16 |
| 26. Communications | 323 | 22 |
| 27. Problem Solving | 570 | 12 |
| 28. Strategic Thinking | 575 | 11 |
| 29. Professional Ethics | 92 | 29 |

This table counts the responses of assessment participants who indicated their certification level as 1, 2, or 3. Bold text highlighted in yellow indicates top three choices.

Program Management responses to the competency boost intentions question are presented in Table 21. We compare the top competencies in this table with the competencies expected to be most affected by retirement over the next five years. Strategic Thinking, Systems Engineering Leadership, Risk Management, Problem Solving, Configuration Management, Communication and Professional Ethics are all high importance competencies expected to be relatively more affected by retirements. Relatively more respondents express intention to boost their proficiency in all of these except Professional Ethics.

Professional Ethics ranked second to last in planned proficiency boost.

Relatively more respondents plan to boost Acquisition, a lower importance competency, but one that will be relatively more affected by retirements.

Table 21. Competencies Program Management respondents intend to boost their proficiency in during the next 12 months

| Competency | Total # of Times Selected | Selection Rank |
|---|---|---|
| 1. Technical Basis for Cost | 92 | 6 |
| 2. Modeling and Simulation | 54 | 15 |
| 3. Safety Assurance | 17 | 26 |
| 4. Stakeholder Requirements Definition (Requirements Development) | 97 | 5 |
| 5. Requirements Analysis (Logical Analysis) | 65 | 11 |
| 6. Architectural Design (Design Solution) | 46 | 18 |
| 7. Implementation | 36 | 21 |
| 8. Integration | 84 | 8 |
| 9. Verification | 42 | 20 |
| 10. Validation | 21 | 24 |
| 11. Transition | 31 | 22 |
| 12. System Assurance | 17 | 27 |
| 13. Reliability, Availability, and Maintainability (RAM) | 50 | 16 |
| 14. Decision Analysis | 30 | 23 |
| 15. Technical Planning | 79 | 9 |
| 16. Technical Assessment | 45 | 19 |
| 17. Configuration Management | 60 | 13 |
| 18. Requirements Management | 60 | 14 |
| 19. Risk Management | 104 | 4 |
| 20. Technical Data Management | 18 | 25 |
| 21. Interface Management | 14 | 29 |
| 22. Software Engineering | 48 | 17 |
| **23. Acquisition** | **182** | **2** |
| **24. System Engineering Leadership** | **193** | **1** |
| 25. System of Systems | 63 | 12 |
| 26. Communications | 67 | 10 |
| 27. Problem Solving | 86 | 7 |
| **28. Strategic Thinking** | **149** | **3** |
| 29. Professional Ethics | 17 | 28 |

This table counts the responses of assessment participants who indicated their certification level as 1, 2, or 3. Bold text in yellow highlighting indicates top three choices.

Fuller data on the ranking of the top three competencies selected by respondents within the Systems Engineering and Program Management communities are presented in Appendix H.

## Advancement and mentoring intentions

Responses to advancement and mentoring intentions-related questions are consistent between Systems Engineering and Program Management assessment participants (Figures 17 and 18). They indicate that most respondents plan to continue working in the SPRDE career field over the next six months. In addition, respondents generally seem to be motivated to advance professionally, but are not interested in applying for PSE, as indicated by the high percentage of negative and unsure responses to this intentions question. Most respondents are willing to mentor others.

Figure 17. Advancement and mentoring intentions of Systems Engineering respondents

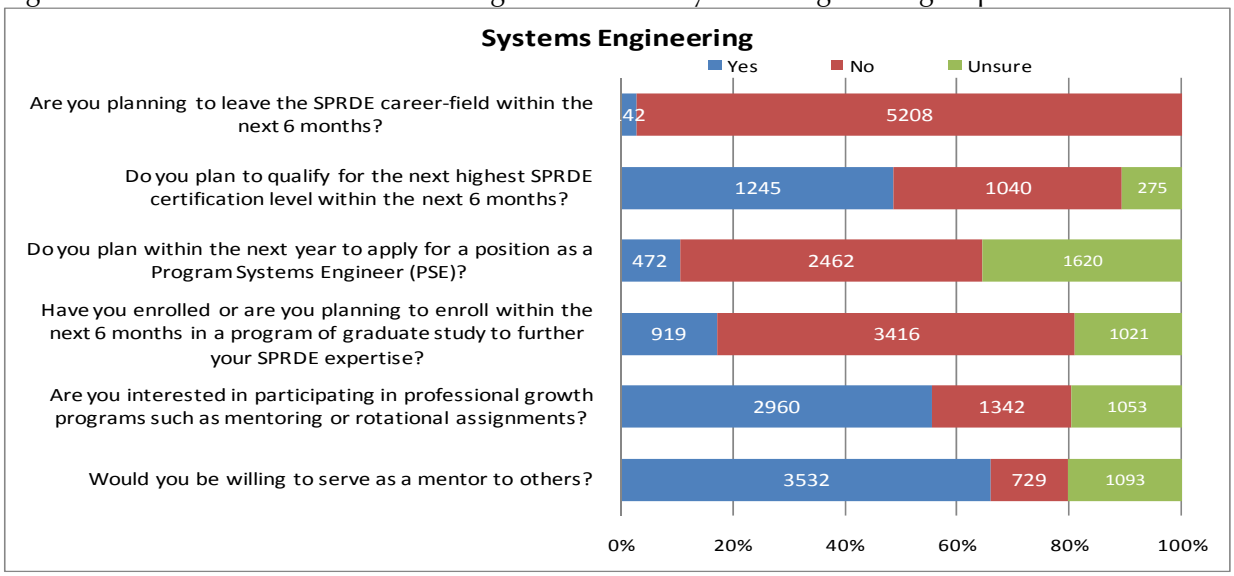
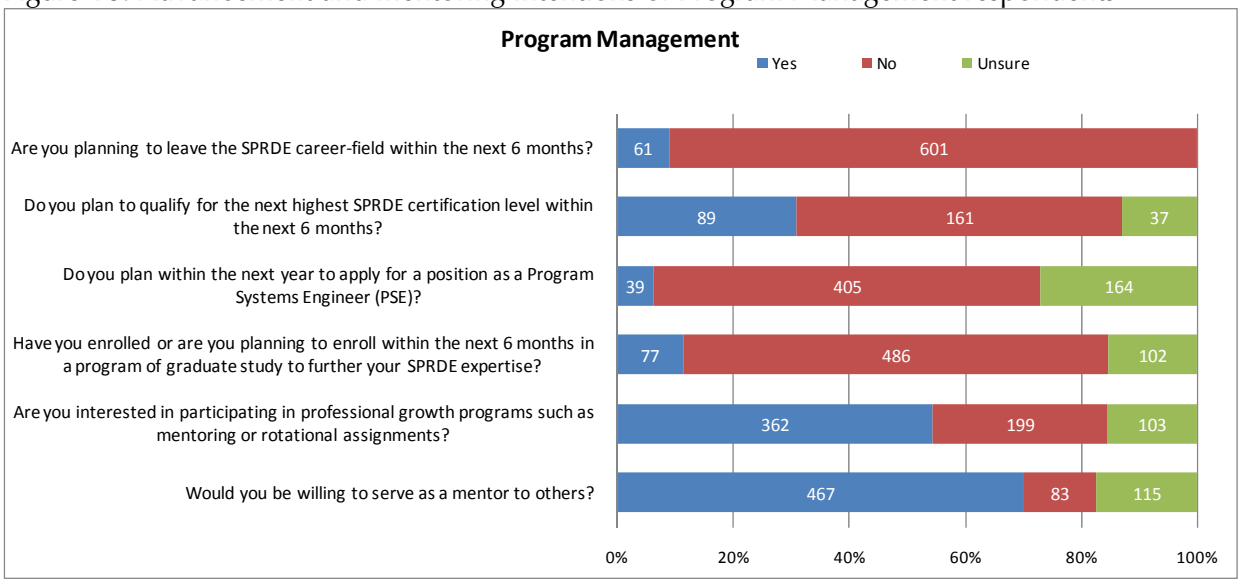


Figure 18. Advancement and mentoring intentions of Program Management respondents




## Section summary

Relatively more respondents report planning to boost their proficiency in several of the high importance competencies predicted to be impacted by near-term retirement including, Systems Engineering Leadership, Problem Solving, Strategic Thinking (PM), Risk Management (PM), and Configuration Management (PM). However, there are mixed intentions on boosting proficiency in Communication, and Professional Ethics (the remaining professional competency of high importance to Systems Engineering and Program Management respondents) ranks lowest of all competencies in intentions to boost proficiency. Intervention methods (e.g., training, mentoring, etc.), if not already in existence, should be put in place to facilitate the development needs of respondents in high importance competencies, specifically those predicted to be substantially affected by the departure of federal civilians in the next five years.

Respondents are interested in professional growth and in mentoring others, but do not have a strong desire to advance to

PSE. SPRDE management should make sure there is a clear distinction between these two career positions and the path from one to the other.

# Section 8: Conclusion and next steps

Our analysis of employee-provided responses to the SPRDE competency assessment suggests that the SPRDE competency model captures technical competencies pertinent to the Systems Engineering and Program Management workforce communities, but not the Science & Other Engineering workforce community. The percentage of responses we received from Systems Engineering and Program Management participants suggest that these two communities represent the majority of the SPRDE workforce. Professional competencies seem to be applicable to all workforce communities.

Systems Engineering and Program Management respondents generally agree on the competencies that are most important to their success on the job; competencies identified as highly important to Systems Engineering respondents are a subset of those considered to be highly important to Program Management respondents. For Systems Engineering respondents, competency importance consistently increases with increasing certification level. In contrast, this pattern of importance does not always apply across certification levels within the Program Management community. Competencies determined to be of high importance to Level 1 certified Program Management are a subset of Level 3 high importance competencies, and Level 2 high importance competencies are a subset of Level 1 high importance competencies.

Systems Engineering and Program Management respondents report *intermediate* to *advanced* proficiency in the competencies of high importance to their respective communities and intermediate proficiency in most other competencies; but some fraction of respondents report the ability to apply most competencies in *somewhat complex* situations or only an awareness of some competencies. Small percentages of respondents report expert proficiency at all levels of certification. Mean proficiency

values increase with increasing certification level and are highest for professional competencies.

Our civilian retirement analysis predicts that approximately 1,000 respondents will retire over the next five years across all SPRDE segments, which will include roughly 500 Systems Engineering respondents and about 70 Program Management respondents. Among competencies found to be highly important to Systems Engineering respondents, Systems Engineering Leadership is expected to be most affected by retirements, followed by the professional competencies. These findings also apply to Program Management respondents, but with the following additions: the high importance competencies Strategic Thinking, Risk Management, and Configuration Management are also expected to be relatively more affected by near-term retirement. Although military respondents are not included in this estimate, we found through our demographic analyses that the majority of the SPRDE workforce is federal civilian.

Systems Engineering and Program Management respondents expressed relatively more intent to boost their proficiency in many of the high importance competencies predicted to experience the greatest proficiency deficit due to near-term retirement. Only two high importance competencies were less consistently mentioned as a competency respondents intend to improve their proficiency: Communication (for Program Management respondents) and Professional Ethics (for both Systems Engineering and Program Management respondents). Our intentions analyses also indicate that respondents are willing to mentor others. Despite a general enthusiasm for professional growth, most respondents do not have a strong desire to advance to PSE.

