RT-149: Leadership Development Framework for the Technical Acquisition Workforce

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EXECUTIVE SUMMARY

Large and complex technical undertakings – sophisticated weapon systems, diverse research institutions, major programs of national importance, and the like – require unique skills of their leaders. These individuals must have a strong technical background AND a special ability to lead people of varying backgrounds and disciplines.

The required skill set is not easily acquired after one has already been confronted with the difficulties inherent in these positions. These skills must instead be honed over a career of increasingly challenging assignments, starting as soon as the fledgling technical leader has graduated from a foundational engineering or science baccalaureate program.

In this study, we ask what such a career-long development journey might look like, and suggest an approach to acquiring the necessary skills. We base our work on existing scholarship, which has largely focused on understanding what the characteristics of successful technical leaders are, particularly at the highest levels. However, our approach has been more deductive than previous efforts, which is to say, that we have attempted to establish not what a typical career has been for successful technical leaders, but rather, what it should be. We have based our conclusions on integrative understanding from our own extensive cumulative experience as executives in industry and government, along with insights gained from numerous colleagues from a diverse set of institutions.

We do not claim that this is the way others have developed great technical leaders. Although the methods we recommend have been demonstrated to be effective, the sum total of our recommendations represents a new approach, and our assertion that this is the way we should proceed. The good news is that the approach reported on here can be applied by individual aspiring and developing leaders, by their supervisors and executive sponsors, or by entire agencies or subordinate commands at any level in the Department of Defense. The successful application of the Framework and Career Model we have developed does not depend on a formal top-down program: indeed, while our study has focused on the Department of Defense, this approach is applicable to any technical leadership situation, inside or outside of government.

The Framework recognizes three broadly defined career stages – junior, mid-level, and senior, modelled on the typical supervisory responsibilities of leaders at each level, but equally applicable to non-supervisory roles.

The core of the Framework is a set of 24 carefully curated competencies that reflect the dual nature of the technical leader’s role: each of the 24 is essentially technical in nature, but is also essentially a leadership competency. It is our belief, based on our own experience, interviews with subject matter experts, and the existing literature, that any individual who acquires this set of competencies will naturally perform at the highest level in positions of technical
leadership responsibility. That is why a formal program is not required in order to take advantage of the Framework, which can be applied by individuals as well as institutions.

To assist individuals and organizations in applying the Framework, we define six broad categories of development method: education, training, job assignment, rotational assignments, mentoring, and coaching, and we provide guidance on the use of these methods as tools for development consistent with each career stage.

The Framework is applied through a cyclical process centered on the emerging technical leader, which includes a set of best practices derived from our observation and analysis of technical leadership programs at a variety of best-in-class companies and agencies recognized for their success in leadership development. We have assembled these into a Career Model, combining a number of tools and practices into a single integrated whole, in some cases bringing practices together for the first time.

The Model incorporates a number of insights, of which perhaps the most important one is that technical leadership development cannot succeed as an independent initiative. Success in building technical leaders in an organization requires that the development process must be fully integrated (or at the very least, consistent) with the organization’s formal human resource management practices, including recruitment, promotion, and job assignment. Although this finding may appear to contradict our assertion that an individual can apply the Framework to their own career planning and execution, this is not so: what we are talking about here is the application of technical leadership development as an organizational policy, as opposed to leaving the matter up to the initiative and discretion of individuals.

A second key finding is that leadership development must be associated with objective assessment techniques that are evidence-based and reflective of accomplishments, not capabilities. We offer a tool that allows individuals to track their own progress toward attainment of the 24 competencies at each level, and that promotes the all-important conversation between the emerging/developing leader and their supervisor regarding that progress.

Finally, we have found that the very best technical leadership development programs are highly tailored. While we do not believe that tailoring can or should involve skipping or replacing any of the 24 core competencies, we have found that the framing of those competencies within an organization and the way in which they are applied to specific disciplines and organizational sub units is very important: it is particularly true that the mission of the organization and the nature of the technical discipline involved do matter.

The Framework and Career Model we offer here are as complete and well founded as can be, given the state of leadership development research. We must point out, however, that there are a number of questions for which our current understanding does not provide answers. Among these are the following: what evidence is there that a particular development method, training, for example, or coaching, is effective in a particular circumstance? And how do we
know that a particular individual, having completed some prescribed development program, has actually learned the concepts and behaviors inherent in a particular competency? These questions are left for further examination and resolution as the result of future investigation.

When it comes to the development of technical leaders at all levels, from the most junior to the most senior, we have only been able to take the first step, describing the landscape and offering some ideas based on expert opinion and limited prior research findings. Providing rigorous technical analysis that confirms or refutes our finding will require substantial additional work. We look forward to sharing this journey with our colleagues.
1 INTRODUCTION

1.1 SIGNIFICANT CONTRIBUTIONS FROM THIS STUDY

The goal of this Research Topic has been to develop a Framework for Technical Leadership Development within the five technical acquisition career fields in the Department of Defense: Engineering, Information Technology, Production Quality and Manufacturing, Science and Technology, and Test and Evaluation, along with an associated career model for the application of the Framework. The development of the Framework and career model are clearly important contributions, and this work has also resulted in several additional unique contributions.

The study documents for the first time a comprehensive analysis of the relevant scholarly literature on the subject of technical leadership development, from academic and consulting sources. This survey represents a solid examination of our current understanding about how technical leaders have been, and are best, developed, and serves as a strong foundation for further work in this area, both within the Department of Defense, and elsewhere.

We have asked how it is that we can be sure that a developing leader has attained the competencies that the development process is designed to instill. We would like to have evidence-based metrics for this purpose. We have based our conclusions on the results of a literature survey, and on interviews with subject matter experts. We have developed and recommended a competency assessment approach that provides one way to collect and apply metrics to guide further development actions in each particular instance.

For the first time ever, this study asks how we know whether a particular development method is or is not more or less effective than other similar methods when applied to the development of technical leadership skills. Our conclusions in this area are based on the aforementioned review of existing scholarly literature (which is not particularly extensive on this point), and also from the results of interviews conducted with a sampling of known subject matter experts in the area of technical leadership development.

Finally, we have developed a concept of operations for the technical leadership development career model. Building on the Framework, it incorporates two important structural features, specifically, the complementary application of methods and periodic assessment. This concept of operations provides an enterprise or organization the guidance on training and development of technical leaders at all levels, and enables technical leaders to take ownership and advance their own career. These accomplishments are summarized in Figure 1.
**Significant Accomplishments of this Study**

1. Framework for technical leadership development
2. Associated career model for DoD technical leaders
3. Comprehensive review of literature related to technical leadership
4. Preliminary assessment of competency attainment metrics
5. Preliminary validation of development methods
6. Concept of Operations

Figure 1 Significant Accomplishments

### 1.2 Key Recommendations

Figure 2 summarizes the key recommendations of this study, for which we give a brief synopsis here, and which are treated at greater length in Section 13 of the report:

1. The Department of Defense should implement a Technical Leadership Development policy that is based on the Framework and Career Model described in this report;

2. In keeping with the industry and government best practices identified in our research, the implementation of this policy should be distributed and tailored, and should be executed at subordinate levels of the Department of Defense as guided by the individual needs of component echelons of command;

3. In order to be most effective, the execution of the Framework and Career Model should be fully integrated and coordinated with Human Resource functions for recruitment, personnel evaluation, and promotion;

4. While the elements of the Framework and Career Plan are in keeping with our best understanding of the process of technical leadership development based on prior scholarship and expert opinion, implementation of these elements is best reviewed on an annual basis to incorporate lessons learned from the experience of implementation;

5. In keeping with the above recommendation, the Department of Defense should continue to conduct research into the development of technical leaders; this research should in particular address the following three areas:
a. Continued in-depth benchmarking with best-in-class organizations within the Department, elsewhere in government, and in private industry;

b. Rigorous, statistically sound experimental investigation of the efficacy of specific development methods;

c. Longitudinal, human subject research involving target and control groups to determine suitable metrics for assessing of competency attainment.

<table>
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<th>Key Recommendations</th>
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<tr>
<td>1. Implement a Technical Leadership Development Policy based on the Framework and Career Plan</td>
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<td>2. Delegate implementation of this policy to appropriate subordinate levels in DoD</td>
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<td>3. Integrate technical leadership development with existing HR functions</td>
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<td>4. Revisit and improve the policy annually</td>
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<td>5. Initiate the continuing research to further validate methods and metrics.</td>
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Figure 2 Key Recommendations

1.3 INTRODUCTION TO THE PROBLEM: WHAT IS MEANT BY “TECHNICAL LEADERSHIP”

Large technical organizations such as big aerospace companies, government agencies, and independent research institutes, are frequently not led by technical specialists; in turn, many technical specialists follow a special “technical” track that relieves them of formal supervisory responsibility. The best technical organizations, however, are those that are led by individuals who are both highly competent technically and brilliant practitioners of the art of leadership. We think of great technical leaders such as Alan Mulally at Boeing, Norm Augustine at Martin Marietta, Simon Ramo at TRW, and Mike Griffin at NASA. The highest performing technical organizations, however, do not simply have brilliant technical leaders at the top, they have a systematic culture of technical leadership that pervades the organization, one in which high performing scientists and engineers at every level are encouraged to hone their leadership skills, to exercise, those skills both in formal and informal positions of authority, and to simultaneously build their technical skills; as well as their leadership skills; over the course of a career. In that way, when the time comes to pick the next top leader, there is a group of candidates available to compete for the job that are all outstanding in both the technical and leadership dimensions. In our development of a list of competencies for technical leaders, we have concentrated specifically on those competencies that have both technical and leadership
value. One may imagine that the short list of 24 competencies that we base the Framework on is a set that lies at the intersection of the much longer list of purely technical competencies on the one hand, and the much longer list of purely leadership competencies on the other. Although we only discuss this shorter set in this report, it is critically important to remember that technical leaders are required to be fully competent technically, and fully competent as leaders. All three competency sets are important (purely technical, purely leadership, and their intersection).

The U.S. Department of Defense is arguably the most technical organization in the world, as measured by the sophistication of its science and engineering accomplishments, by the size of its technical establishment, and by the impact that technology has on its ongoing operations. It stands to reason that the DoD, and in particular the part of the Department that researches, develops, acquires and tests new technologies, should have a technical leadership cadre modeled after those best-in-class high performing technical organizations. There are several unspoken truths that underlie this quest:

1. Leadership is not isomorphic with management. Entire books have been written on this topic and we do not need to belabor it here. Indeed, it is arguable that not all technical leaders need even have management skills: this is where the division between technical and management tracks comes in. All technical specialists should aspire to leadership, even if not all of them exercise it through the formal supervision of others.

2. In spite of the caveat above, leadership can, and must, be exercised both formally and informally, and a really successful technical leader will have held both supervisory and technical SME positions alternatively throughout a career.

3. Technical specialists should continue to grow professionally both in their field of expertise and across an increasingly broad range of related technical disciplines throughout their careers, but there are some purely technical skills that are unique to the technical leadership task that must be added to the mix.

4. Leaders should continue to hone their leadership skills over a career, but there are some leadership abilities that are unique to leadership of a technical enterprise that need to be added to the mix.

It is within items 3 and 4 in the list above that we find the motivation for the present work: it is in the identification and explication of the items falling under these headings and in finding the best ways to develop them, that this technical leadership development framework will have the greatest impact.