During discussions in the early stages of the model development, SPRDE management mentioned that they were considering creating certification level(s) beyond Level 3. Responses to the demographic portion of the SPRDE competency assessment reveal that the majority of SPRDE respondents are currently Level 3 certified.

We recommend SPRDE management consider using our analysis results to:

- Develop proficiency standards
- Develop gap-closure strategies for high importance competencies predicted to be relatively more affected by retirement over the next five years
- Consider developing mentoring programs
- Consider the creation of an additional certification level.

Finally, we recommend that a strong emphasis be placed on the development of professional competencies. Responses to the assessment indicate that professional competencies captured in the SPRDE model are universally important to the entire SPRDE workforce and they will likely be substantially impacted by the departure of Level 3 certified employees over the next five years.

This page intentionally left blank.

# Appendix A: SPRDE Workforce Competency Model

Table 22. The Model

| Units of Competence | Competencies | Competency Elements |
|---|---|---|
| Analytical | **Competency 1.** Technical Basis for Cost | **Element 1.** Provide technical basis for comprehensive cost estimates and program budgets that reflect program phase requirements and best practices using knowledge of cost drivers, risk factors, and historical documentation (e.g. hardware, operational software, lab/support software). |
| | **Competency 2.** Modeling and Simulation | **Element 2.** Develop, use, and/or interpret modeling or simulation in support of systems acquisition throughout the entire Defense Acquisition Management System (changed from framework). Understand and use M&S from other domains in support of systems acquisition. |
| | **Competency 3.** Safety Assurance (changed from Safety Analysis) | **Element 3.** Review Safety Assurance artifacts to determine if requirements and constraints needed to meet SE design goals for: Safe For Intended Use (SFIU), warfighter survivability, user safety, software safety, environmental safety, Programmatic Environmental, Safety and Health Evaluations (PESHE), and/or Critical Safety applications were met. |
| | **Competency 4.** Stakeholder Requirements Definition (Requirements Development) | **Element 4**. Elicit inputs from relevant stakeholders and translate the inputs into technical requirements. |
| | **Competency 5.** Requirements Analysis (Logical Analysis) | **Element 5.** Define and refine system, subsystem, and lower-level functional and performance requirements and interfaces to facilitate the Architecture Design process. |
| | **Competency 6.** Architecture Design (Design Solution) | **Element 6.**Identify the full set of decomposed requirements and overall design considerations, across the full system life-cycle and in all operating environments, that should be addressed during systems engineering in order to obtain the "'best value "for the user. |
| | | **Element 7.** Track and manage design considerations (boundaries, interfaces, standards, available production process capabilities, performance and behavior characteristics) to ensure they are properly addressed in the technical baselines. |
| | | **Element 8.** Translate outputs from the Stakeholder Requirements Definition and Requirements Analysis processes to generate a final design or physical architecture, using the Architecture Design process, including reviews of alternative designs. |
| | | **Element 9.** Conduct walkthroughs with stakeholders to ensure that requirements will be met and will deliver |

| Units of Competence | Competencies | Competency Elements |
|---|---|---|
| | | planned systems results under all combination of design usage environments throughout the operational life of a system. |
| | **Competency 7.** Implementation | **Element 10.** Fabricate hardware/code software to realize system elements. |
| | **Competency 8.** Integration | **Element 11.** Use the Integration process to ensure that the lower-level system elements are incorporated into higher-level system elements and that the final system is incorporated into its operational environment. |
| | **Competency 9.** Verification | **Element 12.** Design and implement a testing process to compare a system against required system capabilities, to link Modeling and Simulation (M&S), Developmental Test and Evaluation (DT&E) and Operational Test and Evaluation (OT&E) together, in order to document system capabilities, limitations, and risks. |
| | | **Element 13.** Assess the "Did you build it right?" question in the Verification Process by determining if system elements meet design specifications as defined in the functional, allocated, and product baselines using reviews of test plans, among other inputs. |
| | **Competency 10.** Validation | **Element 14.** Assess the "Did you build the right thing?" question in the Validation Process, by determining whether there was a satisfactory performance of systems within their intended operational environment, using validation metrics. |
| | **Competency 11.** Transition | **Element 15.** Move the system elements to the next Level in the physical architecture or move the end item to the user for use. |
| | **Competency 12.** System Assurance | **Element 16.** Apply and execute the appropriate systems engineering, software assurance, and certification-related policies, principles, and practices across all levels and phases of an acquisition program to increase the level of confidence that a system functions as intended, is free from exploitable vulnerabilities, and protects critical program information. |
| | **Competency 13.** Reliability, Availability & Maintainability (RAM) | **Element 17.** Determine how best to integrate and phase RAM into the systems engineering processes across the design. |
| | | **Element 18.** Evaluate the RAM of systems, including the following: Maintenance Engineering/Sustaining Engineering review and assessment; considerations of different use environments, operators, and maintainers; and the monitoring of performance versus predictions of performance. |
| Technical Management | **Competency 14.** Decision Analysis | **Element 19.** Develop and/or use a Decision Analysis process to incorporate factors such as operational environment, mission performance, cost, and design considerations into decision-making. |
| | **Competency 15.** Technical Planning | **Element 20.** Use Technical Planning to ensure enabling technical and technical management processes, technical reviews, and the program office's organization are documented in the Systems Engineering Plan and applied throughout a system's acquisition lifecycle. |

| Units of Competence | Competencies | Competency Elements |
|---|---|---|
| | **Competency 16.** Technical Assessment | **Element 21.** Develop and/or use Technical Assessment metrics (i.e., Technical Performance Measures, Measures of Effectiveness, requirements compliance, and risk assessments) to measure technical progress, review life-cycle costs, and assess the effectiveness of plans and requirements. |
| | **Competency 17.**Configuration Management | **Element 22.** Use a Configuration Management process to track configuration changes and ensure that a product or system's attributes are consistent with its requirements, evolving technical baseline over its life-cycle. |
| | **Competency 18.** Requirements Management | **Element 23.** Use Requirements Management to trace back to user-defined capabilities and other sources of requirements, and to document all changes and the rationale for those changes. |
| | **Competency 19.** Risk Management | **Element 24.** Develop a Risk Management Plan to cover system and software risk elements in order to assess and manage the risks throughout the life-cycle. |
| | | **Element 25.** Apply the Risk Management process across an acquisition program to manage program technical risk accounting for all relevant design considerations. |
| | **Competency 20.** Technical Data Management | **Element 26.** Evaluate how the Technical Data Management planning process is applied in the context of the Acquisition Strategy to acquire, access, manage, protect, and apply technical data during the system life-cycle. |
| | **Competency 21.** Interface Management | **Element 27.** Apply the Interface Management process to ensure interface compatibility both within the system, including software systems, and with external systems. |
| | | **Element 28.** Evaluate how Interface Management techniques ensure that all internal and external interface changes in requirements are properly documented and communicated in accordance with the configuration management plan. |
| | **Competency 22.** Software Engineering | **Element 29.** Software Measures. Use quantitative methods to assess and track software progress against a baseline (planned vs. actual) and provide status updates in order to make timely program decisions. |
| | | **Element 30.** Integration of Software and Systems Engineering. Integrate essential acquisition and sustainment activities related to software through the use of multidisciplinary teams to optimize design, manufacturing, and supportability processes. |
| | | **Element 31.** Software Impact on Acquisition Strategy. Determine software-related considerations and risks that must be addressed as part of the system acquisition strategy. |
| | | **Element 32.** Software Requirements. Evaluate inputs from relevant stakeholders that translate into functional and technical requirements that are documented, managed, traceable and verifiable through the software life-cycle process and describe the desired behavior of the software system to be built to satisfy the intended |

| Units of Competence | Competencies | Competency Elements |
|---|---|---|
| | | user(s). |
| | | **Element 33.** Software Architecture. Understand the software structure of the system, including the definition of software components, and the relationships between software components, the system, and the operational architectures. |
| | **Competency 23.** Acquisition | **Element 34.** Determine the appropriate amount of systems engineering and the resources needed during each acquisition phase, across the full acquisition and system lifecycle, to achieve acceptable levels of risk for entry into the next acquisition phase. |
| | | **Element 35.** Assess the proposed solution's operational viability and costs of alternative systems during the Materiel Solution Analysis (formerly called Concept Refinement) Phase, taking into account the design considerations to achieve a balanced system design. |
| | | **Element 36.** Integrate proven technologies, develop new hardware/software prototypes, evaluate solutions, and determine performance requirements during the Technology Development Phase to ensure that the cost, schedule, and other constraints are met and that risks are reduced. |
| | | **Element 37.** Integrate hardware, software, and human systems, protect critical program information, ensure safety and affordability, and reduce manufacturing risks during the Engineering and Manufacturing Development (formerly called System Development and Demonstration) Phase to demonstrate supportability and interoperability within incremental stages of system development. |
| | | **Element 38.** Apply a Low-Rate Initial Production approach to attain Initial Operational Capability and Full-Rate Production and Deployment, considering Diminishing Manufacturing Sources and Material Shortages (DMSMS); assess changes in the design of manufacturing processes, and apply continuous testing and evaluation practices during the Production and Deployment Phase to reveal manufacturing and production problems and ensure continuous enhancements to the product. |
| | | **Element 39.** Plan the Logistics Management system manpower needs and support plans, and apply within a Performance-Based Logistics (PBL) environment, for the full system lifecycle, to ensure effective use of the system. |
| | **Competency 24.** Systems Engineering Leadership | **Element 40.** Lead teams by providing proactive and technical direction and motivation to ensure the proper application of systems engineering processes and the overall success of the technical management process. |
| | **Competency 25.** System of Systems | **Element 41.** Translate the unique operational, governance, and architecture considerations of System of Systems programs into the systems engineering approach. |
| Professional | **Competency 26.** Communication | **Element 42.** Communicate technical and complex concepts in a clear and organized manner, both verbally |

| Units of Competence | Competencies | Competency Elements |
|---|---|---|
| | | and in writing, to inform and persuade others to adopt and act on specific ideas. |
| | **Competency 27.** Problem Solving | **Element 43.** Make recommendations using technical knowledge and experience, developing a clear understanding of the system, identifying and analyzing problems using a Total Systems approach, weighing the relevance and accuracy of information, accounting for interdependencies, and evaluating alternative solutions. |
| | **Competency 28.** Strategic Thinking | **Element 44.** Formulate and ensure the fulfillment of objectives, priorities, and plans consistent with the long-term business and competitive interests of the organization in a global environment. |
| | **Competency 29.** Professional Ethics | **Element 45.** Maintain strict compliance to governing ethics and standards of conduct in engineering and business practices to ensure integrity across the acquisition lifecycle. |

This page intentionally left blank.

# Appendix B: Responses related to career level

Table 23. Career level responses

| Response Category | Count | Percent |
|---|---|---|
| All responses | 10173 | 100% |
| Entry-level specified | 297 | 3% |
| Journey-level specified | 698 | 7% |
| Senior-level specified | 1146 | 11% |
| No level specified | 8032 | 79% |
| All responses with level specified | 2141 | 21% |

Table 24. Career level response distribution, by SPRDE workforce segment

| Segments & Distribution | Air Force | Army | Navy | 4th Estate |
|---|---|---|---|---|
| Full workforce representation<br>(Total SPRDE workforce representation: 10173) | 2038 | 2380 | 4597 | 1158 |
| Percentage of responses | 20% | 23% | 45% | 11% |
| Entry-level specified responses | 46 | 31 | 107 | 113 |
| Journey-level specified responses | 108 | 112 | 250 | 228 |
| Senior-level specified responses | 138 | 244 | 499 | 265 |
| Count of all career level responses | 292 | 387 | 2141 | 606 |
| Percentage of career level responses<br>(Total number of career level responses: 3426) | 9% | 11% | 62% | 18% |
| Variance in workforce segment | -12% | -12% | +17% | +6% |

Table 25. Correlation of career level proxies to career level

| Demographic Factor | Correlation to career level |
|---|---|
| System Engineering Experience | .479 |
| Non-System Engineering Experience | .308 |
| Federal-Civilian Experience | .504 |
| Pay Grade | .282 |
| Certification Level | .540 |
| Age | .482 |

This page intentionally left blank.

# Appendix C: Difference between employee and supervisor proficiency responses

This table lists the differences between employee and supervisor ratings for each element of the SPRDE competency model. It shows that employee and supervisor results are highly correlated at the 95 percent confidence level when the t-test value is .05 or below.

Table 26. Difference between employee and supervisor proficiency responses

| Element | Number of Observations | Difference between mean employee and supervisor proficiency responses | Paired t-test |
|---|---|---|---|
| Element 1 | 1818 | -.1169 | .0007 |
| Element 2 | 1604 | -.1657 | .0000 |
| Element 3 | 1634 | -.1189 | .0000 |
| Element 4 | 1871 | -.0717 | .0046 |
| Element 5 | 1831 | -.1983 | .0000 |
| Element 6 | 1855 | -.1363 | .0003 |
| Element 7 | 1847 | -.0699 | .0136 |
| Element 8 | 1814 | -.0942 | .0019 |
| Element 9 | 1843 | -.1374 | .0040 |
| Element 10 | 1848 | -.1330 | .0003 |
| Element 11 | 1828 | -.1438 | .0003 |
| Element 12 | 1744 | -.1248 | .0002 |
| Element 13 | 1694 | -.1757 | .0000 |
| Element 14 | 1567 | -.1336 | .0000 |
| Element 15 | 1592 | -.1285 | .0000 |
| Element 16 | 1578 | -.1406 | .0003 |
| Element 17 | 1604 | -.0854 | .0160 |
| Element 18 | 1599 | -.1140 | .0028 |
| Element 19 | 1743 | -.0278 | .1850 |
| Element 20 | 1701 | -.0917 | .0123 |

| Element | Number of Observations | Difference between mean employee and supervisor proficiency responses | Paired t-test |
|---|---|---|---|
| Element 21 | 1772 | .0034 | .3859 |
| Element 22 | 1751 | .0659 | .4582 |
| Element 23 | 1636 | -.0479 | .1191 |
| Element 24 | 1492 | -.1819 | .0000 |
| Element 25 | 1789 | .0885 | .0470 |
| Element 26 | 1597 | .0207 | .9525 |
| Element 27 | 1940 | .1776 | .0000 |
| Element 28 | 1931 | .1552 | .0000 |
| Element 29 | 1815 | .0214 | .3301 |
| Element 30 | 1931 | -.0883 | .0491 |
| Element 31 | 1928 | -.0918 | .0001 |
| Element 32 | 1828 | -.0243 | .0870 |
| Element 33 | 1740 | .0042 | .1151 |
| Element 34 | 1762 | .1768 | .0199 |
| Element 35 | 1897 | .1721 | .0005 |
| Element 36 | 1730 | .0237 | .4269 |
| Element 37 | 1808 | .0481 | .5061 |
| Element 38 | 1701 | .1224 | .1461 |
| Element 39 | 1730 | 0.0182 | .3054 |
| Element 40 | 1800 | .1589 | .0253 |
| Element 41 | 1820 | .0709 | .9590 |
| Element 42 | 1719 | .2766 | .0001 |
| Element 43 | 1822 | .1297 | .0166 |
| Element 44 | 1804 | .0651 | .9166 |
| Element 45 | 1658 | .1121 | .6766 |

# Appendix D: SPRDE demographic and intentions questions

This table contains the demographic and intentions questions provided to SPRDE assessment participants and the possible response options. The final column ties the demographic and intentions questions to the applicable SPRDE research goals, which are as follows:

- SPRDE Goal-1: Assess the current Systems Engineering capability of the SPRDE workforce.
- SPRDE Goal-2: Describe how those capabilities are distributed across DoD organizations and programs.
- SPRDE Goal-3: Project how those capabilities will be affected by departures.
- SPRDE Goal-4: Determine the potential of the current SPRDE workforce to boost the DoD's Systems Engineering capability.
- SPRDE Goal-5: Develop a profile of the SPRDE workforce.

Table 27. SPRDE demographic and intentions questions, response options, and planned usage of responses

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| 1. Please identify the workforce community with which you are most closely associated. | 1. Systems Engineering<br>2. Science and Other Engineering<br>3. Contracts<br>4. Community Support<br>5. Financial<br>6. Manufacturing and Production<br>7. Facilities<br>8. Information Technology / Information Management<br>9. Environment<br>10. Program Management<br>11. Analyst | Goal-3 |

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| | 12. Security and Law Enforcement<br>13. Safety and Occupational Health<br>14. Industrial Trades<br>15. Medical<br>16. Administration<br>17. Logistics<br>18. Human Resources<br>19. Media and Public Affairs<br>20. Intelligence<br>21. Education and Training<br>22. Science<br>23. Legal<br>24. Other / None | |
| 2. How many years of experience have you had as a Systems Engineer? | Less than 5<br>5 to 10<br>11 to 15<br>16 to 25<br>More than 25 | Goal-5 |
| 3. How many years of experience have you had as an engineer or scientist other than as a Systems Engineer? | Less than 5<br>5 to 10<br>11 to 15<br>16 to 25<br>More than 25 | Goal-5 |
| 4. If you are in the civil service (or NSPS) system, what is your current grade level (or pay-band)? | N/A: Not civil service (or NSPS)<br>GS-10 or below<br>GS-11 to GS-13<br>GS-14 or higher<br>NSPS Pay Band 1<br>NSPS Pay Band 2<br>NSPS Pay Band 3<br>Other Pay Plan | Goal-5 |
| 5. If you are active-duty military, what is your current rank? | N/A: Not active-duty military<br>E1 to E5<br>E6 to E9<br>O1 to O3<br>O4 or higher | Goal-5 |
| 6. What is your current certification level? | One<br>Two<br>Three<br>Don't Know - N/A | Goal-5 |
| 7. What is your highest level of educational attainment? | High school diploma<br>Associate degree<br>Bachelor's degree<br>Master's degree<br>Doctoral degree<br>Other | Goal-5 |
| 8. Is your highest-level degree in science, technology, engineering, or math (STEM)? | Yes<br>No | Goal-5 |
| 9. What DoD Acquisition organizations do you support? (to select multiple organizations use the Ctrl key) | Aeronautical Systems Center<br>Air Armament Center<br>Air Force Flight Test Center<br>Air Force Materiel Command<br>Air Force Research Laboratory | Goal-2 |

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| | Air Force Space Command<br>Army Ammunition Plants<br>Army Armament Research, Development and Engineering Center (ARDEC)<br>Army Audiology and Speech Center<br>Army Aviation and Missile Research Development and Engineering Center (AMRDEC)<br>Army Aviation Integration Directorate<br>Army Aviation Missile Command<br>Army Chemical Management Agency<br>Army Communications Electronics Command CECOM<br>Army Communications-Electronics Research, Development and Engineering Center (CERDEC)<br>Army Contracting Command<br>Army Corps of Engineers<br>Army Ctr for Environmental Health Rsch<br>Army Depots<br>Army Edgewood Chemical Biological Center (ECBC)<br>Army Evaluation Center<br>Army Forces Command<br>Army Geospatial Center<br>Army Human Resources Command<br>Army Installation Management Agency<br>Army Intelligence Command<br>Army Joint Munitions Agency<br>Army Logistics Innovation Agency<br>Army Materiel Command<br>Army Materiel Systems Analysis Activity (AMSAA)<br>Army Medical Materiel Agency<br>Army Natick Soldier Research, Development and Engineering Center (NSRDEC)<br>Army National Guard Bureau<br>Army NETCOM<br>Army PEO - Ammo (Ammunition)<br>Army PEO - C3T (Command, Control & Communications Tactical)<br>Army PEO - FCS (Future Combat Systems)<br>Army PEO - GCS (Ground Combat Systems)<br>Army PEO – Soldier<br>Army PEO CBD<br>Army PEO EIS<br>Army PEO GCSS<br>Army PEO Integration<br>Army PEO-STRI (Simulation, Training & Instrumentation)<br>Army Program Executive Office (PEO) Aviation<br>Army Research Development and Engineering Command<br>Army Research Laboratory (ARL)<br>Army Simulation Training and Testing Center (STTC)<br>Army Space & Missile Defense Command<br>Army Special OPS Command<br>Army Sustainment Command<br>Army Tank and Automotive Research, Development and Engineering Center (TARDEC)<br>Army Tank-Automotive and Armaments Command<br>Army Test & Evaluation Command<br>Army Training and Doctrine Command | |

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| | Army-HQ<br>Chemical Materials Agency<br>DISA Europe<br>DISA HQ<br>DISA Pacific<br>DITCO (Defense Information Technology Contracting Organization)<br>Electronics Systems Center<br>JTF-GNO (Joint Task Force-Global Network Operations)<br>Marine Corps Systems Command<br>Naval Air Systems Command<br>Naval Facilities Engineering Command<br>Naval Sea Systems Command<br>Naval Supply Systems Command<br>Ogden-Air Logistics Center<br>Oklahoma-Air-Logistics Center<br>Space and Missiles Center<br>Space and Naval Warfare Systems Command<br>Warner-Robins-Air Logistics Center<br>Other | |
| 10. If you are supporting a major program more with more than 50% of your time, what is the current Acquisition Phase of the work? | 1- Pre-Acquisition/Planning<br>2- Material Solutions Analysis<br>3- Technical Development<br>4- Engineering, Manufacturing & Development<br>5- Production & Deployment<br>6- Operations & Support<br>7- Don't Know | Goal-2 |
| 11. Is your position slated to be relocated or eliminated by the latest BRAC changes? | Yes<br>No | Goal-3 |
| 12. When do you plan to retire or resign? | Less than 4 years<br>In 4 to 10 years<br>More than 10 years | Goal-3 |
| 13. Which age category do you fall under? | Less than 35 years old<br>36 to 45 years old<br>46 to 55 years old<br>over 55 years old | Goal-3 |
| 14. What is your current status? | Active Duty Military<br>Federal Civilian - Prior Military Service<br>Federal Civilian - No Prior Military Service | Goal-3, Goal-5 |
| 14a. If you are currently active-duty military, for how many years on active-duty have you served? | Less than five years<br>Between 5 to 10 years<br>Between 11 to 15 years<br>Between 16 to 20 years<br>Between 21 to 25 years<br>More than 25 years | Goal-3 |
| 14b. If you are currently active-duty military, are you planning on working as a federal SPRDE civilian after completing military service? | Yes<br>No<br>Unsure of intent | Goal-3 |
| 14c. If you are currently a federal civilian, how long have you been in the federal civilian workforce? | Less than five years<br>Between 5 to 10 years<br>Between 11 to 15 years<br>Between 16 to 20 years<br>Between 21 to 25 years<br>More than 25 years | Goal-3 |