Needless to say, there are items in the framework that are purely technical, and there are items that would be found in any leadership development program. These are also necessary but it’s
the ones with a foot in both camps that are the discriminators that make a successful technical leader.

The goals for this research include the need for a technical leadership development framework that is achievable, flexible, and affordable. We believe the framework described in this report meets those goals.

The Framework is flexible in several different ways. First, the definition of the career stages on which it is based (Section 4) permits a wide number of different interpretations without compromising the essential character of the career structure envisioned. Second, we offer narrative descriptions of the key competency indicators (KCI) that define competency at each career stage, allowing different agencies and supervisors to adapt the indicators to their particular situation. Third, we recognize and describe six different development methods that can be used in various combinations at various times to help emerging and developing leaders attain the full set of competencies required at their level. Individuals and their supervisors can take advantage of a wide variety of tools to develop the required skill sets. Some of these tools are part of the formal workplace structure, but others are available outside the workplace at an individual’s own discretion.

The structure described above makes the Framework affordable, in that it does not contemplate any new programs, expansion of existing programs, or new funding initiatives. Indeed, it is our contention that the means to grow great technical leaders are already fully available within the current DoD structure. It is our belief that providing emerging and developing leaders with tools that enable them to take responsibility for their own development, and their supervisors with complementary tools to guide them, and help them select job opportunities and rotational assignments that provide technical leadership growth, is the best way to ensure the success of this initiative.

The Framework is achievable for the very reasons described above: our “concept of operations” for this initiative, described in Section 11, includes two important elements – leadership and inspiration from the highest levels in DoD, and execution through leadership at the grass roots, by first-level technical supervisors. We believe that the basis for a DoD-wide culture of technical leadership excellence is already in place, that agency and service managers and supervisors are primed to support this initiative, that individual technical personnel are highly motivated to embrace their own career development, and most importantly, that the budget to achieve the needed training is already in place and available, although in many cases it is not being applied to the right ends.

The detailed description of the Framework, and its execution, makes up the bulk of this report. Figure 3 provides a very condensed overall view of the Framework structure, which is based on four distinct career stages: junior, mid-level, senior and executive. These career stages constitute element (1) of the Framework. At each career stage element (2) provides a set of Key Competency Indicators (KCI) in two competency classes: technical leadership competencies and enabler competencies. Attainment of all the KCIs at a particular stage constitutes full
competency as a technical leader at that stage. Competency is developed through application of the six development methods of element (3): education, training, experience, rotational assignments, mentoring, and coaching. Not all of these methods are needed at every stage and in every case; they can be flexibly applied by individuals and their supervisors. Element (4), provides a means for verifying that the KCIs prescribed at each stage have been attained. Because of the flexibility and individual choice embodied in element (4), an independent assessment of attainment is critical to the overall quality of the Framework. The final component, element (5) is unique to this Framework, as its objective is to provide rigorous evidence for the efficacy of particular methods. At this point, our evidence is limited to the work of others; that is, it depends on the findings of the scholarly literature, and opinions expressed by subject matter experts interviewed as part of our benchmarking work. In an important sense, element (5) is not actively employed during the execution of the Framework. It can rather be thought of as a “meta-element” through which the development methods of element (3) can be continuously assessed and upgraded.

1.4 Roadmap to this Volume

This report constitutes the final deliverable for Systems Engineering Research Center (SERC) Research Topic (RT) 149: Framework for Technical Leadership Development. A companion deliverable, the Supervisor’s Handbook, is composed largely of material extracted from this report, in some cases streamlined and simplified for clarity and ease of application in the field.

Section 1 sets the stage for the study and provides a top level overview of key accomplishments, recommendations and the Framework itself.

Section 2 provides a review of previous work in this topic area based on a comprehensive examination of the scholarly literature on this subject.

Sections 3 through 7 consist of a detailed description of each element of the Framework; specifically, Section 3 gives an overview of the Framework elements, Section 4 describes the career stages (Framework element 1), Section 5 describes the competency model (Framework element 2), Section 6 discusses leadership development methods and their application (Framework element 3), Section 7 discusses methodologies for assessing competency attainment (Framework element 4), and Section 8 reports on efforts to validate the use of the various methods (Framework element 5).

Taken together, Sections 9 through 11 describe the execution of the Framework through the implementation of the career model. Section 9 reports on our assessment of existing DAU course content that could be applied against the 24 competencies as one application of the training development method.

Section 10 describes a number of existing career models, including career ladders and paths.
Section 11 provides a complete description of the proposed career model and its implementation in DoD organizations.

Section 12 addresses opportunities for further work to extend, improve, and strengthen the Framework and career model through additional benchmarking and experimental studies.

Section 13 provides detailed information regarding our conclusions and recommendations from this study.

A comprehensive bibliography provides access to the best of the more than 150 sources we consulted during this study. The Appendices contain additional useful background material.
THE TECHNICAL LEADERSHIP DEVELOPMENT FRAMEWORK

(1) Career Stages
   Junior → Mid-Level → Senior

(2) Competency Model
   - Technical
   - Enabling

(3) Leadership Development Methods
   - Education
   - Training
   - Experience
   - Job Rotations
   - Mentoring
   - Coaching

(4) Competency Attainment Metrics

(5) Leadership Development Method Validation

Figure 3 Technical Leadership Development Framework Elements
2 BACKGROUND

2.1 OBJECTIVES

Better Buying Power 3.0 addresses a “growing concern that the United States’ technological superiority over potential adversaries is being threatened today in a way that we have not seen for decades” (Kendall, 2014, p. 2) and identifies a number of key initiatives to counter this threat. One of these initiatives is to “Improve the Professionalism of the Total Acquisition Workforce.” While much of this initiative focuses on improving the technical and engineering qualifications of the acquisition workforce, the initiative also stresses the need for higher and more experience-based standards for those who fill key leadership positions. These must include leadership skills and abilities, not just technical skills (Felder, Yang, Pennotti, Duliba, & Mo, 2015).

Existing certification standards for technical acquisition career fields emphasize functional skills. While there are a variety of leadership programs in which acquisition professionals may participate (such as the Graduate School USA’s Executive Leadership and Executive Potential Programs (ELP/EPP), none of these are explicitly linked to certification standards and participation appears to be mostly ad hoc. There is a need for a systematic framework for developing leadership skills that would be pursued in parallel with the development of technical and functional skills. Such a Framework, as described in this report, would function in rough parallel with the DAWIA certification scheme, starting at Level I, proceeding through Levels II and III, and potentially extending beyond Level III certification in a complementary manner, but would not be strictly linked to it. Developing that framework is the focus of this study.

An additional goal has been to define a balanced career path structure for the Department of Defense (DoD) technical acquisition workforce that combines training, education, experiential learning, developmental assignments, and other elements leading to appropriate knowledge, skills and abilities suitable at each stage of a technical career, from entry level through key leadership positions. The underlying hypothesis is that such a balanced career pattern of career progression exists and can be defined.

In this study we investigate methods used to build the Knowledge, Skills and Abilities (KSAs) associated with technical leadership, such as rotational assignments, fellowships, professional reading, mentoring and coaching, education, and training. We also make recommendations regarding which methods work best at building each necessary KSA.

2.2 CONTEXT

Research on leadership and management education has shown that a successful technical leader inevitably needs to possess three key areas of competency:

- Systems thinking, critical thinking, and thought leadership,
• Program management skill, and
• Technical domain knowledge.

There is an increasing realization that the nature of complex, highly networked, digitally rich and distributed systems—of—systems (SoS) is such that they must be managed seamlessly throughout the life cycle. It is further recognized that key disciplines such as systems engineering, test and evaluation, research, operations and maintenance must be meaningfully integrated in order to keep pace with changes in user requirements, technology, external threats, and market opportunities, each of which is moving at unprecedented speeds (Felder & Collopy, 2012). Thoughtful practitioners also realize that systems engineering is the discipline that provides “adult supervision” for this new integrated process. If SE is to be deployed across the life cycle of systems, then SE education should address the life cycle of a systems engineering career: Systems Engineers need to be not only educated initially, but must have a clear and effective path to increased technical and leadership skill throughout their careers.

The Department of Defense has for some time been focused on the development of its senior technical professionals, not only Systems Engineers, but also members of the other technical acquisition specialties as well (e.g. engineering, test and evaluation, science and technology, and program management). Under the Defense Acquisition Workforce Improvement Act (DAWIA), the Department instituted a series of internal DoD career certification levels (I, II, and III). However, it has been recognized that focusing on the achievement of a top-level internal certification does not necessarily meet the desired objectives with regard to technical leadership. To achieve proficiency, it is important to have a complete leadership development program, in which DAWIA certification by itself is a necessary but not sufficient leadership development approach.

The Department of Defense has developed a competency-based model for key leadership position requirements, as outlined in the USD(AT&L) 2013 Key Leadership Positions and Qualification Criteria memo (Department of Defense, 2013). This model includes four overall competency groups (executive leadership, program execution, technical management, and business management) and four leadership development techniques (education, training, experience, and currency). The executive leadership competencies are partially based on the Office of Personnel Management (OPM) executive core qualifications. The technical management competency group focuses on the following skills: systems engineering design for optimized product performance; technical acumen; risk identification and management; configuration management; technical reviews and audits; logistics & product support; support & sustainment; supportability analysis; product support planning; technical or product data management; enterprise architecture; cyber security; agile IT development; broad knowledge of IT governing policies and emerging technologies; T&E strategy; T&E master plan; T&E infrastructure; and DT&E assessments.

The Department of Defense needs a leadership development program that nurtures technical leaders with competencies in all four groups, through classroom education, work assignments, soft skills training, mentoring, and other techniques as appropriate.
Organizations are dependent on their people having the appropriate knowledge, skills and abilities in order to meet the organizations’ objectives and missions. Yet, in a global study conducted by IBM that surveyed over four hundred human resource executives from forty nations, organizations identified the gap in leadership capability as a primary workforce challenge (IBM Global Business Services, 2008). In particular, over seventy-five per cent of the organizations studied stated that developing leadership capability is a critical issue.

Within government, the U.S. Government Accountability Office (GAO) has identified strategic human capital management as a high risk since 2001 (Government Accountability Office, 2015). At the Department of Defense (DoD), the GAO identified one specific challenge, as the fact that over sixty percent of the DoD’s senior civilian leaders will be entitled to retire by 2015 (Government Accountability Office, 2012).

While there is growing theoretical and empirical literature on leadership development (Avolio, 2005; D. V. Day, Fleenor, Atwater, Sturm, & McKee, 2014; DeRue & Myers, 2014; Van Velsor, McCauley, & Ruderman, 2010), the research on leadership development in the technical domain remains at a relatively early stage. Current approaches to the development of technical leadership among systems engineers incorporate various training and development elements on an ad hoc basis, without an integrated framework and with no method to evaluate the effectiveness of such a framework. Although DeRue and Myers have developed a conceptual framework on general leadership development, their focus was to organize key insights from the literature rather than organize the key training and development program elements (DeRue & Myers, 2014). Industry, in contrast, recognizes the various leadership development approaches, but lacks a framework. Lockheed Martin’s Engineering Leadership Development Program, for example, consists of leadership training, technical training, attendance at leadership development conferences, rotational assignments, mentoring, coaching, on-the-job training, and participation on special task forces, but it is not clear how these approaches are integrated or evaluated (Lockheed Martin, 2015). Similarly, while Northrop Grumman’s Future Technical Leaders Program consists of three years of on-the-job assignments, specialized training, networking opportunities, access to senior management and mentoring, neither the integration nor effectiveness of these elements is clear (Northrop Grumman, 2015).