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| 15. What retirement program/system are you currently under or eligible for? | CSRS<br>FERS<br>Active Duty Military<br>Currently Retired Military | Goal-3 |
| 16. Are you planning to leave the SPRDE career-field within the next 6 months? | Yes<br>No | Goal-3 |
| 17. Do you plan to qualify for the next highest SPRDE certification level within the next 6 months? | Yes<br>No<br>Unsure of intent<br>Already Level 3 | Goal-4 |
| 18. Do you plan within the next year to apply for a position as a Program Systems Engineer (PSE)? | Yes<br>No<br>Unsure of intent<br>Already PSE | Goal-4 |
| 19. Select the top three competencies in which you plan to boost your proficiency during the next 12 month period. (to select multiple competencies use the Ctrl key) | 1. Technical Basis for Cost<br>2. Modeling and Simulation<br>3. Safety Assurance<br>4. Stakeholder Requirements Definition (Requirements Development)<br>5. Requirements Analysis (Logical Analysis)<br>6. Architectural Design (Design Solution)<br>7. Implementation<br>8. Integration<br>9. Verification<br>10. Validation<br>11. Transition<br>12. System Assurance<br>13. Reliability, Availability, and Maintainability (RAM)<br>14. Decision Analysis<br>15. Technical Planning<br>16. Technical Assessment<br>17. Configuration Management<br>18. Requirements Management<br>19. Risk Management<br>20. Technical Data Management<br>21. Interface Management<br>22. Software Engineering<br>23. Acquisition<br>24. System Engineering Leadership<br>25. System of Systems<br>26. Communications<br>27. Problem Solving<br>28. Strategic Thinking<br>29. Professional Ethics | Goal-4 |
| 20. Have you enrolled or are you planning to enroll within the next 6 months in a program of graduate study to further your SPRDE expertise? | Yes<br>No<br>Unsure of intent | Goal-4 |
| 21. Are you interested in participating in professional growth programs such as mentoring or rotational assignments? | Yes<br>No<br>Unsure | Goal-4 |

| Demographic/Intentions Question | Response Options | Applicable SPRDE Research Goal(s) |
|---|---|---|
| 22. Would you be willing to serve as a mentor to others? | Yes<br>No<br>Unsure | Goal-4 |
| 23. To what extent do you apply the Defense Acquisition Guidebook (DAG) to systems engineering efforts in your current position? | Always<br>Most of the time<br>Some of the time<br>Never | Goal-5 |
| 24. Were you aware that the DAG is available on the DAU website? | Yes<br>No<br>Unsure | Goal-5 |
| 25. Do you have Manufacturing experience? | Yes<br>No | Goal-5 |

# Appendix E: Workforce demographic analysis continued

**Over half of the SPRDE workforce references the DAG and the majority of the workforce is aware that the DAG is available on-line.**

Results presented in Table 28 are derived from the following demographic questions: *To what extent do you apply the Defense Acquisition Guidebook (DAG) to systems engineering efforts in your current position?* and *Were you aware that the DAG is available on the DAU website?*

The majority of the SPRDE workforce uses the DAG (69 percent), but the frequency varies. The 4th Estate segment reports using the DAG most frequently and the Air Force segment reports using the DAG least frequently. Close to one-third of the workforce reports never using the DAG (30 percent). The majority of the SPRDE workforce is aware that the DAG is available online.

Table 28. Familiarity and use of the Defense Acquisition Guidebook, by SPRDE segment

| | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Use and Familiarity | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| Use Always | 694 | 7 | 138 | 7 | 176 | 7 | 284 | 6 | 96 | 8 |
| Use Most of the Time | 1,763 | 17 | 299 | 15 | 414 | 17 | 776 | 17 | 274 | 24 |
| Use Some of the Time | 4,601 | 45 | 903 | 44 | 1,104 | 46 | 2,037 | 44 | 557 | 48 |
| Use Never | 3,091 | 30 | 696 | 34 | 682 | 29 | 1,487 | 32 | 226 | 20 |
| Unknown | 24 | 0 | 2 | 0 | 4 | 0 | 13 | 0 | 5 | 0 |
| All Respondents | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |
| Aware that the DAG is available on the DAU web-site | 7,096 | 70 | 1,454 | 71 | 1,708 | 72 | 3,053 | 66 | 881 | 76 |

**Most SPRDE respondents support multiple acquisition organizations.**

Results presented in Table 29 are derived from the following demographic question: *What DoD Acquisition organizations do you support?* Table 29 lists all the acquisition organization options provided to assessment participants and an estimate of the number of respondents that support each organization by SPRDE Workforce Segment.[11] Respondents were asked to select all of the acquisition organizations they support from a list of 74 options. Some respondents reported that they support as many as 10 organizations while other respondents report supporting

[11] Several participants selected as many as 10 acquisition organizations. These responses were truncated; therefore we did not include them in our support estimate. Also, a few participants left this question blank. We did not include these responses in our estimate either. Employees also had the option of choosing "Other" if the organization(s) they support was not listed among the choices in the assessment.

as few as one. Assessment results suggest that it is common for an employee to support one to three projects at one time.

Table 29. Number of respondents that support each acquisition organization, by SPRDE segment

| | *SPRDE-All* | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Acquisition Organization | # | % | # | % | # | % | # | % | # | % |
| Aeronautical Systems Center | *404* | *100* | 310 | 77 | 3 | 1 | 4 | 1 | 87 | 22 |
| Air Armament Center | *139* | *100* | 135 | 97 | 0 | 0 | 1 | 1 | 3 | 2 |
| Air Force Flight Test Center | *52* | *100* | 42 | 81 | 0 | 0 | 4 | 8 | 6 | 12 |
| Air Force Materiel Command | *1085* | *100* | 1015 | 94 | 10 | 1 | 14 | 1 | 46 | 4 |
| Air Force Research Laboratory | *348* | *100* | 312 | 90 | 4 | 1 | 15 | 4 | 17 | 5 |
| Air Force Space Command | *265* | *100* | 220 | 83 | 0 | 0 | 9 | 3 | 36 | 14 |
| Army Ammunition Plants | *35* | *100* | 0 | 0 | 30 | 86 | 3 | 9 | 2 | 6 |
| Army Armament Research Development and Engineering Center (ARDEC) | *0* | *100* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Army Audiology and Speech Center | *1* | *100* | 0 | 0 | 0 | 0 | 1 | 100 | 0 | 0 |
| Army Aviation and Missile Research Development and Engineering Center (AMRDEC) | *393* | *100* | 3 | 1 | 373 | 95 | 3 | 1 | 14 | 4 |
| Army Aviation Integration Directorate | *9* | *100* | 1 | 11 | 8 | 89 | 0 | 0 | 0 | 0 |
| Army Aviation Missile Command | *142* | *100* | 1 | 1 | 128 | 90 | 1 | 1 | 12 | 8 |
| Army Chemical Management Agency | *18* | *100* | 0 | 0 | 17 | 94 | 0 | 0 | 1 | 6 |
| Army Communications Electronics Command CECOM | *148* | *100* | 2 | 1 | 129 | 87 | 3 | 2 | 14 | 9 |
| Army Communications-Electronics Research Development and Engineering Center (CERDEC) | *0* | *100* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Army Contracting Command | *11* | *100* | 0 | 0 | 6 | 55 | 0 | 0 | 5 | 45 |
| Army Corps of Engineers | *23* | *100* | 1 | 4 | 11 | 48 | 3 | 13 | 8 | 35 |
| Army Ctr for Environmental Health Rsch | *1* | *100* | 1 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Army Depots | *35* | *100* | 1 | 3 | 32 | 91 | 1 | 3 | 1 | 3 |
| Army Edgewood Chemical Biological Center (ECBC) | *85* | *100* | 0 | 0 | 76 | 89 | 6 | 7 | 3 | 4 |
| Army Evaluation Center | *13* | *100* | 0 | 0 | 13 | 100 | 0 | 0 | 0 | 0 |
| Army Forces Command | *3* | *100* | 2 | 67 | 0 | 0 | 0 | 0 | 1 | 33 |
| Army Geospatial Center | *3* | *100* | 2 | 67 | 1 | 33 | 0 | 0 | 0 | 0 |
| Army Human Resources Command | *1* | *100* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 100 |
| Army Installation Management Agency | *5* | *100* | 0 | 0 | 3 | 60 | 0 | 0 | 2 | 40 |
| Army Intelligence Command | *5* | *100* | 2 | 40 | 2 | 40 | 0 | 0 | 1 | 20 |
| Army Joint Munitions Agency | *21* | *100* | 2 | 10 | 15 | 71 | 3 | 14 | 1 | 5 |
| Army Logistics Innovation Agency | *8* | *100* | 2 | 25 | 3 | 38 | 0 | 0 | 3 | 38 |
| Army Materiel Command | *355* | *100* | 4 | 1 | 329 | 93 | 5 | 1 | 17 | 5 |
| Army Materiel Systems Analysis Activity (AMSAA) | *24* | *100* | 1 | 4 | 21 | 88 | 2 | 8 | 0 | 0 |

| | *SPRDE-All* | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| Acquisition Organization | # | % | # | % | # | % | # | % | # | % |
| Army Medical Materiel Agency | *9* | *100* | 1 | 11 | 7 | 78 | 1 | 11 | 0 | 0 |
| Army Natick Soldier Research Development and Engineering Center (NSRDEC) | *3* | *100* | 2 | 67 | 0 | 0 | 0 | 0 | 1 | 33 |
| Army National Guard Bureau | *5* | *100* | 2 | 40 | 2 | 40 | 1 | 20 | 0 | 0 |
| Army NETCOM | *5* | *100* | 0 | 0 | 4 | 80 | 0 | 0 | 1 | 20 |
| Army PEO - Ammo (Ammunition) | *88* | *100* | 2 | 2 | 80 | 91 | 3 | 3 | 3 | 3 |
| Army PEO - C3T (Command Control & Communications Tactical) | *0* | *100* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Army PEO - FCS (Future Combat Systems) | *45* | *100* | 3 | 7 | 23 | 51 | 0 | 0 | 19 | 42 |
| Army PEO - GCS (Ground Combat Systems) | *100* | *100* | 1 | 1 | 86 | 86 | 2 | 2 | 11 | 11 |
| Army PEO – Soldier | *62* | *100* | 0 | 0 | 53 | 85 | 4 | 6 | 5 | 8 |
| Army PEO CBD | *39* | *100* | 3 | 8 | 24 | 62 | 11 | 28 | 1 | 3 |
| Army PEO EIS | *24* | *100* | 2 | 8 | 21 | 88 | 1 | 4 | 0 | 0 |
| Army PEO GCSS | *19* | *100* | 3 | 16 | 15 | 79 | 0 | 0 | 1 | 5 |
| Army PEO Integration | *50* | *100* | 2 | 4 | 40 | 80 | 0 | 0 | 8 | 16 |
| Army PEO-STRI (Simulation Training & Instrumentation) | *32* | *100* | 4 | 13 | 27 | 84 | 0 | 0 | 1 | 3 |
| Army Program Executive Office (PEO) Aviation | *105* | *100* | 3 | 3 | 92 | 88 | 2 | 2 | 8 | 8 |
| Army Research Development and Engineering Command | *277* | *100* | 3 | 1 | 268 | 97 | 4 | 1 | 2 | 1 |
| Army Research Laboratory (ARL) | *35* | *100* | 2 | 6 | 24 | 69 | 8 | 23 | 1 | 3 |
| Army Simulation Training and Testing Center (STTC) | *5* | *100* | 4 | 80 | 1 | 20 | 0 | 0 | 0 | 0 |
| Army Space & Missile Defense Command | *76* | *100* | 4 | 5 | 49 | 64 | 5 | 7 | 18 | 24 |
| Army Special OPS Command | *29* | *100* | 1 | 3 | 19 | 66 | 6 | 21 | 3 | 10 |
| Army Sustainment Command | *6* | *100* | 1 | 17 | 3 | 50 | 1 | 17 | 1 | 17 |
| Army Tank and Automotive Research Development and Engineering Center (TARDEC) | *2* | *100* | 2 | 100 | 0 | 0 | 0 | 0 | 0 | 0 |
| Army Tank-Automotive and Armaments Command | *112* | *100* | 0 | 0 | 89 | 79 | 3 | 3 | 20 | 18 |
| Army Test & Evaluation Command | *57* | *100* | 4 | 7 | 44 | 77 | 8 | 14 | 1 | 2 |
| Army Training and Doctrine Command | *14* | *100* | 1 | 7 | 11 | 79 | 2 | 14 | 0 | 0 |
| Army-HQ | *21* | *100* | 2 | 10 | 17 | 81 | 1 | 5 | 1 | 5 |
| Chemical Materials Agency | *12* | *100* | 1 | 8 | 11 | 92 | 0 | 0 | 0 | 0 |
| DISA Europe | *5* | *100* | 2 | 40 | 1 | 20 | 1 | 20 | 1 | 20 |
| DISA HQ | *41* | *100* | 4 | 10 | 4 | 10 | 7 | 17 | 26 | 63 |
| DISA Pacific | *5* | *100* | 3 | 60 | 1 | 20 | 0 | 0 | 1 | 20 |
| DITCO (Defense Information Technology Contracting Organization) | *4* | *100* | 3 | 75 | 0 | 0 | 0 | 0 | 1 | 25 |
| Electronics Systems Center | *70* | *100* | 61 | 87 | 0 | 0 | 2 | 3 | 7 | 10 |
| JTF-GNO (Joint Task Force-Global Network Operations) | *8* | *100* | 4 | 50 | 0 | 0 | 3 | 38 | 1 | 13 |
| Marine Corps Systems Command | *370* | *100* | 7 | 2 | 23 | 6 | 329 | 89 | 11 | 3 |

| Acquisition Organization | *SPRDE-All* | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| | # | % | # | % | # | % | # | % | # | % |
| Naval Air Systems Command | *1718* | *100* | 8 | 0 | 3 | 0 | 1610 | 94 | 97 | 6 |
| Naval Facilities Engineering Command | *108* | *100* | 2 | 2 | 0 | 0 | 104 | 96 | 2 | 2 |
| Naval Sea Systems Command | *2521* | *100* | 2 | 0 | 6 | 0 | 2442 | 97 | 71 | 3 |
| Naval Supply Systems Command | *63* | *100* | 0 | 0 | 0 | 0 | 53 | 84 | 10 | 16 |
| Ogden-Air Logistics Center | *119* | *100* | 105 | 88 | 0 | 0 | 3 | 3 | 11 | 9 |
| Oklahoma-Air-Logistics Center | *93* | *100* | 74 | 80 | 0 | 0 | 1 | 1 | 18 | 19 |
| Space and Missiles Center | *179* | *100* | 91 | 51 | 5 | 3 | 7 | 4 | 76 | 42 |
| Space and Naval Warfare Systems Command | *443* | *100* | 5 | 1 | 1 | 0 | 421 | 95 | 16 | 4 |
| Warner-Robins-Air Logistics Center | *188* | *100* | 154 | 82 | 1 | 1 | 9 | 5 | 24 | 13 |
| Other | *1201* | *100* | 151 | 13 | 110 | 9 | 241 | 20 | 699 | 58 |

**Most SPRDE respondents were unaffected by the latest BRAC changes.**

Results presented in Table 30 are derived from the following demographic question: *Is your position slated to be relocated or eliminated by the latest BRAC change?*

The majority of the SPRDE workforce was unaffected by the latest BRAC changes (96 percent). Of all of the segments, the Army segment was most affected (11 percent).

Table 30. BRAC-related changes to position, by SPRDE segment

| Position Affected by Latest BRAC Change | SPRDE-All | | Air Force | | Army | | Navy | | 4th Estate | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % | Participant Count | % |
| No | 9,716 | 96 | 1,989 | 98 | 2,119 | 89 | 4,519 | 98 | 1,089 | 94 |
| Yes | 443 | 4 | 45 | 2 | 258 | 11 | 73 | 2 | 67 | 6 |
| Unknown | 14 | 0 | 4 | 0 | 3 | 0 | 5 | 0 | 2 | 0 |
| All Responses | 10,173 | 100 | 2,038 | 100 | 2,380 | 100 | 4,597 | 100 | 1,158 | 100 |

This page intentionally left blank.

# Appendix F: Frequency distribution of proficiency ratings for the Systems Engineering and Program Management respondents, by certification level

## Systems Engineering: Level 1

Table 31.Frequency distribution of proficiency rating responses of Level 1 certified Systems Engineering employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost | 21% | 38% | 26% | 13% | 2% | 2.4 | 2.0 |
| 2. Modeling and Simulation | 22% | 32% | 29% | 13% | 4% | 2.5 | 2.0 |
| 3. Safety Assurance | 29% | 38% | 25% | 7% | 2% | 2.2 | 2.0 |
| 4. Stakeholder Requirements Definition (Requirements Development) | 23% | 30% | 30% | 14% | 3% | 2.4 | 2.0, 3.0 |
| 5. Requirements Analysis (Logical Analysis)* | 15% | 28% | 31% | 20% | 5% | 2.7 | 3.0 |
| 6. Architecture Design (Design Solution) | 20% | 29% | 29% | 16% | 5% | 2.6 | 3.0 |
| 7. Implementation** | 16% | 26% | 33% | 19% | 6% | 2.7 | 3.0 |
| 8. Integration | 16% | 29% | 29% | 20% | 6% | 2.7 | 2.0 |
| 9. Verification | 17% | 28% | 30% | 20% | 6% | 2.7 | 3.0 |
| 10. Validation | 15% | 27% | 32% | 19% | 6% | 2.7 | 3.0 |
| 11. Transition | 26% | 30% | 27% | 14% | 3% | 2.4 | 2.0 |
| 12. System Assurance | 21% | 33% | 29% | 14% | 4% | 2.5 | 2.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 29% | 34% | 26% | 9% | 2% | 2.2 | 2.0 |
| 14. Decision Analysis | 20% | 30% | 29% | 16% | 5% | 2.5 | 2.0 |
| 15. Technical Planning | 26% | 32% | 27% | 11% | 4% | 2.4 | 2.0 |
| 16. Technical Assessment | 23% | 32% | 28% | 14% | 3% | 2.4 | 2.0 |
| 17. Configuration Management | 24% | 31% | 27% | 14% | 4% | 2.4 | 2.0 |
| 18. Requirements Management | 20% | 31% | 28% | 14% | 6% | 2.5 | 2.0 |
| 19 .Risk Management | 26% | 29% | 29% | 13% | 3% | 2.4 | 2.0 |
| 20. Technical Data Management | 23% | 33% | 30% | 10% | 3% | 2.4 | 2.0 |
| 21. Interface Management | 30% | 31% | 23% | 12% | 4% | 2.3 | 2.0 |
| 22. Software Engineering | 33% | 29% | 23% | 11% | 5% | 2.3 | 1.0 |
| 23. Acquisition | 32% | 32% | 24% | 10% | 2% | 2.2 | 1.0 |
| 24. Systems Engineering Leadership | 24% | 23% | 26% | 20% | 7% | 2.6 | 3.0 |
| 25. System of Systems | 34% | 26% | 25% | 10% | 5% | 2.3 | 1.0 |
| 26. Communication* | 6% | 19% | 34% | 30% | 11% | 3.2 | 3.0 |
| 27. Problem Solving* | 8% | 21% | 34% | 27% | 10% | 3.1 | 3.0 |

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 28. Strategic Thinking | 20% | 27% | 32% | 16% | 4% | 2.6 | 3.0 |
| 29. Professional Ethics* | 9% | 20% | 33% | 25% | 12% | 3.1 | 3.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

## Systems Engineering: Level 2

Table 32. Frequency distribution of proficiency rating responses of Level 2 certified in the Systems Engineering employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost | 12% | 32% | 35% | 18% | 3% | 2.7 | 3.0 |
| 2. Modeling and Simulation | 20% | 30% | 30% | 16% | 4% | 2.5 | 3.0 |
| 3. Safety Assurance | 23% | 33% | 30% | 12% | 2% | 2.4 | 2.0 |
| 4. Stakeholder Requirements Definition (Requirements Development) | 18% | 25% | 33% | 20% | 4% | 2.7 | 3.0 |
| 5. Requirements Analysis (Logical Analysis)* | 10% | 23% | 37% | 24% | 6% | 2.9 | 3.0 |
| 6. Architecture Design (Design Solution) | 17% | 25% | 34% | 20% | 3% | 2.7 | 3.0 |
| 7. Implementation** | 13% | 22% | 35% | 24% | 6% | 2.9 | 3.0 |
| 8. Integration** | 12% | 24% | 34% | 25% | 6% | 2.9 | 3.0 |
| 9. Verification** | 14% | 23% | 34% | 23% | 7% | 2.9 | 3.0 |
| 10. Validation** | 11% | 25% | 35% | 24% | 5% | 2.9 | 3.0 |
| 11. Transition | 20% | 26% | 33% | 18% | 3% | 2.6 | 3.0 |
| 12. System Assurance** | 18% | 26% | 35% | 17% | 4% | 2.6 | 3.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 22% | 32% | 29% | 14% | 3% | 2.4 | 2.0 |
| 14. Decision Analysis | 14% | 25% | 35% | 20% | 5% | 2.8 | 3.0 |
| 15. Technical Planning | 18% | 28% | 34% | 16% | 4% | 2.6 | 3.0 |
| 16. Technical Assessment | 15% | 28% | 36% | 17% | 4% | 2.7 | 3.0 |
| 17. Configuration Management | 16% | 26% | 35% | 18% | 5% | 2.7 | 3.0 |
| 18. Requirements Management | 15% | 28% | 32% | 20% | 5% | 2.7 | 3.0 |
| 19 .Risk Management | 16% | 28% | 36% | 16% | 4% | 2.6 | 3.0 |
| 20. Technical Data Management | 17% | 30% | 32% | 18% | 3% | 2.6 | 3.0 |
| 21. Interface Management | 21% | 30% | 31% | 15% | 4% | 2.5 | 3.0 |
| 22. Software Engineering | 30% | 30% | 24% | 13% | 4% | 2.3 | 2.0 |
| 23. Acquisition | 25% | 30% | 28% | 14% | 3% | 2.4 | 1.0, 2.0 |
| 24. Systems Engineering** Leadership | 15% | 22% | 32% | 24% | 8% | 2.9 | 3.0 |
| 25. System of Systems | 27% | 28% | 27% | 15% | 3% | 2.4 | 2.0 |
| 26. Communication* | 4% | 13% | 33% | 34% | 16% | 3.4 | 4.0 |
| 27. Problem Solving* | 6% | 15% | 33% | 33% | 13% | 3.3 | 3.0 |
| 28. Strategic Thinking | 15% | 23% | 33% | 21% | 8% | 2.8 | 3.0 |
| 29. Professional Ethics* | 5% | 15% | 33% | 33% | 15% | 3.4 | 3.0, 4.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