Gurdjian, Halbeisen and Lane (2014) investigate the reasons why leadership development programs fail. Importantly, two of the four reasons for the failure of leadership development programs are related to the lack of performance metrics. The first reason for failure, the lack of context, can be re-interpreted as a performance metric. For example, they provide the illustration of one organization that identified three important leadership transitions. One was the transformation of project executors, handling day-to-day problems, into project directors who manage relationships with the government and important clients. This leadership transition would require different metrics than the transition that from budget experts into business builders. Therefore, the failure to include context can be interpreted as a recommendation that leadership development metrics should take into account the context or purpose within which that development is desired. The last reason for failure of leadership
development programs they explicitly identify is failing to measure results (Gurdjian et al. 2014). The study suggests that observing behavior-change through a 360-degree feedback exercise and monitoring the career development of participants are helpful in assessing the value of leadership development programs. Other measurements include analyzing the differences in productivity and revenue prior to and after the leadership development training. Addressing these factors proactively can contribute to the success of a leadership development program.

The purpose of this paper is to introduce a technical leadership development framework, as well as to propose metrics to determine the effectiveness or efficacy of the leadership development approaches contained in such a framework. We begin with a review of leadership theories, styles, and development that serves to provide focus before proceeding to the discussion of technical leadership development.

### 2.3 Leadership Theories, Styles and Development

Hernez-Broome and Hughes (2004) categorize leadership styles into two main approaches: transactional leadership and transformational leadership. Transactional leadership is characterized by leader-follower exchanges and the nature of transactional leadership tends to result in low project success rate and short-lived outcomes (Hernez-Broome & Hughes, 2004; Riaz & Hussain Haider, 2010). Transformational leadership, on the other hand, is an ethically-based model that focuses on the mutual synergistic interests of both leaders and followers (Caldwell et al., 2012). This model emphasizes sharing a mutual vision, treating people fairly and creating a supportive environment to achieve organization success. Researchers suggest that transformational leadership is a better approach than transactional leadership as it may lead to a higher level of commitment and energy (Hernez-Broome & Hughes, 2004; Thite, 1999). Howard (2005) suggests another approach to classifying leadership styles, and lists key words for each style so that recruiters can use this use this analysis method to determine the leadership style of candidates.

Another study presents a two-dimensional framework, the loci and mechanisms of leadership, to codify leadership theory and research over the past century (Hernandez, Eberly, Avolio, & Johnson, 2011). Three major theories in trait, behavioral and contingency research were also discussed and analyzed for their effectiveness and contribution to the leadership literature (Farris, 1988; Hernandez et al., 2011). Farris (1988) also highlighted key characteristics in leadership and organizational ability, responsiveness and the ability to create positive climates, and concluded that technical competencies are linked to an organization’s performance.

The intrapersonal and interpersonal elements of leadership development research are discussed in an overview study spanning twenty-five years of leadership development research (D. V. Day et al., 2014). While identifying a variety of process factors that impact development practices, including mentoring and coaching, 360-degree feedback, leadership training, job assignments, and action learning, they focus on 360-degree feedback, self-other agreement,
and self-narrative. In addition, they review five ways to evaluate leadership development, including social network analysis, Q-methodology, formative and summative evaluation, hierarchical linear modeling, and return on leadership development investment. They conclude that a leadership development program should include a method to evaluate such a program, but note that this does not occur frequently in practice. Their overall conclusion is that the field of general leadership development is still in its early stages.

2.4 Technical Leadership Development Frameworks

The idea that technical leaders need both leadership skills and technical skills, and that these skills need to be developed over an entire career, is hardly new. As early as 1992, Cordero and Farris (1992) analyzed the careers of research engineers and their competency with regard to leadership. At around the same time, it was recognized that management skills are needed for engineers, and that techniques such as coaching and mentoring were important in this development (Ashley, 1993).

Farr and Brazil (2009) and Farr, Walesh, & Forsythe (1997) present nine broad and independent attributes for defining essential leadership qualities for engineers, and identify the different leadership attributes required over different stages of their career paths. They introduce a leadership development model for engineers consisting of three components: assessment, challenge and support. The first component of this model, assessment, focuses on promoting self-awareness through various activities, such as self-assessment and 360-degree feedback. This component allows participants to not only identify where they think they are, but also where others think they are. It often inspires participants to change their behavior and consequently boosts their self-confidence. The second component promotes the idea of incorporating challenging activities in leadership development. For example, engineers often prefer to stay in their technical comfort zone and refuse to actively communicate with others. This study suggests that interpersonal communication and managerial skills should be integrated in technical leadership development. The final component, support, is the key to amalgamate all three components. Forms of supporting include providing the required time and resources, rotational job assignment and coaching. The study promotes a technical leadership development framework that combines the assessment-challenge-support model, on-the-job-training and self-actualization to develop the necessary qualities throughout the career path taken by most engineers.

Kasser, Hitchins, Frank, and Zhao (2013) describe nine existing competency models for assessing systems engineering competency. Overlaps and differences between these models are analyzed and a comprehensive framework, the competency model maturity framework (CMMF), is introduced to standardize all nine of the competency models. CMMF is a two-dimensional model with a vertical dimension based on knowledge, cognitive characteristics and individual traits, and a horizontal dimension that assesses the candidates’ abilities. In addition to a systems engineering knowledge requirement, problem, implementation and solution domains also constitute the knowledge component, as technical leaders must properly identify
a problem before implementing an appropriate solution. The study proposes that, in the horizontal dimension, systems engineers can be classified in five different types, from level I to level V (Kasser et al., 2013; Ruderman, Clerkin, & Connolly, 2014). The proposed two-dimensional framework can be used to structure the assessment of systems engineers’ competencies.

In addition, Ruderman, Clerkin, and Connolly (2014) introduce a Beyond Competencies Model that enhances the traditional competency leadership development model by emphasizing the physiological, emotional and mental processes. This model goes beyond a traditional competencies model by incorporating three aspects of the inner world: “circuitry”, inner content and conscious engagement. “Circuitry” is influenced by the physical, chemical, and neurological functions of human bodies, while the inner content element concerns the emotional reactions and intuitive feelings. The study suggests that a rewarding and positive environment can enhance the circuitry. The third element is conscious engagement, the ability to observe, adjust and regulate mental processes. Developing conscious engagement allows leaders to respond mindfully to negative situations.

### 2.5 Previous Systems Engineering Research Center (SERC) Work

Previously, the Systems Engineering Research Center performed research on developing technical leadership which was focused primarily on beyond Level III certification including the SYS350 courses at the Defense Acquisition University (DAU) (RT-4). The RT-4 Technical Leadership Development Program created a series of three workshops for experienced technical acquisition professionals, tested them in a series of student pilots delivered during FY 12-14, and validated that they can be used to accelerate the development of the technical leadership capabilities of high potential, senior DoD systems engineers and technologists. Transition of those workshops to DAU is currently underway under research tasks RT-129 and RT-140.

Three weeks of hands on training opportunity for the Department’s senior engineers is helpful, but it is not sufficient to grow the necessary knowledge, skill and abilities (KSAs) to become a competent technical leader. Technical leadership KSAs are needed though an engineer’s career. Opportunities for building those KSAs are also available throughout an engineer’s career. To date, however, no one has identified these technical leadership needs and opportunities, and consequently, there is no program available to meet those needs. Several previous SERC career path research tasks have developed a foundation upon which this task will build, these include the Helix series (Pyster et al., 2014; Pyster, Henry, Hutchison, & Clifford, 2016; Pyster, Henry, Hutchison, Jauregui, & Clifford, 2015), the Technical Leadership Development Program (Gavito et al., 2013; Gavito et al., 2010), and the Army Systems Engineering Career Development Model (Gavito & Pennotti, 2014). This line of research provides, for the first time, a rigorous study of what makes a great systems engineer: the results of these studies, as continued in the current work, are also to some extent applicable to technical disciplines beyond systems engineering.
The development of technical leadership techniques and processes is fully applicable to any technical career field.

RT-45, RT-106, RT-130, and RT-135 Helix explored (and continue to explore) the characteristics of successful systems engineers, their effectiveness and what employers are doing to improve it. Helix has collected data from over 200 systems engineers and related professionals, resulting in Atlas, a theory of what enables systems engineers to be effective, recognizing the primary forces to grow the effectiveness of systems engineers are their experiences, mentoring, and education & training. According to this theory, Technical Leadership is one of the 6-proficiency/competency areas that are central to effective systems engineering. Several organizations have begun to adopt elements of Atlas in their workforce development efforts.

The Helix project has established an objective survey of traits that characterize great systems engineers (SEs), along with a comprehensive analysis of roles and job titles that are filled by SEs across multiple industries and within the government (Pyster et al., 2014). Using Bloom’s taxonomy, Pyster, et al, identify twenty categories of skills across four areas (systems engineering discipline, systems engineering mindset, interpersonal skills, and technical leadership) that distinguish excellent systems engineers. These skills include systems complexity, vision, flexibility, internal motivation, communication, teamwork, influence, team building, conflict management, and stakeholder management.

The Technical Leadership Development research generally focused on training technical leaders at the most senior levels, and validates that advanced training, in the form of hands-on workshops, can be used to accelerate the development of technical leadership capabilities among high potential, senior Department of Defense system engineers and technologists (Gavito et al. 2010). Gavito, et al, developed a series of three five-day workshops, centered on various aspects of technical leadership. The first course, the Systems Lens, utilized a combination of lecture, simulation, group work and experience-based learning to help participants understand and respond to the challenges encountered in leading the development of technical products and systems during all phases of the life cycle. The second course, the Business Lens, emphasized the strategic, financial and technological dynamics surrounding a technical product or system to empower leaders to effectively communicate with and lead a team. The final course, the Enterprise Lens, underlined the full spectrum of enterprise issues and enhanced participants’ ability to manage organizational change while simultaneously achieving organizational objectives. These three workshops together can help prepare engineers for senior technical leadership positions.

Building on this foundation, the RT-104 Army Systems Engineering Career Development Model defined a Career Development Model for the Army and determined that all the elements required to implement the model were readily available. What was required was to integrate them into a coherent system and systematically manage them toward a common set of goals. RT-121 Army Systems Engineering Career Development Model, a follow-on research task, conducted a detailed assessment of each of the elements of the career development model defined under RT 104 and made three recommendations: a) shift the career development
culture from one focused on capabilities to one that emphasizes evidence-based value propositions, b) develop a set of learning experiences aimed at enhancing technical leadership beginning in parallel with Level 1 certification training and extending beyond level 3, and c) implementing a Decision Support System to aid acquisition professionals and their supervisors in planning and executing.

The Army Systems Engineering Career Development work established the value of using value propositions to guide and measure the effectiveness of leadership training, and introduced a system-based framework for the Army’s technical career development program, concepts that are extended to the general DoD technical acquisition workforce in the present work (Gavito & Pennotti, 2014). Gavito and Pennotti propose a systems engineering career development model that could be used to assess more than nine thousand Army Engineering Acquisition Career Field members, and help prepare them to fill key technical leadership positions within the Army. The model consists of five components that aim to improve the capabilities and competencies of systems engineers. The four leadership development approaches in this model are education, experience, tenure and currency. Participants must fulfill the requirements and standards set in each element in order to qualify to become a Critical Acquisition Position (CAP) leader. The last component, cross-functional competencies, recommends the use of an integrated career development and management system and mentoring in technical leadership development.
3 Framework Elements Overview

3.1 Elements of the Technical Leadership Development Framework

On the basis of the review above, we have structured a technical leadership development framework designed to prepare career acquisition professionals in the technical disciplines for leadership at the highest level, starting immediately upon hiring as a college graduate level, and proceeding through incremental steps until the leader is eligible for executive grade.

By “Framework” we intend a structure within which various elements can work flexibly to produce the desired result. Our framework has five elements, namely:

1. Defined career stages
2. A set of competencies defined by KSAs and associated KCIs
3. Development methods/components
4. Metrics to assess individual attainment of the KCIs
5. Validation of the development methods

Figure 4 provides a general overview of the five Framework elements. Our purpose in this section is to explain the role of each element, and to provide the rationale for its inclusion in the framework. Subsequent sections will provide detailed analysis of each element in turn.

3.2 Element 1: Career Stages

Careers progress not according to fixed stage-gate milestones, but organically, moving at times more quickly, at times more slowly, and taking surprising and unexpected turns and occasional detours. Any career development framework has to accept and accommodate this reality. In these terms, defining specific career stages doesn’t make much sense. On the other hand, a framework intended to guide and oversee the development of a particular set of professionals does need some structure, and at the foundation of such a structure, it is useful to have a definition – however flexible it may be – accounting for the transition from stage to stage within that career progression. Thus, the first Framework element involves the definition of the Junior, Mid-Level, and Senior career stages. We discuss the details of this element in Section 4 of this report. Our separation among career stages is based on common practices across many fields, is highly flexible, to reflect the wide variety of situation within the target workforce, and is somewhat fuzzy, in order to avoid forcing individuals into an excessively formulaic structure.

As a useful rule of thumb, we define the three career stages as follows:

- Junior: management of self;
- Mid-level: management of others;
- Senior: management of managers.
3.3 **ELEMENT 2: COMPETENCIES**

The foundation for our framework is the previous work accomplished in a number of efforts (discussed in Section 2 above) that seeks to identify those characteristics that are emblematic of great technical leaders. We have distilled these insights into a list of 24 competencies: statements of Knowledge, Skills, and Abilities (KSAs), of which 12 are uniquely technical in
nature, while the remaining 12 enabling competencies reflect general leadership traits that technical leaders can particularly benefit from.

Each of the 24 competencies is made up of multiple Key Competency Indicators (KCIs) that identify steps at each career stage leading to full competency at the Senior level. KCIs attained at each stage are retained throughout the development process, so the assumption is that a KCI which is important at the Junior level will continue to be important as an individual develops additional skills. Achievement of all KCIs at a given career level constitutes full competency at that level, and qualifies the individual to move to the next career stage.

It should be noted that the KCIs are identified with roles, not positions. This distinction recognizes the fact that more junior leaders may from time to time be thrust into more senior roles: the competencies they display in those roles are associated with the later career stage, although in the aggregate they may not have achieved full competency in all the KCIs associated with that more senior role.

In addition to the description of the KSAs and KCIs, Section 5 provides a validation analysis for our choice of KSAs and KCIs. We have used two validation techniques: first, analysis of the considerable literature on this subject. All the KSAs and most of the KCIs have their basis in previous published work. Second, we have validated the KSAs and KCIs though interviews with subject matter experts identified by their management as exemplary technical leaders. This validation process is discussed in detail in Section 5.

3.4 ELEMENT 3: DEVELOPMENT METHODS

Section 6 of this report discusses our examination of the various methods available to instill the target KCIs. These include the following six methods:

- Education
- Training
- On the job experience
- Rotational assignments
- Mentoring, and
- Coaching

These methods are well established, and for the most part, are defined as usually understood.

3.5 ELEMENT 4: COMPETENCY ATTAINMENT

In our review of many studies of technical leadership development, we found that only in rare instances was there any post-facto examination of whether the target audience, having
received the training or other development experience, actually internalized the desired competency. As a remedy, in this study we offer a limited number of potential validation tools designed to verify that the desired knowledge, skill or ability has been learned. This is of necessity a limited and preliminary set of validation touchstones, since our primary goal has been the construction of the Framework. Expanding and refining the validation scheme introduced in Section 7 is a future goal.

3.6 Element 5: Method Validation

In Section 8, we ask the question: “how do we know that the proposed development methods are actually effective in helping leaders acquire the desired competencies?” In most of the previous work we have reviewed, the application of the six methods has been recommended without comment as to efficacy. In this study, we have made an effort to examine the effectiveness of each method with respect to each of the career stages, and as applied to the various KCIs. This examination includes a review of previous research on this topic, as well as an online survey examining the prevalence of each method in a variety of industry and government settings, and interviews with Technical Leader SMEs and organizational HR offices charged with leadership development.

3.7 The Framework in General – How It Works

To recap, the Framework elements work together to facilitate the achievement of appropriate competency by technical leaders across the full scope of a career in the following ways:

• The Framework is founded on 12 technical leadership competencies (KSAs) and 12 general leadership enabling competencies (KSAs) based on the literature and validated by recognized subject matter experts;
• The basic competencies (KSAs) are applied across three career stages flexibly defined in Framework element 1 based on the usual and customary career paths seen in industry and government;
• At each career stage, one or more key competency indicators (KCIs) defined in Framework element 2 reflects the appropriate application of each KSA at that career level;
• The sum of all the KCIs for one KSA across the career stages results in full achievement of that competency (KSA);
• The sum of all the KCIs at one career stage results in full competency across all KSAs for a particular career stage;
• Six classes of development methods are defined in Framework element 3, and are available to use in developing the KCIs at each career level. The development methods are not mandatory: achievement of the full set of competencies at any given career level is;
• The attainment of competency in single KCIs or a family of them is established through independent assessment metrics in Framework element 4;
• The validity of the development methods is assessed through a validation process in Framework element 5 that includes prior research.
4 FRAMEWORK ELEMENT (1) – CAREER STAGES

4.1 CAREER STAGE OVERVIEW

As the Technical Leadership Development Framework is focused on developing a leadership roadmap to ensure a deep pool of talent at all levels of the enterprise, we define career stages in terms of leadership levels. We open with a description of the junior career stage, and develop the discussion by moving through a sequential, upward progression for a total of four career stages, culminating in the executive level. While our scope for this research is large, established organizations, we occasionally highlight references to other types of organizations to provide enhanced clarity. In order to identify when a particular individual belongs to a specific career stage, we identify three criteria to define the career stages: the level of responsibility, the level of decision-making authority (which is frequently demonstrated in the level of program that an employee has responsibility), and the level of expertise.

The first career stage we identify is the junior career stage, which is characterized by the employee functioning as an individual practitioner or contributor to the team. In most technical professions, including the ones we consider in this Framework, the junior category includes non-supervisory, university-educated professionals, and is frequently the first category that an employee belongs to if they join a large, established organization upon university graduation. Because people in the junior stage have no people reporting in to them, leadership at the junior stage can be observed through the employees’ persuasion, advice and guidance, and negotiation with others around them. People in the junior career stage are also characterized by minimal decision-making authority, which is expressed through their not being responsible for programs. Leadership is therefore characterized by the employees’ informal persuasion, advice and guidance to those who are responsible for programs. Finally, people in the junior career stage have an introductory level of expertise. While they may possess significant academic knowledge (indicated by a Bachelor’s or Master’s degree), they are just in the beginning stage of applying the academic knowledge to problems external to the academic world.

The next career stage in this upward progression is the mid-level career stage. One primary characteristic of this stage is that an employee is now responsible for people, having supervisory duty. It includes at least two types of positions: supervisory positions and team lead positions. Within the government, the criteria for supervisory positions correspond to Factor 3-2 (of Factor 3 – Supervisory and Managerial Authority Exercised), in which the leader plans, assigns, and evaluates the work of subordinates (U.S. Office of Personnel Management, 1998b, p. 15). Team leads are distinguished from supervisors by conducting primarily coordinating and supportive duties (U.S. Office of Personnel Management, 1998a, p. 8). The second primary characteristic of this stage is the level of decision-making authority: at the mid-

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1 Note that in certain professions, such as law and medicine, there is a further expectation of a professional degree beyond the Baccalaureate. In the finance and business consulting worlds, an MBA is a requirement for promotion to supervisory status, which is how we define “mid-level.”
level career stage, the employee has decision-making authority over programs having a limited
to moderate level of size, scope, and complexity. The third characteristic of the mid-level
career stage is that the employee possesses an intermediate level of expertise.² Within
scientific work in government, it is acknowledged that expertise is a second way to progress:
“While supervision is one ladder to high-level responsibility in scientific work, another ladder is
There may be varying combinations of these three criteria resulting in a designation of mid-level across different professions and industries. For example, in academia, law, and medicine, a mid-level employee may possess a high level of subject matter expertise, yet have no junior-level employees reporting in to them.³

The third career stage is the senior level, which, in terms of people responsibility, is typically characterized as managing managers; that is, they have second-level supervision. Within the government, one example is Factor 3-3.b.1, in which the leader uses “any of the following to direct, coordinate, or oversee work: supervisors, leaders, team chiefs, group coordinators, committee chairs, or comparable personnel; and/or providing similar oversight of contractors” (U.S. Office of Personnel Management, 1998b, p. 16). In terms of the level of decision-making authority, a senior-level employee may have responsibility for programs having a large level of size, scope, and complexity. Finally, an employee may be categorized at the senior level if they have demonstrated an expert level of subject matter expertise. Similar to the mid-level, there may be varying combinations of these three criteria resulting in a designation of senior level across different professions and industries. For example, in academia, law, and medicine, a senior employee may be a subject matter expert, and yet not supervise other managers.

The fourth and final career stage, as defined by leadership level, is the executive stage. The defining characteristic of the executive level differs from the three criteria for the first three levels. Specifically, the defining characteristic of the executive level is that the person has responsibility for the enterprise or the large-scale organization. Within civilian government, it is designated by Senior Executive Service; within the uniformed services, it is designated as Flag or General Officer rank; and within industry, it is designated either as Vice President or Chief Officer.

4.2 Defining the Career Stages

While there is no strict equivalency among careers in disparate fields and across government, industry and the academic world, many professions follow a reasonably similar trajectory.

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² A potential metric or indicator of expertise in engineering is Professional Engineer registration. Depending on the organization, Professional Engineer registration may indicate either the mid-level or senior stage.
³ In the uniformed services, this step does not exist in the same way, where a university degree usually implies a commission, and even the lowest ranked commissioned officers are automatically considered supervisors or leaders.
Industry, civilian government, and the uniformed services all recognize a top level of management seen as “executive” in its responsibilities.