## Systems Engineering: Level 3

Table 33. Frequency distribution of proficiency rating responses of Level 3 certified Systems Engineering employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost** | 7% | 23% | 36% | 28% | 7% | 3.0 | 3.0 |
| 2. Modeling and Simulation | 16% | 29% | 29% | 19% | 7% | 2.7 | 3.0 |
| 3. Safety Assurance | 18% | 26% | 31% | 19% | 5% | 2.7 | 3.0 |
| 4. Stakeholder Requirements Definition (Requirements Development)** | 11% | 19% | 30% | 30% | 9% | 3.1 | 3.0 |
| 5. Requirements Analysis (Logical Analysis)* | 6% | 15% | 31% | 36% | 13% | 3.4 | 4.0 |
| 6. Architecture Design (Design Solution)** | 9% | 18% | 32% | 31% | 10% | 3.2 | 3.0 |
| 7. Implementation* | 6% | 14% | 31% | 36% | 13% | 3.4 | 4.0 |
| 8. Integration* | 6% | 12% | 30% | 38% | 15% | 3.4 | 4.0 |
| 9. Verification* | 7% | 16% | 30% | 34% | 13% | 3.3 | 4.0 |
| 10. Validation* | 5% | 14% | 31% | 37% | 12% | 3.4 | 4.0 |
| 11. Transition** | 10% | 20% | 33% | 28% | 9% | 3.0 | 3.0 |
| 12. System Assurance** | 10% | 18% | 32% | 31% | 9% | 3.1 | 3.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 17% | 27% | 32% | 19% | 6% | 2.7 | 3.0 |
| 14. Decision Analysis** | 7% | 18% | 33% | 32% | 10% | 3.2 | 3.0 |
| 15. Technical Planning | 10% | 21% | 31% | 28% | 10% | 3.1 | 3.0 |
| 16. Technical Assessment** | 8% | 20% | 31% | 30% | 10% | 3.1 | 4.0 |
| 17. Configuration Management** | 9% | 18% | 32% | 32% | 9% | 3.1 | 3.0 |
| 18. Requirements Management** | 9% | 18% | 30% | 31% | 11% | 3.2 | 4.0 |
| 19 .Risk Management** | 9% | 21% | 33% | 28% | 10% | 3.1 | 3.0 |
| 20. Technical Data Management | 10% | 22% | 34% | 26% | 8% | 3.0 | 3.0 |
| 21. Interface Management** | 12% | 21% | 33% | 25% | 8% | 3.0 | 3.0 |
| 22. Software Engineering | 22% | 26% | 27% | 19% | 7% | 2.6 | 3.0 |
| 23. Acquisition | 16% | 24% | 30% | 24% | 7% | 2.8 | 3.0 |
| 24. Systems Engineering Leadership* | 6% | 12% | 26% | 35% | 21% | 3.5 | 4.0 |
| 25. System of Systems** | 14% | 22% | 29% | 25% | 11% | 3.0 | 3.0 |
| 26. Communication* | 1% | 6% | 22% | 44% | 26% | 3.9 | 4.0 |
| 27. Problem Solving* | 2% | 7% | 24% | 42% | 25% | 3.8 | 4.0 |
| 28. Strategic Thinking | 8% | 17% | 29% | 34% | 13% | 3.3 | 4.0 |
| 29. Professional Ethics* | 2% | 9% | 22% | 42% | 25% | 3.8 | 4.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

## Program Management: Level 1

Table 34. Frequency distribution of proficiency rating responses of Level 1 certified Program Management employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost* | 7% | 34% | 41% | 18% | 1% | 2.7 | 3.0 |
| 2. Modeling and Simulation | 22% | 31% | 33% | 13% | 0% | 2.4 | 3.0 |
| 3. Safety Assurance | 32% | 44% | 20% | 5% | 0% | 2.0 | 2.0 |
| 4. Stakeholder Requirements Definition (Requirements Development)** | 16% | 21% | 37% | 21% | 6% | 2.8 | 3.0 |
| 5. Requirements Analysis (Logical Analysis)* | 10% | 29% | 36% | 22% | 3% | 2.8 | 3.0 |
| 6. Architecture Design (Design Solution) | 16% | 30% | 36% | 17% | 1% | 2.6 | 3.0 |
| 7. Implementation** | 15% | 28% | 34% | 21% | 3% | 2.7 | 3.0 |
| 8. Integration** | 13% | 24% | 43% | 18% | 3% | 2.7 | 3.0 |
| 9. Verification** | 17% | 26% | 32% | 20% | 4% | 2.7 | 3.0 |
| 10. Validation** | 13% | 24% | 36% | 25% | 1% | 2.8 | 3.0 |
| 11. Transition | 28% | 19% | 35% | 18% | 0% | 2.4 | 3.0 |
| 12. System Assurance | 22% | 32% | 27% | 17% | 2% | 2.4 | 2.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 28% | 32% | 31% | 9% | 0% | 2.2 | 2.0 |
| 14. Decision Analysis** | 19% | 26% | 29% | 21% | 4% | 2.6 | 3.0 |
| 15. Technical Planning | 20% | 30% | 38% | 11% | 2% | 2.4 | 3.0 |
| 16. Technical Assessment | 22% | 22% | 43% | 12% | 1% | 2.5 | 3.0 |
| 17. Configuration Management | 21% | 29% | 32% | 18% | 0% | 2.5 | 3.0 |
| 18. Requirements Management** | 13% | 31% | 27% | 21% | 7% | 2.8 | 2.0 |
| 19 .Risk Management** | 15% | 30% | 36% | 17% | 2% | 2.6 | 3.0 |
| 20. Technical Data Management | 25% | 31% | 26% | 15% | 3% | 2.4 | 2.0 |
| 21. Interface Management | 24% | 34% | 29% | 11% | 2% | 2.3 | 2.0 |
| 22. Software Engineering | 32% | 35% | 22% | 9% | 2% | 2.2 | 2.0 |
| 23. Acquisition | 23% | 31% | 37% | 8% | 1% | 2.3 | 3.0 |
| 24. Systems Engineering Leadership* | 13% | 24% | 33% | 21% | 9% | 2.9 | 3.0 |
| 25. System of Systems | 30% | 25% | 25% | 13% | 7% | 2.4 | 1.0 |
| 26. Communication* | 3% | 14% | 41% | 30% | 12% | 3.3 | 3.0 |
| 27. Problem Solving* | 6% | 19% | 41% | 26% | 9% | 3.1 | 3.0 |
| 28. Strategic Thinking* | 16% | 16% | 28% | 35% | 4% | 3.0 | 4.0 |
| 29. Professional Ethics* | 12% | 16% | 30% | 30% | 12% | 3.1 | 4.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

## Program Management: Level 2

Table 35. Frequency distribution of proficiency rating responses of Level 2 certified Program Management employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost** | 11% | 32% | 35% | 11% | 10% | 2.8 | 3.0 |
| 2. Modeling and Simulation | 27% | 39% | 22% | 9% | 3% | 2.2 | 2.0 |
| 3. Safety Assurance | 29% | 32% | 27% | 6% | 5% | 2.3 | 2.0 |
| 4. Stakeholder Requirements Definition (Requirements Development)** | 15% | 20% | 38% | 24% | 2% | 2.8 | 3.0 |
| 5. Requirements Analysis (Logical Analysis)** | 7% | 24% | 43% | 23% | 4% | 2.9 | 3.0 |
| 6. Architecture Design (Design Solution) | 13% | 26% | 38% | 17% | 7% | 2.8 | 3.0 |
| 7. Implementation** | 13% | 18% | 35% | 27% | 6% | 2.9 | 3.0 |
| 8. Integration | 10% | 30% | 35% | 14% | 12% | 2.9 | 3.0 |
| 9. Verification** | 9% | 21% | 43% | 23% | 4% | 2.9 | 3.0 |
| 10. Validation | 15% | 25% | 34% | 15% | 11% | 2.8 | 3.0 |
| 11. Transition | 19% | 31% | 33% | 12% | 5% | 2.5 | 3.0 |
| 12. System Assurance** | 16% | 31% | 33% | 8% | 12% | 2.7 | 3.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 20% | 37% | 27% | 6% | 11% | 2.5 | 2.0 |
| 14. Decision Analysis | 11% | 27% | 27% | 24% | 11% | 3.0 | 2.0, 3.0 |
| 15. Technical Planning | 14% | 32% | 34% | 14% | 7% | 2.7 | 3.0 |
| 16. Technical Assessment | 10% | 27% | 42% | 11% | 10% | 2.8 | 3.0 |
| 17. Configuration Management** | 10% | 25% | 38% | 12% | 15% | 3.0 | 3.0 |
| 18. Requirements Management | 10% | 21% | 42% | 14% | 13% | 3.0 | 3.0 |
| 19 .Risk Management** | 7% | 29% | 34% | 23% | 6% | 2.9 | 3.0 |
| 20. Technical Data Management | 18% | 31% | 26% | 22% | 3% | 2.6 | 2.0 |
| 21. Interface Management | 20% | 36% | 29% | 7% | 8% | 2.5 | 2.0 |
| 22. Software Engineering | 20% | 29% | 31% | 15% | 5% | 2.6 | 3.0 |
| 23. Acquisition | 20% | 31% | 28% | 16% | 5% | 2.5 | 2.0 |
| 24. Systems Engineering Leadership* | 6% | 15% | 37% | 31% | 10% | 3.3 | 3.0 |
| 25. System of Systems | 16% | 26% | 30% | 23% | 5% | 2.7 | 3.0 |
| 26. Communication* | 3% | 15% | 24% | 42% | 15% | 3.5 | 4.0 |
| 27. Problem Solving* | 6% | 14% | 25% | 41% | 14% | 3.4 | 4.0 |
| 28. Strategic Thinking* | 7% | 24% | 29% | 29% | 10% | 3.1 | 3.0 |
| 29. Professional Ethics* | 4% | 17% | 26% | 29% | 23% | 3.5 | 4.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