<table>
<thead>
<tr>
<th>Career Stage</th>
<th>People Responsibility</th>
<th>Program Responsibility</th>
<th>Knowledge Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td>Managing one’s self</td>
<td>Not responsible for any programs</td>
<td>Introductory level of professional knowledge</td>
</tr>
<tr>
<td>Mid-level</td>
<td>Managing the team</td>
<td>Decision-making authority over programs having a limited to moderate level of size, scope, and complexity</td>
<td>Intermediate level of professional knowledge and expertise</td>
</tr>
<tr>
<td>Senior</td>
<td>Managing managers</td>
<td>Decision-making authority over programs having a large level of size, scope, and complexity</td>
<td>Subject matter expert, expanding breadth and depth</td>
</tr>
</tbody>
</table>

In many professions, there is a transitional point at which the incumbent is understood to have earned some sort of permanent status: this is reflected in the practice of granting tenure to academics. Similar status in the uniformed services has generally been granted at the O-4 level, which nominally occurs at career year seven, and has historically conferred the right to remain on active duty until retirement. Being named a partner in a law firm is similar in nature. All of these transitions occur at about the seven to ten year mark and can be viewed as roughly equivalent to reaching Senior status (the granting of “scrambled eggs” on Officer’s headgear is a symbol of this status – although this custom is somewhat different in the U.S. Navy). There is generally no such marker in private industry, although many companies did, and some still do, grant “sumptuary” perquisites to supervisors at about this level. This is the traditional “key to the executive restroom,” idea, which could manifest itself as a reserved parking spot, wood office furniture, or more meaningfully, compensation such as incentive pay that is based on the performance of the manager’s organization. In almost all cases (not the law firm or university examples) managers at this level supervise other managers: that is, they have second level supervision.

At the mid-level, there is another typical career step, which involves elevation to supervisory duty. In industry, this used to be frequently signaled through a private office, but in today’s cube world, it probably just means a higher walled cubicle. This step does not exist in the same way in the uniformed services, where a university degree usually implies a commission, and even the lowest ranked commissioned officers are automatically considered supervisors/leaders. Likewise, in many professions, including academia, law, and medicine, few practitioners below the “senior” level have any direct reporting juniors. In engineering, achievement of Professional Engineer registration may or may not correspond to the mid-level, or to the senior level, depending on the firm and the circumstances.

Finally, of course, we have the junior level, where in most professions, the employee acts as an individual practitioner. In most technical professions, including the ones we consider in this
Framework, the junior category includes non-supervisory, university educated professionals. Note that in certain professions, such as law and medicine, there is a further expectation of a professional degree beyond the Baccalaureate. In the finance and business consulting worlds, an MBA is a requirement for promotion to supervisory status, which is how we define “mid-level.”

This brief review indicates that there are many varieties of career track or path, depending on technical specialty, academic background, and industry type. A good deal of this variability also exists in the Department of Defense civilian acquisition workforce, so our definitions of the three career levels below Executive (which is defined, as discussed above, by law) are fairly flexible, taking into account not only variability across disciplines, but also allowing for non-traditional career paths that do not follow the general models described above.

Each career stage has specific criteria associated with it, however, for overall context, we generally use the following practical separation among the levels:

- Juniors practice management of self (individual practitioners)
- Mid-level leaders manage others (first level supervision)
- Senior leaders manage other managers (second level supervision)
- Executives manage enterprises comprised of many organizations (top level supervision as defined by Drucker (2008))

While we have attempted to make career stage definitions as flexible as possible in order to accommodate a wide variety of career paths, there are some situations that merit particular comment. These include career paths that are:

- Extremely accelerated
- Much more deliberate
- Non-supervisory

Generally, an individual experiencing a very rapid career trajectory is notably more perceptive and talented than their peers, and has demonstrated an ability to learn and progress at a high rate. As a result, these individuals tend to take responsibility for their own learning, and by the nature of the accelerated career trajectory, they tend to be exposed to a rich variety of job experiences, training opportunities, rotational assignments and mentoring by senior leaders. Nonetheless, the speed of an accelerated career leaves open the opportunity to miss important learning requirements. The sponsors of these individuals should be aware of this fact, and continuously monitor their protégé’s progress with a view to filling in any competency gaps that may occur.

In like manner, a slower than average career trajectory, where an individual may spend a long time entrenched in a single job assignment, needs particular care on the part of the supervisor to ensure that the individual continues to be exposed to variety, and does not become stale.
Finally, there is a small but important group of technical leaders whose contribution is strictly as subject matter experts in their technical field. In some agencies and companies, these individuals are treated as national resources. It is important to recognize that, even though we have defined the career stage levels in terms of supervisory status, there is a parallel track in which advancement is based on scope of technical responsibility and expertise (the last two columns of Table 1). Those who pursue this track are no less technical leaders than are those who rise the supervisory ladder.
5 FRAMEWORK ELEMENT (2) — COMPETENCIES

5.1 PRELIMINARY DEFINITIONS

At the outset, prior to the technical and enabling leadership competency definitions, the following overall terms are defined: enterprise, organization, suborganization, superior, subordinate, and peer. An enterprise is defined as an entity at a very high level of responsibility with a very wide scope. In the DoD, it is the DoD level which is defined to be the enterprise, and this is termed the DoD Enterprise. In industry, an entity that may be more limited than the DoD but that is still led by an executive is defined as an Executive Enterprise. Executive Enterprises are characterized by profit-and-loss responsibility together with the full spectrum of supporting functions, including finance, security, facilities, public affairs, human resources, legal and IT.

An organization is defined to be the entity one hierarchical level below the enterprise, that is, enterprises are comprised of organizations. In the DoD, organizations include the Army, the Navy, the Air Force, and the 4th Estate Agencies (see Figure 5). In industry, organizations include production and finance. Suborganizations are defined to be the entity one hierarchical level below the organization, that is, an organization is comprised of suborganizations. An entity is the generic term that refers to either an enterprise, an organization, or suborganization.

![Figure 5 The DoD Enterprise](image)

The following relative terms are defined next: subordinate, superior, and peer. Subordinate refers to the hierarchical level below the current level, superior refers to the hierarchical level above the current level, and peer refers to the same hierarchical level. Characterized in terms of reporting relationship, a subordinate directly reports in to a person at the current level, and a person at the current level reports in to their superior. For example, if a technical leader is at the senior level, a subordinate refers to a mid-level leader, a superior refers to an executive leader, and a peer refers to another senior leader. If a technical leader is at the mid-level, a
subordinate refers to a junior-level leader, a superior refers to a senior-level leader, and a peer refers to another mid-level leader. These relative terms can also be applied to the enterprise level, organization level, and suborganization level. For example, in the DoD, the organization level is subordinate to the DOD Enterprise. The Army is a peer to the Navy, which is a peer to the Air Force. Suborganizations are peers to each other.

The external environment refers to the main factors, conditions or events outside the entity (the enterprise, organization, or suborganization), that potentially can impact the entity’s activities, decisions, and performance. These include the social, political, and economic environment.

The Technical Leadership Development Framework is based on three defined career stages: junior, mid-level, senior stages. To recap, Table 2 provides a brief summary for each stage’s responsibilities related to who they manage, program authority, and levels of expertise in the requisite knowledge area.

<table>
<thead>
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<td>Decision-making authority over programs having a large level of size, scope, and complexity</td>
<td>Subject matter expert, expanding breadth and depth</td>
</tr>
</tbody>
</table>

5.2 TECHNICAL LEADERSHIP COMPETENCIES

Described visually, the technical competencies may be thought of as belonging to the class on the right, and the general leadership competencies may be thought of as belonging to the class on the left (see Figure 6). Their intersection is the focus of the Framework competencies, that is, technical leadership competencies. Technical leadership competencies consist of technical competencies which have important leadership aspects, and leadership competencies which enable technical competencies. While the technical leadership competencies are grouped into two groups for ease of understanding, it is important to note that these are all technical leadership competencies. For example, communication not only enables the technical competencies, but is embedded in many of them. Therefore, communication as a leadership competency overlaps the technical competency group to form a single intersection, that of technical leadership competencies.
The set of 24 competencies selected for inclusion in the leadership development framework were culled from a much longer potential list developed through review of the literature, use of existing OPM and other government competency models, and discussions with colleagues and subject matter experts. The initial set of candidate competencies was refined from approximately 45 to a smaller set of 20, and then expanded as a result of review and discussion among the team members and with outside reviewers. Importantly, the evolving set of competencies was extensively reviewed through interviews with over 30 subject matter experts, individuals from industry and government who were identified by their organizations as outstanding technical leaders. While each one of these interviews provided insight and additional corroborating information, it is notable that in every case, the subject matter expert fundamentally confirmed the validity of the chosen competency set and provided affirmation for the appropriateness of the final selection. Although this review does not have the rigor of a large, statistically significant survey, the experts we interviewed do represent a wide range of government and industry organizations, and their affirmation of the set of 24 competencies gives us confidence that this is a good starting point.

This section identifies, defines, and characterizes technical leadership competencies, or knowledge, skills and abilities (KSAs). The description of each technical leadership competency is structured as follows. Subsection 1 opens with the technical competency, drawn from the technical leadership literature. Next, Subsection 2 outlines the key actions of the technical leadership competency. Typically, the key actions include the observable behaviors of performing that technical leadership competency being performed at a senior role. For example, in the technical planning competency, one generic key action is developing overall technical plans for a large (or complex system). Contextualizing that element being performed at a senior role results in the additional following specified key actions: relays convincing, clear
and, relevant information from technical planning up the hierarchical levels in the enterprise; and provides clear direction from the technical plans down the hierarchical levels to subordinate suborganizations and their leaders.

Subsection 3, the technical rationale, discusses why the technical leadership competency is important for technical leadership, while Subsection 4, the leadership rationale, discusses why the technical leadership competency is important for technical leadership. The Cambridge English dictionary defines technical as, “relating to the knowledge, machines, or methods used in science and industry; involving or needing special skills or knowledge, esp. in science or engineering (= the design and building of machines, equipment and structures).” Subsection 5 summarizes why the technical leadership competency is important for the technical leader. Finally, Subsection 6 identifies the technical source or origin of the technical leadership competency.

We summarize the technical leadership competencies in Table 3.

<table>
<thead>
<tr>
<th>Competency Name</th>
<th>Competency Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Planning</td>
<td>Organizing and scoping the technical work across all the technical phases (from analysis and design, through to development, deployment, and operation)</td>
</tr>
<tr>
<td>Technical Requirements</td>
<td>Translating the stakeholder’s behavioral and functional needs and expectations into technical statements (including technical problem scope, technical product constraints, and technical requirements)</td>
</tr>
<tr>
<td>Logical decomposition</td>
<td>Separating or disintegrating a problem, function, or system into its constituent parts, often into a hierarchical structure</td>
</tr>
<tr>
<td>Product verification and validation</td>
<td>Comparing and evaluating the final technical product or system with the initial requirements, specifications, and stakeholders’ expectations</td>
</tr>
<tr>
<td>Product transition</td>
<td>Deploying the technical product into production, test, operations and sustainment</td>
</tr>
<tr>
<td>Lifecycle</td>
<td>Managing the product movement through the lifecycle, including setting the criteria by which the technical product may be evaluated as it passes from one stage to another</td>
</tr>
<tr>
<td>Technical risk management</td>
<td>Identifying, quantifying, and mitigating technical risk, and accepting any residual technical risk</td>
</tr>
<tr>
<td>Systems thinking</td>
<td>Seeing the big picture, seeking holistic explanations and relationships when examining technical problems, and focusing on connections and interfaces among the subsystems in a system</td>
</tr>
<tr>
<td>System complexity</td>
<td>Understanding the interfaces within and between systems, and recognizing the potential for emergent behavior due to differences in system components and interfaces.</td>
</tr>
<tr>
<td>Abstraction</td>
<td>Identifying and translating a pattern in one domain to a different domain</td>
</tr>
<tr>
<td>Paradoxical mindset</td>
<td>Holding opposite views simultaneously to make better decisions</td>
</tr>
</tbody>
</table>
5.2.1 Technical Planning Competency

5.2.1.1 Definition

The technical planning competency is defined as organizing and scoping the technical work across all the technical phases (from analysis and design, through to development, deployment, and operation). Technical planning includes the ability to create technical plans that are not typically present in business plans or business project plans, such as technical design and architecture plans, product implementation or development plans, verification and validation plans, test and evaluation plans (or unit, integration, and user acceptance testing plans), and product transition plans (or deployment plans). Technical planning also includes the ability to identify the control points as the product moves through the lifecycle. In addition to their unique technical characteristics, technical planning incorporates technical task identification, prioritizing, resource assignment, scheduling, and cost control (Gavito et al., 2010, p. 47) (Pyster et al., 2015, p. 36).

5.2.1.2 Actions

A technical leader performing technical planning well in a senior role:
• Develops overall technical plans, for a large (or complex) system, that:
  – Support the strategy, vision, mission and long range goals (which recognize needs) of the organization or enterprise;
  – Provide direction to mid-level leaders;
  – Are consistent with plans and objectives of peer organizations, both technical and non-technical;
  – Reflect the technical impact of the superior organization’s strategies and missions.
• Guides and directs mid-level leaders to detail out the overall technical plan for a large (or complex) system into the appropriate detailed plans;
• Reviews and approves technical plans for a product or a system developed by subordinate suborganizations;
• Represents and communicates the overall technical plan in the larger technical and non-technical community;
• Relays convincing, clear and, relevant information from technical planning up the hierarchical levels in the enterprise;
• Provides clear direction from the technical plans down the hierarchical levels to subordinate suborganizations and their leaders;
• Coordinates the technical plan and obtains consensus among peer internal suborganizations (both technical and non-technical); and
• Communicates clear, relevant technical plan information to external organizations, including partners in other agencies, industry, academia and perhaps internationally.
5.2.1.3 TECHNICAL RATIONALE

Technical planning is important as a technical competency because technical planning requires understanding the technical activities in order to plan them accurately.

5.2.1.4 LEADERSHIP RATIONALE

Technical planning is important as a leadership competency because technical plans provide direction to subordinate organizations and inform superior organizations.

5.2.1.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

The technical planning competency is a critical technical leadership competency because overall technical plans provide technical direction and guidance to subordinate suborganizations. Because of the technical nature of technical planning content, it cannot be outsourced to a non-technical agent. Additionally, the role of technical planning in the success of a suborganization is critically dependent on the technical planner’s understanding of the role, relationships, direct and indirect impacts of engineering, science, and technology working across organizational levels and boundaries. This combination of technical understanding, management, and sensitivity to organizational interactions makes this competency foundational to the exercise of technical leadership in an organization.

5.2.1.6 TECHNICAL SOURCE

• Gavito’s Technical Leadership Development Program, 2010
• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015
• Huntsville Interviews (DK, DH)

5.2.2 TECHNICAL REQUIREMENTS DEFINITION AND ANALYSIS COMPETENCY

5.2.2.1 DEFINITION

The technical requirements definition and analysis competency is defined as translating the stakeholder’s behavioral and functional needs and expectations into technical statements (including technical problem scope, technical product constraints, and technical requirements) (Gavito et al., 2010, p. 45) (BKCASE Editorial Board, 2016e).

5.2.2.2 ACTIONS

A technical leader performing technical requirements definition and analysis well in a senior role:

• Understands stakeholder’s role in setting requirements, and balances needs of a broad range of stakeholders at all levels and the essential (and necessary) inconsistency in the requirements they express;
• Negotiates technical requirements with stakeholders;
• Coaches mid-level leaders in gathering and negotiating technical requirements with stakeholders;
• Provides clear explanations regarding inconsistencies;
• Coaches mid-level leaders in transforming stakeholder inputs into system requirements, in translating potentially non-technical requirements into technical language, and in evaluating their subsequent development into lower level requirements and specifications;
• Understands and balances the hierarchical importance of requirements, i.e., key performance parameters (KPPs), with top-level goals, both functional and non-functional;
• Enforces discipline in managing and documenting the immediate and cascading impact to requirements, particularly at the system level.

5.2.2.3 Technical Rationale

Technical requirements definition and analysis is important as a technical competency because the development of technical requirements, and their transformation into specifications that are implemented in a design, is a technical task. Additionally, the technical leader requires technical knowledge to understand which technical requirements are feasible, and therefore can be agreed with the stakeholder, and which are infeasible, and therefore should not be agreed with the stakeholder.

5.2.2.4 Leadership Rationale

Technical requirements definition and analysis is important as a leadership competency because the technical leader is responsible for negotiating technical requirements with stakeholders, and for persuading and explaining to non-technical stakeholders technical conflicts contained in high level system requirements.

5.2.2.5 Why this Competency is Important for Technical Leadership

The technical requirements definition and analysis competency is an important technical leadership competency because failure to properly set and manage technical requirements is a common source of failed technical products, including large unsuccessful IT projects. Requirements are derived through negotiating with stakeholders and involves strong communication and influence skills to manage. Without effective requirements, a program will fail to meet expectations. Therefore, the technical requirements definition and analysis competency is a key tool in the technical leaders kit.

5.2.2.6 Technical Source

• Gavito’s Technical Leadership Development Program, 2010
• SEBoK
• Huntsville Interviews (JR, KvH, K)
5.2.3 LOGICAL DECOMPOSITION COMPETENCY

5.2.3.1 DEFINITION

The logical decomposition competency is defined as a person’s ability to separate or disintegrate a problem, function, or system into its constituent parts, often into a hierarchical structure. Logical decomposition occurs through a hierarchical breakdown of a large or complex system into a set of functions at multiple levels (Gavito et al., 2010, p. 46) (BKCASE Editorial Board, 2016c).

5.2.3.2 ACTIONS

A technical leader performing logical decomposition well in a senior role:

• Decomposes or segments system of systems (including large distributed system-of-systems of national importance) so that:
  – the resulting decomposition is technically suited to ensure success of the system design and development; and
  – the resulting decomposition takes into account of the resources, capabilities and workload of the executing organization(s);
• Guides, directs, reviews and approves system decompositions developed by subordinate suborganizations;
• Develops strategies for system decomposition for review by executive-level technical and non-technical management.

5.2.3.3 TECHNICAL RATIONALE

Logical decomposition is important as a technical competency because the activity of logical decomposition into sub-problems, sub-functions, or subsystems is a method used in science and industry, particularly in science and engineering to design components and systems.

5.2.3.4 LEADERSHIP RATIONALE

Logical decomposition is important as a leadership competency because of the close association between decomposing a system and the assignment of resources (in subordinate organizations) to the resulting subsystems or segments, and because system complexity requires communicating with multiple levels of stakeholders.

5.2.3.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

The logical decomposition competency is a critical technical leadership competency because the appropriate allocation of requirements to a top-level logical architecture is a make or break moment in determining success or failure for programs with high technical content. Only technical leaders have the perspective to be able to do this accurately.
5.2.4 PRODUCTION VERIFICATION AND VALIDATION COMPETENCY

5.2.4.1 DEFINITION

The product verification and validation competency is defined as comparing and evaluating the final technical product or system with the initial requirements, specifications, and stakeholders’ expectations. Technical product verification focuses more on whether the product or system is technically accurate and designed correctly, whereas technical product validation focuses more on whether the product or system meets stakeholder expectations (Gavito et al., 2010, p. 50) (BKCASE Editorial Board, 2016f).

5.2.4.2 ACTIONS

A technical leader performing product verification and validation well in a senior role:

- Understands that verification and validation is not just something that comes into play at the developmental and operational test phases of a program, but that it is part of every step in the system lifecycle;
- Coaches peers on the understanding and associated implications that product verification and validation is a part of every step in the system lifecycle;
- Understands that allocating resources to verification and validation is a powerful tool for reducing lifecycle cost, and budgets accordingly;
- Coaches mid-level leaders in understanding the difference between building the thing right, and building the right thing;
- Enforces process discipline and accountability among subordinate suborganizations with regard to verification and validation policy and practice;
- Advocates strongly for verification and validation with superiors, and if in a programmatic role, strongly supports verification and validation budgets even if this has a negative impact on other aspects of the program, including potential loss of control by the leader over the formal test of the program.

5.2.4.3 TECHNICAL RATIONALE

Verification and validation is important as a technical competency because verification and validation (such as the design of experiments, statistical analysis, and modeling and simulation) are methods used in science and industry, particularly in science and engineering to verify and validate components and systems.
5.2.4.4 LEADERSHIP RATIONALE

Verification and validation is important as a leadership competency because the essential leadership skills of communication, influence, and coaching are integral to ensuring that this competency is executed successfully.

5.2.4.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

The product verification and validation competency is an important technical leadership competency. Since verification and validation is likely to be the first function deferred when technical programs are delayed, technical leaders must be prepared to use persuasion and argumentation to convince both superiors and subordinates not to reduce time and resources allocated to verification and validation because of other lifecycle phases overruns.

5.2.4.6 TECHNICAL SOURCE

- Gavito’s Technical Leadership Development Program, 2010
- Squires and Wade’s Systems Engineering Experience Accelerator, 2011
- SEBoK

5.2.5 PRODUCT TRANSITION COMPETENCY

5.2.5.1 DEFINITION

The product transition competency is defined as deploying the technical product into production, test, operations and sustainment. Product transition includes storing and moving the product, as well as preparing the receiving site. It also includes end user training. In addition, transition extends to include transition from technology to engineering, and the transitioning of code (Gavito et al., 2010, p. 50) (BKCASE Editorial Board, 2016d).

5.2.5.2 ACTIONS

A technical leader performing product transition well in a senior role:

- Coordinates all aspects of transition requirements for:
  - Operations
  - Maintenance
- Fields the transition by handling different users, dealing with multiple agencies and multiple services;
- Coaches mid-level leaders to ensure that technical products are transitioned with full understanding by the receiving organization;
- Effectively coaches mid-level leaders in their understanding of the transition process, and ensures that they are prepared to effectively accept incoming work, and provide high quality technical products for transition outside the organization;
• Enforces process discipline and accountability among subordinate suborganizations with regard to product transition policy and practice;
• Provides input to enhance product transition policy and procedures to superiors;
• Communicates effectively how to operate and maintain the technical product to technical and nontechnical people;
• Effectively leads the transition to the external client, handling both technical and nontechnical users and clients with diverse expectations.

5.2.5.3 TECHNICAL RATIONALE

Product transition is important as a technical competency because of its use in science and engineering to deploy technical products into operation.

5.2.5.4 LEADERSHIP RATIONALE

Product transition is important as a leadership competency because product transition leaders guide and direct transition to the client.

5.2.5.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

As with other competencies in this series, this one is critically important for mission effectiveness in ensuring that product transition is conducted as a team effort, in the absence of which excessive organizational friction leads to cost increases, schedule delays, and inferior quality. If a product is not transitioned effectively, it proceeds no further in the product life cycle, and therefore becomes failed at that point. Consequently, product transition is an important technical leadership competency.