## Program Management: Level 3

Table 36. Frequency distribution of proficiency rating responses of Level 3 certified Program Management employees

| Competency | Awareness | Basic | Intermediate | Advanced | Expert | Mean | Mode |
|---|---|---|---|---|---|---|---|
| 1. Technical Basis for Cost* | 4% | 14% | 34% | 43% | 5% | 3.3 | 4.0 |
| 2. Modeling and Simulation | 20% | 32% | 29% | 15% | 4% | 2.5 | 2.0 |
| 3. Safety Assurance | 22% | 24% | 33% | 19% | 2% | 2.6 | 3.0 |
| 4. Stakeholder Requirements Definition (Requirements Development)* | 7% | 18% | 30% | 37% | 8% | 3.2 | 4.0 |
| 5. Requirements Analysis (Logical Analysis)* | 6% | 14% | 32% | 40% | 8% | 3.3 | 4.0 |
| 6. Architecture Design (Design Solution)** | 10% | 18% | 34% | 31% | 7% | 3.1 | 3.0 |
| 7. Implementation* | 7% | 15% | 34% | 35% | 10% | 3.3 | 4.0 |
| 8. Integration* | 6% | 13% | 30% | 39% | 12% | 3.4 | 4.0 |
| 9. Verification** | 8% | 18% | 34% | 31% | 10% | 3.2 | 3.0 |
| 10. Validation** | 7% | 14% | 32% | 39% | 8% | 3.3 | 4.0 |
| 11. Transition** | 9% | 19% | 35% | 31% | 6% | 3.1 | 3.0 |
| 12. System Assurance** | 11% | 19% | 33% | 32% | 7% | 3.1 | 3.0 |
| 13. Reliability, Availability & Maintainability (RAM) | 16% | 26% | 37% | 16% | 5% | 2.7 | 3.0 |
| 14. Decision Analysis** | 7% | 13% | 37% | 34% | 8% | 3.2 | 3.0 |
| 15. Technical Planning | 9% | 17% | 37% | 31% | 6% | 3.1 | 3.0 |
| 16. Technical Assessment* | 6% | 16% | 36% | 34% | 9% | 3.2 | 3.0 |
| 17. Configuration Management* | 7% | 15% | 33% | 38% | 8% | 3.3 | 4.0 |
| 18. Requirements Management** | 7% | 18% | 36% | 31% | 8% | 3.1 | 3.0 |
| 19 .Risk Management* | 6% | 18% | 31% | 35% | 9% | 3.2 | 4.0 |
| 20. Technical Data Management** | 8% | 23% | 37% | 27% | 6% | 3.0 | 3.0 |
| 21. Interface Management** | 13% | 20% | 36% | 24% | 7% | 2.9 | 3.0 |
| 22. Software Engineering | 23% | 26% | 27% | 19% | 5% | 2.6 | 3.0 |
| 23. Acquisition** | 11% | 21% | 34% | 27% | 7% | 3.0 | 3.0 |
| 24. Systems Engineering Leadership* | 4% | 8% | 24% | 43% | 22% | 3.7 | 4.0 |
| 25. System of Systems* | 10% | 19% | 32% | 29% | 11% | 3.1 | 3.0 |
| 26. Communication* | 1% | 5% | 19% | 48% | 27% | 3.9 | 4.0 |
| 27. Problem Solving* | 2% | 6% | 23% | 45% | 23% | 3.8 | 4.0 |
| 28. Strategic Thinking* | 3% | 10% | 26% | 44% | 17% | 3.6 | 4.0 |
| 29. Professional Ethics* | 2% | 6% | 21% | 42% | 28% | 3.9 | 4.0 |

*High importance competency (highlighted in green) which has mean criticality and frequency ratings greater than or equal to 3.

**Medium importance competency (highlighted in yellow) which has a mean criticality rating below 3, but a mean frequency rating greater than or equal to 3.

# Appendix G: Retirement analysis

The goal of this analysis is to predict the probability that civilian personnel in the Systems Planning, Research, Development and Engineering (SPRDE) community will retire in the next 5 years. To do so, we use data from an earlier CNA study on the retirement behavior of Navy civilian personnel to model retirements.[12] In that study, we used Defense Manpower Data Center data from FY99 through FY08 on Navy civilian personnel, their characteristics, and incidence of retirement to determine which characteristics are statistically significant predictors of retirement. Based on those findings, we model expected retirements in the SPRDE civilian population as a function of these characteristics. By doing so, we are implicitly assuming that, conditional on observed covariates, retirement behavior among Navy civilian personnel is representative of retirement behavior among SPRDE civilian personnel.

A person must become eligible before retiring, so we start by estimating retirement eligibility probabilities. Because the demographic questions in the SPRDE assessment do not align perfectly with retirement eligibility rules, we must estimate, instead of calculate, each person's likelihood of being eligible to retire in the next five years. We can do so by calculating the

[12] For more information, see Koopman, McIntosh, and McHugh (2010)—hereafter referred to as Koopman et al. (2010)—*Causes and Consequences of Navy Civilian's Retirement Behavior,* CNA Research Memorandum D0022018.A1. In that work, we used survival analysis to model retirements, whereas here we use regression analysis. The former is used to model time to an event; the latter is used to model whether or not an event took place during a specified time span. Therefore, while the results presented here cannot be compared directly with those in Koopman et al. (2010), we can compare the signs and magnitudes of the effects of various covariates on retirement behavior across the two studies.

share of individuals in the Navy civilian personnel data who are retirement eligible in a given 5-year window and applying this information to the SPRDE population. Next, we estimate the probability that someone will retire in the next five years, conditional on being eligible to retire, using the Navy civilian personnel data. Finally, the product of these two estimates, the probability of eligibility and probability of retiring conditional on being eligible, gives the probability of retirement.

The remainder of this section describes the data used in this analysis, the approach to estimating the probability of being eligible to retire and the probability of retiring conditional on being eligible, and the results of this analysis.

## SPRDE and Navy civilian personnel data

The SPRDE data were collected via the competency assessment. For the retirement analysis, we retain people who are federal civilian employees [13] and are covered by one of two retirement plans: Civil Service Retirement System (CSRS) and Federal Employees Retirement System (FERS).[14] We also drop those with missing values for age, education, grade level, and years of service (YOS) since these variables are integral to estimating the probability of being eligible to retire and the probability of retiring. After making these sample restrictions, we are left with a final sample size of 9,642.

The Navy civilian personnel data span FY99 through FY08. As with the SPRDE data, we retain people who are covered by CSRS

[13] SPRDE personnel can be either federal civilian employees or active duty military personnel. Since modeling retirements for active duty military personnel is outside the scope of this analysis, these individuals are dropped from the sample.

[14] Few federal civilian personnel in the SPRDE assessment are covered by retirement plans other than CSRS and FERS. See Koopman et al. (2010) for more about CSRS and FERS.

or FERS only and we drop those with missing values for age, education and grade level. Finally, since this analysis uses a 5-year retirement window, we restrict the sample to the most recent 5-year window, FY04 through FY08, where we observed whether a person was eligible for retirement and whether he or she retired in FY04, FY05, FY06, FY07, and FY08.[15]

## Estimating the probability of being eligible to retire

Retirement eligibility criteria (age and YOS) differ slightly under the two retirement programs we consider, CSRS and FERS. Under both programs, people age 60 and older with 20 or more YOS and people age 62 and older with 5 or more YOS are eligible to retire. The difference in eligibility comes into play for younger personnel. Under CSRS, people age 55 or older with 30 or more YOS are eligible to retire. Under FERS, however, retirement eligibility for people under age 60 with 30 or more YOS depends on their minimum retirement age (MRA),which ranges between 55 and 57 according to one's year of birth.[16]

---

[15] As a sensitivity check, with additional time we could run the analysis using other 5-year windows in the sample time frame (FY99 through FY08).

[16] MRA is 55 for people born before 1948 and increases by 2 months for each birth year from 1948 to 1952, at which point MRA becomes 56. MRA remains at 56 for those born through 1964 and increases again by 2 months for each birth year from 1965 to 1969, at which point MRA becomes 57. MRA remains at 57 for people born after 1969. For more information, see http://www.opm.gov/retire/pre/fers/eligibility.asp.

The SPRDE assessment contains information on age and YOS in the following groups:

- *Age:* 35 or younger, 36 to 45, 46 to 55, older than 55[17]
- *YOS:* Less than 5, 5 to 10, 11 to 15, 16 to 20, 21 to 25, more than 25.

Our analysis shows, people who are currently 45 or younger will not be eligible for retirement by 2015. Some who are currently 46 to 55 years old and have more than 25 YOS will be eligible—namely, those who will have 30 or more YOS and will be 55 (under CSRS) or will meet their MRA (under FERS) by 2015. In addition, some individuals who are currently over age 55 and have 15 YOS or less will be eligible for retirement by 2015. Finally, all who are currently over age 55 and have at least 16 YOS will be eligible for retirement by 2015.

Next, we translate this information into probabilities of being eligible to retire in five years. We categorize people by age-by-YOS: those that will not be eligible for retirement (zero probability), those that will be eligible to retire (probability of one), and those that have a lower probability of being eligible to retire (probability between zero and one). We use the Navy civilian personnel data to estimate the probability that they will be eligible to retire by 2015. Specifically, for each of these age-by-YOS groups, we calculate the share of people in the Navy civilian personnel data who are eligible to retire in the most recent 5-year window (FY04 through FY08). Then, we apply these estimates to the SPRDE data as estimates of the probability that people in these cells will be eligible to retire by 2015.

[17]Actually, the first two age groups are listed as "less than 35 years old" and "36 to 45 years old" in the assessment. Unfortunately, this wording excludes people who are exactly 35 years old, and there is no "other" age category. Therefore, we assume that those who are exactly 35 years old would have chosen the first group, and thus we rename the first age group "35 or younger."

## Estimating the probability of retirement

After estimating the probability of being eligible to retire in the next five years for the SPRDE sample, the next step is to estimate the probability of retiring in that window conditional on being eligible. To do so, we return to the Navy civilian personnel data and limit the sample to FY04 (the beginning of the most recent 5-year window in that data set) and to those who are eligible to retire. With this sample, we estimate a logit model, in which the dependent variable is whether someone retired in the 5-year window and the independent variables are:

- Age group
- YOS group
- Retirement plan
- Education (high school degree, bachelor's degree, more than bachelor's degree, other)
- Veteran status
- Pay plan and paygrade (General Schedule (GS): <=10, 11–13, 14+; other)[18]
- Gender
- Race (white, black, other)
- Hispanic ethnicity.

[18] The SPRDE assessment allowed respondents to identify their pay plan and paygrade in one of the following ways: GS <10, GS 11–13, GS 14+, National Security Personnel System (NSPS) 1, NSPS 2, NSPS 3, and other. Because NSPS was rolled out only recently and the Navy civilian personnel data we use are from FY04, none of the individuals in the Navy civilian personnel data are in NSPS. Therefore, we grouped the NSPS personnel in the SPRDE sample along with the "other" pay plan/paygrade group. In the Navy civilian personnel data, the "other" pay plan/paygrade group includes people in the Federal Wage System (FWS), Senior Executive Service (SES), and other pay plans.

These covariates were found to be statistically significant in predicting retirements in Koopman et al. (2010).[19] After estimating this model, we apply the estimated regression coefficients to the SPRDE sample to predict the probability of retirement in the next five years conditional on being eligible.

There is one complicating factor—namely, that the SPRDE assessment did not include questions on gender, race, and ethnicity. These variables were highly significant predictors of retirement in Koopman et al. (2010), and leaving them out of the model would be unwise. So, to address this issue, we used the Navy civilian personnel data to estimate the percent female, black, "other" race, and Hispanic in the age-by-YOS groups used in the SPRDE assessment. We then applied these estimates to the SPRDE sample by age-by-YOS group in order to approximate these characteristics.