5.2.5.6 TECHNICAL SOURCE

• Gavito’s Technical Leadership Development Program, 2010
• Squires and Wade’s Systems Engineering Experience Accelerator, 2011
• SEBoK

5.2.6 LIFECYCLE COMPETENCY

5.2.6.1 DEFINITION

The lifecycle competency is defined as managing the product movement through the lifecycle, including setting the criteria by which the technical product may be evaluated as it passes from one stage to another. The lifecycle is defined as a series of stages through which a technical product is first envisioned and defined, then built, transitioned into production, maintained, and ultimately retired and disposed. A generic system lifecycle model consists of the following sequence of phases: concept and system definitions; design; build; realization/production; integration; verification and validation; support and utilization; retirement; and disposal.
et al., 2010, p. 39) (Pyster et al., 2015, p. 35) (BKCASE Editorial Board, 2016b). The focus of the lifecycle aspect of the system consists of time, or the temporal characteristic.

5.2.6.2 Actions

A technical leader performing the lifecycle competency well in a senior role:

• Manages a technical system of system at the appropriate stage in the lifecycle, and coaches mid-level leaders to manage products and systems at the appropriate stage in the lifecycle;
• Ensures entrance criteria are met for the next phase in the lifecycle;
• Sets the criteria by which the technical product may be evaluated (and therefore pass from one stage to the next), striking an appropriate balance among product quality, product risk, and product cost and schedule;
• Coaches mid-level leaders in their understanding of the lifecycle process, and ensures that they are prepared to effectively accept incoming work, and provide high quality technical plans and activities to the next stage in the lifecycle;
• Understands and coaches mid-level leaders to understand the relationships and impacts of decisions from definition to retirement to disposal;
• Understands the condition of all technical products moving from one stage to another, including full knowledge of any unfinished technical work;
• Maintains strong collaborative relationships with peer leaders “upstream” and “downstream;”
• Provides input to enhance lifecycle policy and procedures to executive-level leaders;
• Views the temporal dimension of a problem under consideration;
• Coaches mid-level to understand the interdependencies of different stages of the product lifecycle on the quality of the final product;
• Effectively negotiates product movement through the lifecycle, resulting in a win for both the acquiring and transitioning organizations;
• Avoids the temptation to take advantage of the other party, whether by passing a poorly performing product down the line, or by attributing product shortfalls to the organization making the handoff, even when the product is technically sound.

5.2.6.3 Technical Rationale

Lifecycle is important as a technical competency because of the technical knowledge and skills required to 1) set the entrance requirements by which the technical product advances from one phase to another, and 2) prepare the technical products and activities (also known as technical work packages) and technical reports by which the technical product advances from one phase to another.

5.2.6.4 Leadership Rationale

The lifecycle is important as a leadership competency because lifecycle leaders guide and direct the leaders who manage the product through the lifecycle, and because they set product evaluation criteria.
5.2.6.5 Why This Competency Is Important for Technical Leadership

The significance of the lifecycle competency for technical leadership originates in the close association between the control points in the lifecycle and the scheduling and cost of resources. With a holistic view of product lifecycle is critical for technical leaders to exercise influence and pervasion in achieving organizational goals and instilling organizational values with acceptable risk to program achievement.

5.2.6.6 Technical Source

- Gavito’s Technical Leadership Development Program, 2010
- SEBoK

5.2.7 Technical Risk Management Competency

5.2.7.1 Definition

The technical risk management competency is defined as identifying, quantifying, and mitigating technical risk, and accepting any residual technical risk. In particular, technical risk management consists of identifying the technical risks; assessing those risks in terms of the severity of the consequence and the probability that the risk will occur; determining their impact on program/project schedule, cost, and performance; developing risk mitigation plans; and acceptance of any residual risk (Gavito et al., 2010, p. 47) (Pyster et al., 2015, p. 36).

5.2.7.2 Actions

A technical leader performing technical risk management well in a senior role:
- Coaches mid-level leaders to quantify technical risks and to develop appropriate risk mitigation strategies;
- Accepts or recommends acceptance of any residual risk;
- Understands organizational risk tolerance and appropriately mitigates to acceptable levels;
- Mentors mid-level leaders, both probing them on their own assessments of risk, and providing them with “top cover” allowing them to be comfortable with their own risk taking;
- Effectively articulates and communicates the technical risk profile to superiors and sometimes non-technical stakeholders, and obtains support for risk assessment and risk management decisions;
- Uses persuasion and reassurance to align the technical risk profile with organizational risk tolerance, and ensures that both subordinates and superiors are comfortable with the risk profile advocated by a technical leader.
5.2.7.3 TECHNICAL RATIONALE
Technical risk management is important as a technical competency because technical risk identification and quantification (probability and severity) require technical understanding and insight.

5.2.7.4 LEADERSHIP RATIONALE
Technical risk management is important as a leadership competency because of the communication and influence skills necessary to manage a nondeterministic factor to superiors and subordinates.

5.2.7.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP
This is an important technical leadership skill because of its centrality to program success, because it combines technical and leadership qualities in equal measure, and because misunderstanding the role of technical risk management in a technical program can have disastrous consequences.

5.2.7.6 TECHNICAL SOURCE
• Gavito’s Technical Leadership Development Program, 2010
• Squires and Wade’s Systems Engineering Experience Accelerator, 2011
• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015

5.2.8 SYSTEMS THINKING COMPETENCY

5.2.8.1 DEFINITION
The systems thinking competency is defined as the ability to see the big picture, seeking holistic explanations and relationships when examining technical problems, and focusing on connections and interfaces among the subsystems in a system. Specifically, systems thinking is descriptive of a holistic approach to thought about a system, in which importance is placed on the interrelationships that form system behavior. Systems thinkers are those who focus on the whole system rather than the individual parts in the system, and who focus on the connections and interfaces between the components, rather than the individual components. In addition, systems thinking is defined as consisting of the ability to see the big picture. Big picture thinking refers to the ability to take the broader view (Pyster et al., 2015, p. 38). Systems thinking is differentiated from the lifecycle in that the lifecycle focuses on the time dimension of the product while systems thinking focuses on the product as a system.

5.2.8.2 ACTIONS
A technical leader performing systems thinking well in a senior role:
• Seeks out holistic explanations, descriptions, and relationships when examining technical problems;
• Focuses on connections and interfaces among the subsystems in the system;
• Envisions and articulates system relationships among existing systems, and extrapolates individual system characteristics into attributes of a system of systems;
• Informs mid-level leaders, executive-level leaders, peers, and stakeholders, where the structural connections in a system can be found, and coaches them on how to do the same;
• Provides guidance to mid-level leaders as they design and develop technical products to consider the system, its place in the system of systems, and the connections and interfaces between components;
• Provides advice and guidance to executive-level leaders as they develop effective organizational strategies and support of organizational missions based on systems thinking.

5.2.8.3 Technical Rationale
Systems thinking is important as a technical competency because the connections and interfaces in the technical product or system, and the system explanations, descriptions, and relationships are technical, whether at the design, realization, or operation phase in the lifecycle, and therefore need to be technically understood.

5.2.8.4 Leadership Rationale
Systems thinking is important as a leadership competency because of the communication, direction, and guidance skills that form this competency.

5.2.8.5 Why This Competency is Important for Technical Leadership
As in other instances, the importance of this competency consists in bringing together special technical insight and persuasive demonstration of that insight. Only a strong leader with exceptional technical skill, and a particular kind of vision is capable of bringing the special insights of systems thinking into play for the solution of difficult technical challenges.

5.2.8.6 Technical Source
• Squires and Wade’s Systems Engineering Experience Accelerator, 2011
• SEBoK

5.2.9 System Complexity Competency

5.2.9.1 Definition
The system complexity competency is defined as understanding the interfaces within and between systems, and recognizing the potential for emergent behavior due to differences in
system components and interfaces. In the literature and industry, system complexity has multiple definitions. One definition of system complexity focuses on the volume, types, and diversity of system elements and relationships or interfaces, while another definition focuses on the lack of system behavior predictability originating from the volume, types and diversity of system elements and interfaces. Importantly, complexity is not equivalent to complicatedness or difficulty (Pyster et al., 2015, pp. 37-38) (BKCASE Editorial Board, 2016a).

5.2.9.2 Actions

A technical leader performing systems complexity well in a senior role:
- Coaches mid-level leaders to understand system complexity, and the resulting impact on system design and architecture decisions;
- Recognizes the impact that system interdependence, data flows among systems, and the virtually infinite number of potential system states have on the design, development, test and operation of complex systems;
- Ensures (through coaching and mentoring) that mid-level leaders take system complexity into account, are trained to recognize system designs that have the potential for emergent behavior, and take steps to mitigate that potential through thoughtful design strategies;
- Ensures that superiors, both technical and non-technical, are cognizant of the special risks associated with the highly distributed and digitally rich systems, particularly when they are embedded in a complex socio-technical environment, and are supportive of efforts to provide for mitigation of potential emergent behavior of a negative type;
- Leads by example in learning the rapidly changing science of complexity.

5.2.9.3 Technical Rationale

System complexity is important as a technical competency because as the complexity of systems increases, a person’s proficiency in system complexity is required to successfully design, realize, and operate the complex systems.

5.2.9.4 Leadership Rationale

Similar to systems thinking, systems complexity is important as a leadership competency because of the communication, direction, and guidance skills that form a part of this competency.

5.2.9.5 Why This Competency Is Important for Technical Leadership

This competency is becoming increasingly important for technical leaders because of the increasing system complexity, that is, systems are becoming more and more interconnected.

5.2.9.6 Technical Source

- SEBoK
5.2.10 Big Picture Thinking Competency

5.2.10.1 Definition

The big picture thinking competency is defined as managing the technical aspects external to the system. Big picture thinking is differentiated from systems thinking in that big picture thinking focuses on the technical aspects external to the system, that is, the technical environment in which the system exists, or the system in its organizational context, or a particular system in the context of all other systems. Whereas systems thinking is inward-facing, big-picture thinking is outward-facing, relating to external stakeholders, customers, and suppliers. Big picture thinking addresses organizational context factors such as business implications and political implications of the system, and how the system fits in the organizational landscape (i.e. relative to finance and human resources).

5.2.10.2 Actions

A technical leader performing big picture thinking well in a senior role:

• Understands how the technical system, along with its budgetary, political, mission and support aspects, fits within the executive-level context;
• Identifies the overall context of the immediate system.
• Focuses on external connections rather than internal structure.
• Relays the context of why a decision was made a particular way to mid-level leaders, providing mentoring and coaching of why a decision was not accepted.
• Understands how the system fits in the context external to the agency, that is, in the Congressional context or landscape, and the national technical context or landscape;
• Illuminates the context for both executive level and mid-level leaders;
• Effectively represents the system in relevant Congressional committees, providing advice and guidance to relevant national standards boards.

5.2.10.3 Technical Rationale

No technical solution ever exists outside its context. Ordinary engineers and technologists, including information technology specialists, work mostly inside the boundary. Technical leaders understand the context, including the technical context (indirectly related technical components or systems).

5.2.10.4 Leadership Rationale

Big picture thinking is an important leadership competency because leaders’ capability to provide the big picture for their subordinates enables their subordinates to fully understand where the technical solution fits in its context, and therefore lead more effectively.
5.2.10.5 Why this Competency is Important for Technical Leadership

Big picture thinking is an important technical leadership competency. Without it, technical leaders can be easily entangled in the weeds of details and lose sight of a holistic perspective of the engineering endeavor. A clue to its importance lies in the fact that attempting to describe “big picture thinking” from a technical perspective or a leadership perspective results in using the same words.