Estimating the logit equation for retirement we found that people age 46 to 55 are 30 percent less likely to retire than those who are over 55, and the difference is significant. In addition, YOS is significantly and positively related to retirement; people with more than 25 YOS are 44 percent more likely to retire in the next five years than those with less than 5 YOS. The results reported here are generally consistent with the results estimated in Koopman et al. (2010).

After estimating the logit model, we use the estimated regression coefficients to predict the conditional probability of retirement in the next five years. The product of this and the estimated probability of being eligible in the next five years gives the unconditional probability of retiring in the next five years. Across the sample of 9,642 SPRDE personnel, we found that 24 percent are predicted to be eligible to retire in the next five

[19] We had also planned on controlling for community in the model since this variable was highly significant in the retirement analysis in Koopman et al. (2010). However, the way this variable was collected in the assessment renders it unusable for this analysis.

years, and, among those who are eligible to retire, we predict that 44 percent will retire in that time frame. Therefore, among all SPRDE individuals (both eligible and ineligible to retire in the next five years), we estimate that 11 percent will retire in the next five years.

In addition to this document, individual-level estimates of the probability of being eligible to retire, the probability of retiring if eligible, and the probability of retiring, all in the next five years, were produced for each of the 9,642 people included in this analysis.

This page intentionally left blank.

# Appendix H: Intentions data

Table 37. Top three competencies in which Systems Engineering respondents intend to boost their proficiency during the next 12 months.

| Systems Engineering | | | | |
|---|---|---|---|---|
| Competency | First Choice | Second Choice | Third Choice | Total |
| 1. Technical Basis for Cost | **535** | 0 | 0 | 535 |
| 2. Modeling and Simulation | **839** | 79 | 0 | **918** |
| 3. Safety Assurance | 171 | 52 | 10 | 233 |
| 4. Stakeholder Requirements Definition (Requirements Development) | **426** | 154 | 20 | 600 |
| 5. Requirements Analysis (Logical Analysis) | 310 | 274 | 53 | 637 |
| 6. Architectural Design (Design Solution) | 269 | 224 | 130 | 623 |
| 7. Implementation | 184 | 126 | 52 | 362 |
| 8. Integration | 318 | 283 | 140 | **741** |
| 9. Verification | 199 | 220 | 146 | 565 |
| 10. Validation | 58 | 178 | 124 | 360 |
| 11. Transition | 49 | 59 | 32 | 140 |
| 12. System Assurance | 111 | 72 | 35 | 218 |
| 13. Reliability, Availability, and Maintainability (RAM) | 236 | 200 | 82 | 518 |
| 14. Decision Analysis | 123 | 78 | 30 | 231 |
| 15. Technical Planning | 255 | 219 | 93 | 567 |
| 16. Technical Assessment | 202 | **313** | 168 | 683 |
| 17. Configuration Management | 207 | 243 | 117 | 567 |
| 18. Requirements Management | 138 | 223 | 141 | 502 |
| 19. Risk Management | 142 | **335** | 253 | 730 |
| 20. Technical Data Management | 53 | 116 | 123 | 292 |
| 21. Interface Management | 23 | 82 | 67 | 172 |
| 22. Software Engineering | 121 | 212 | 254 | 587 |
| 23. Acquisition | 177 | 269 | 267 | 713 |
| 24. System Engineering Leadership | 346 | **507** | **935** | **1788** |
| 25. System of Systems | 43 | 133 | 365 | 541 |
| 26. Communications | 39 | 127 | 157 | 323 |
| 27. Problem Solving | 32 | 139 | **399** | 570 |
| 28. Strategic Thinking | 25 | 43 | **507** | 575 |
| 29. Professional Ethics | 8 | 3 | 81 | 92 |

Blue = Top first choice, Purple = Top second choice, Orange = Top third choice

Table 38. Top three competencies in which Program Management respondents intend to boost their proficiency during the next 12 months

| Program Management | | | | |
|---|---|---|---|---|
| Competency | First Choice | Second Choice | Third Choice | Total |
| 1. Technical Basis for Cost | 92 | 0 | 0 | 92 |
| 2. Modeling and Simulation | 44 | 10 | 0 | 54 |
| 3. Safety Assurance | 12 | 3 | 2 | 17 |
| 4. Stakeholder Requirements Definition (Requirements Development) | 72 | 24 | 1 | 97 |
| 5. Requirements Analysis (Logical Analysis) | 26 | 36 | 3 | 65 |
| 6. Architectural Design (Design Solution) | 19 | 17 | 10 | 46 |
| 7. Implementation | 13 | 15 | 8 | 36 |
| 8. Integration | 32 | 27 | 25 | 84 |
| 9. Verification | 12 | 14 | 16 | 42 |
| 10. Validation | 6 | 7 | 8 | 21 |
| 11. Transition | 13 | 13 | 5 | 31 |
| 12. System Assurance | 10 | 5 | 2 | 17 |
| 13. Reliability, Availability, and Maintainability (RAM) | 23 | 18 | 9 | 50 |
| 14. Decision Analysis | 18 | 9 | 3 | 30 |
| 15. Technical Planning | 39 | 29 | 11 | 79 |
| 16. Technical Assessment | 13 | 18 | 14 | 45 |
| 17. Configuration Management | 27 | 25 | 8 | 60 |
| 18. Requirements Management | 22 | 17 | 21 | 60 |
| 19. Risk Management | 37 | 39 | 28 | 104 |
| 20. Technical Data Management | 6 | 7 | 5 | 18 |
| 21. Interface Management | 4 | 6 | 4 | 14 |
| 22. Software Engineering | 15 | 18 | 15 | 48 |
| 23. Acquisition | 55 | 82 | 45 | 182 |
| 24. System Engineering Leadership | 53 | 57 | 83 | 193 |
| 25. System of Systems | 8 | 20 | 35 | 63 |
| 26. Communications | 14 | 33 | 20 | 67 |
| 27. Problem Solving | 9 | 31 | 46 | 86 |
| 28. Strategic Thinking | 6 | 15 | 128 | 149 |
| 29. Professional Ethics | 1 | 0 | 16 | 17 |

Blue = Top first choice, Purple = Top second choice, Orange = Top third choice

# List of Figures

Figure 1. Most important competencies for Systems Engineering and Program Management respondents ..... 4
Figure 2. SPRDE Competency Model ..... 11
Figure 3. Mean criticality versus mean frequency plot of competencies rated by Systems Engineering community respondents..... 37
Figure 4. Mean criticality versus mean frequency plot of competencies rated by Science & Other Engineering community respondents..... 38
Figure 5. Mean criticality versus mean frequency plot of competencies rated by Program Management community respondents..... 40
Figure 6. Average and common proficiency ratings for Level 1 certified Systems Engineering respondents, by competency ..... 48
Figure 7. Average and common proficiency ratings for Level 2 certified Systems Engineering respondents, by competency ..... 50
Figure 8. Average and common proficiency ratings for Level 3 certified Systems Engineering respondents, by competency ..... 51
Figure 9. Average and common proficiency ratings for Level 1 certified Program Management respondents, by competency ..... 54
Figure 10. Average and common proficiency ratings for Level 2 certified Program Management respondents, by competency ..... 55
Figure 11. Average and common proficiency ratings for Level 3 certified Program Management respondents, by competency ..... 57
Figure 12. Predicted SPRDE workforce status over the next five years..... 65
Figure 13. Comparison of current mean proficiency ratings for civilian Systems Engineering respondents, by technical competency ..... 66

Figure 14. Comparison of current mean proficiency ratings for civilian Systems Engineering respondents, by professional competency ..... 67
Figure 15. Comparison of current mean proficiency ratings for civilian Program Management respondents, by technical competency ..... 69
Figure 16. Comparison of current mean proficiency ratings for civilian Program Management respondents, by professional competency ..... 70
Figure 17. Advancement and mentoring intentions of Systems Engineering respondents ..... 76
Figure 18. Advancement and mentoring intentions of Program Management respondents ..... 77

# List of Tables

Table 1. Participation rates by SPRDE segment ..... 14
Table 2. Systems Engineering experience responses by SPRDE segment ..... 26
Table 3. Other experience as a scientist or engineer responses by SPRDE segment ..... 26
Table 4. Manufacturing experience responses by SPRDE segment ..... 27
Table 5. Military versus civilian responses by SPRDE segment ..... 28
Table 6. Civilian grade level/pay band responses by SPRDE segment ..... 29
Table 7. Military rank responses by SPRDE segment ..... 30
Table 8. Certification level responses by SPRDE segment ..... 31
Table 9. Education levels and focus responses by SPRDE segment ..... 32
Table 10. Workforce community responses by SPRDE segment ..... 33
Table 11. Comparison of high importance competencies across workforce communities ..... 41
Table 12. Importance ratings for the Systems Engineering community, by competency and certification level ..... 43
Table 13. Importance ratings for the Program Management community, by competency and certification level ..... 45
Table 14. Mean proficiency ratings for the Systems Engineering community, by competency and certification level ..... 52
Table 15. Mean proficiency ratings for the Program Management community, by competency and certification level ..... 58
Table 16. Estimated five-year probabilities: eligibility and retirement ..... 63
Table 17. Number of respondents predicted NOT to retire from the Systems Engineering and Program Management workforce communities over the next five years relative to current numbers ..... 65

Table 18. Comparison for civilian Systems Engineering respondents of current overall mean proficiency ratings versus current mean proficiency ratings for respondents predicted NOT to retire over the next five years..... 68
Table 19. Comparison for civilian Program Management respondents of current overall mean proficiency ratings versus current mean proficiency ratings for respondents predicted NOT to retire over the next five years..... 71
Table 20. Competencies in which Systems Engineering respondents intend to boost their proficiency during the next 12 months ..... 74
Table 21. Competencies Program Management respondents intend to boost their proficiency in during the next 12 months..... 75
Table 22. The Model..... 83
Table 23. Career level responses ..... 89
Table 24. Career level response distribution, by SPRDE workforce segment ..... 89
Table 25. Correlation of career level proxies to career level..... 89
Table 26. Difference between employee and supervisor proficiency responses .... 91
Table 27. SPRDE demographic and intentions questions, response options, and planned usage of responses ..... 93
Table 28. Familiarity and use of the Defense Acquisition Guidebook, by SPRDE segment..... 100
Table 29. Number of respondents that support each acquisition organization, by SPRDE segment..... 101
Table 30. BRAC-related changes to position, by SPRDE segment ..... 103
Table 31.Frequency distribution of proficiency rating responses of Level 1 certified Systems Engineering employees..... 105
Table 32. Frequency distribution of proficiency rating responses of Level 2 certified in the Systems Engineering employees..... 106
Table 33. Frequency distribution of proficiency rating responses of Level 3 certified Systems Engineering employees..... 107

Table 34. Frequency distribution of proficiency rating responses of Level 1 certified Program Management employees..... 108
Table 35. Frequency distribution of proficiency rating responses of Level 2 certified Program Management employees..... 109
Table 36. Frequency distribution of proficiency rating responses of Level 3 certified Program Management employees..... 110
Table 37. Top three competencies in which Systems Engineering respondents intend to boost their proficiency during the next 12 months..... 119
Table 38. Top three competencies in which Program Management respondents intend to boost their proficiency during the next 12 months..... 120

This page intentionally left blank.

4825 Mark Center Drive, Alexandria, VA 22311-1850 703-824-2000 www.cna.org