5.2.10.6 Technical Source


5.2.11 Abstraction Competency

5.2.11.1 Definition

The abstraction competency is defined as identifying and translating a pattern in one domain to a different domain. More specifically, abstraction is the ability to identify patterns or generic structures or principles in one domain, and translate them to a different domain in which the surface details or characteristics look different, but the underlying pattern or generic structures or principles are similar, to solve a problem, generate a solution, or develop a new product. The larger the difference in the domains’ surface details and characteristics, the higher the level of abstraction.

5.2.11.2 Actions

A technical leader performing abstraction well in a senior role:

- Recognizes patterns or abstractions across very divergent domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain;
- Discerns patterns and structures in the relationships among multiple diverse systems;
- Provides recommendations to superiors, because of the ability to abstract up ideas and solutions, to the appropriate organizational level;
- Understands how concepts and tools can be applied in varied situations and domains;
- Guides mid-level leaders in identifying connections and new opportunities (including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;
- Leads multidisciplinary teams in subordinate suborganizations across multiple technical fields;
- Guides mid-level leaders in the right direction with regard to scientific, mathematical and engineering insights.
5.2.11.3 TECHNICAL RATIONALE

Abstraction is important as a technical competency because this skill allows the technical person to advance beyond their initial specialized training in a single area to handle multiple disciplines and domains.

5.2.11.4 LEADERSHIP RATIONALE

Abstraction is important as a leadership competency because the ability to perform abstraction well builds the trust and confidence level of subordinate leaders in leaders who, while not having their specialized training, are still able to provide them with guidance and direction.

5.2.11.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

This is a highly critical technical leadership skill, particularly at the senior level. Technical leaders in the senior role must be able to understand what is going on across the domains, because they lead subordinate leaders in different domains.

5.2.11.6 TECHNICAL SOURCE

• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015
• SEBoK

5.2.12 PARADOXICAL MINDSET COMPETENCY

5.2.12.1 DEFINITION

The paradoxical mindset competency is defined as holding opposite views simultaneously to make better decisions (Pyster et al., 2015, p. 38).

5.2.12.2 ACTIONS

A technical leader performing paradoxical mindset well in a senior role:

• Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment, while:
  – Providing reassurance and direction to mid-level leaders during resolution of the resulting challenges;
  – Nurturing divergent views among mid-level leaders and coaching them on how to do so with their team members;
  – Ensuring that executive-level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.
• Is comfortable with apparent paradox and can examine technical problems from higher dimensions in which paradoxes may be resolved;
• Understands how to bring divergent technical approaches to resolution at the appropriate time in the system lifecycle;
• Sustains mid-level leaders’ motivation, because paradoxical thinking injects an uncomfortable level of uncertainty for technical professionals who typically thrive on clarity, certainty, and solutions. In addition, one’s technical subordinates must be motivated and encouraged to engage in multiple divergent views of a problem simultaneously;
• Reassures superiors that the presence of multiple divergent and possible contradictory views is a good thing.

5.2.12.3 TECHNICAL RATIONALE
Paradoxical mindset is important as a technical competency because the decisions, problems, and courses of actions across all the phases of the system lifecycle that the paradoxical mindset are applied to are technical.

5.2.12.4 LEADERSHIP RATIONALE
Paradoxical mindset is important as a leadership competency because the ability to hold divergent and contradictory positions simultaneously allows the individual to more fully understand the decision or course of action to be made, and therefore enhances the quality of the decision or course of action.

5.2.12.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP
If for no other reason, this skill is important to technical leaders because it keeps them from being blindsided by too narrow a technical focus. However, it is also very important when dealing with large systems of national importance to have as wide and as agile a perspective on possible answers as we can. This is particularly significant at a time when the breathtakingly rapid change in technology causes ideas to become obsolete almost as quickly as they can be articulated. Threats, as well as technologies, are constantly changing, and having a paradoxical mindset facilitates a rapid and effective response.

5.2.12.6 TECHNICAL SOURCE
• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015

5.3 ENABLING COMPETENCIES FOR TECHNICAL LEADERSHIP
The competencies described in this section are general leadership competencies that are particularly relevant as key success factors to technical leadership in organizations. They enable the competent technical leader to execute the technical competencies described in the preceding section. In developing, describing, and characterizing these enabling competencies, we have drawn on selected works from the substantial leadership literature. The Successful
Manager’s Handbook, for example, consists of 28 leadership competencies, of which 24 are reflected in the technical leadership competencies described below (the exceptions being corporate financial and process management competencies). The first section of The ASTD Leadership Handbook’s five sections is on leadership competencies (Biech, 2010). It contains nine leadership competencies, of which seven are incorporated below (the exceptions being financial and talent retention competencies). Additional references are identified in the various enabling competencies. In our development of each of them, we have also customized the general leadership competencies into enabling ones by highlighting specific aspects in the elements that are salient for technical leaders.

The description of each enabling competency is structured as follows. As this structure and its description parallels the technical competencies, we highlight only the differences in the structure. Subsection 1 opens with a definition of the enabling competency, drawn from the general leadership literature, because it provides a more expansive definition than the technical leadership literature. The structure of Subsection 2 for the enabling leadership competencies parallels the technical leadership competencies, that is, the section consists of the actions being performed at a senior role. Subsection 3 discusses why the enabling competency is important to support the technical competencies, while Subsection 4, discusses why the enabling competency is important as a leadership skill. Finally, Subsection 5 outlines the technical source or origin of the enabling competency.

For convenience, Table 4 summarizes the definitions of the enabling competencies.

<table>
<thead>
<tr>
<th>Enabling Competency</th>
<th>Enabling Competency Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing People</td>
<td>Expanding people’s ability to do technical work effectively, expanding their ability to lead others effectively, increasing their decision-making capability (with associated trade-offs and judgment calls), helping people understand their career paths and career growth, encouraging people to be good citizens in the workplace, and fostering people’s fulfillment from doing their work.</td>
</tr>
<tr>
<td>Leading People</td>
<td>Guiding, directing, or motivating others in a dignifying and empowering way to further the goals and priorities of the organization.</td>
</tr>
<tr>
<td>Thinking Critically</td>
<td>Using logic and analysis to identify and evaluate the strengths, weaknesses, and implications of different courses of action, as well as</td>
</tr>
</tbody>
</table>

4 Other leadership handbooks are not based on competencies. For example, The Bass Handbook of Leadership: Theory, Research, and Managerial Applications, Fourth Edition (Bass & Bass, 2008) discusses personal attributes of leaders, personal attributes of leadership, styles of leadership, charismatic and transformational leadership, management and organizations, diversity and cultural effects, and development and identification of leaders and leadership, while the Oxford Handbook of Leadership (Rumsey, 2012) discusses the attributes, training, and development of leaders, leadership in context, the dynamics of leadership, and leadership effectiveness and the Oxford Handbook of Leadership and Organizations (D. Day, 2014) discusses history and background, research issues, leader-centric theories and approaches, follower-centric theories and approaches, and emerging issues in organizational leadership.
| **Building Trust** | Relating to others in such a way that they believe the leader. |
| **Communicating Effectively** | Clearly expressing information and meaning to another person or group using verbal, written, and nonverbal skills. |
| **Establishing and Maintaining Stakeholder Relationships** | Building and sustaining partnerships with other internal or external groups who can impact or are impacted by the technical leader. |
| **Influencing Others** | Persuading others to accept a particular view as expressed in an idea, proposal, initiative or decision. |
| **Developing Strategy and Vision** | Setting the long-term organizational goals, and evaluating and adopting the courses of action and allocating resources to achieve those goals. |
| **Fostering Agility** | Adapting quickly, learning, responding, and thriving when work tasks, the environment, context, or conditions change; also adapting quickly when work procedures or structures change. |
| **Promoting Innovation** | Creating new or significantly improved products or processes, as well as developing original approaches to handle challenges and opportunities. |
| **Building Government Acumen** | Making good judgments and managing human, financial, technological, and information resources in a federal, state, or local context, that consists of both federal, state, or local employees and external contractors. |
| **Possessing a Macro Perspective** | Understanding the political, economic, and social aspects or context or landscape, and managing effectively in such a context. |

## 5.3.1 Developing People Competency

### 5.3.1.1 Definition

The developing people competency is defined as expanding people’s ability to do technical work effectively, expanding their ability to lead others effectively, increasing their decision-making capability (with associated trade-offs and judgment calls), helping people understand their career paths and career growth, encouraging people to be good citizens in the workplace, and fostering people’s fulfilment from doing their work. Ideally, development in the senior role is focused more on expanding an individual’s effectiveness in new situations, open-ended problems, or those lacking an agreed solution, rather than usual or typical situations, closed-ended problems, or those having agreed solutions (D. V. Day, 2012, p. 81).

### 5.3.1.2 Actions

The technical leader operating at the senior level is keenly aware of the importance of human development to the success of a technical enterprise. This encompasses the following critical skills:

- Develops mid-level leaders personally through coaching and mentoring, enabling them to both lead and conduct their technical work more effectively;
- Leverages rotational assignments of mid-level leaders to provide developmental opportunities where there may be a large domain knowledge divide, potentially accepting...
short-term inefficiencies (due to learning curve effects of wide rotations) for long-term gains (of building cross-functional skills, breadth of experiences, systemic knowledge);

- Leads diversity at the mid-level and the senior levels, encouraging or accepting differing views. Beyond recognized demographics, diversity also includes different personality types, educational backgrounds, program experiences, and other factors, to offer a variety of viewpoints and approaches to solutions;
- Leads and shapes mid-level leaders’ roles, encouraging additional breadth and/or depth in the role (and therefore the associated skill set), while aligning it to the organizational vision and strategy;
- Helps mid-level leaders define and develop their own careers;
- Provides training and learning opportunities for those they are leading;
- Makes recommendations regarding the people development process to their superior and/or the appropriate lateral counterpart.

5.3.1.3 TECHNICAL RATIONALE

Developing people is a technical enabling competency because it counteracts the senior level leader’s technical tendency to focus predominantly on the task and associated technical processes to a focus on the people and associated development processes. To an extent far greater than in non-technical enterprises, technical workers must continue to develop both their technical and leadership skills. In a fast moving world of technological change, it is even more important that people be given the opportunity to grow.

5.3.1.4 LEADERSHIP RATIONALE

People development is a key component of the traditional leadership lexicon: the good leader acts as a coach and mentor to their staff, training their own replacement, and supporting the growth of their subordinates. Gebelein, et al. (2000) identify building talent and coaching and developing others as two of their key leadership competencies.

5.3.1.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Developing people is important for technical leadership because it is an important factor in growing the technical workforce. Technical leaders are able to develop technical leaders subordinate to them in a way that nontechnical leaders cannot, because technical leaders understand both the technical aspect of technical leadership and the leadership aspect of technical leadership.

5.3.1.6 TECHNICAL SOURCE

- Gavito’s Technical Leadership Development Program, 2010 (contains mentoring and coaching)
- Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (contains mentoring and coaching)

5.3.2 **LEADING PEOPLE**

5.3.2.1 **DEFINITION**

The leading people competency is defined as guiding, directing, or motivating others (Barrett, 2014, p. 3) in a dignifying and empowering way to further the goals and priorities of the organization (Vaill, 1992, p. 130). Leading people includes delegating to subordinates, and enabling them to act. It is also possible for subordinates to lead others when they provide guidance, direction, or motivation to peers or superiors. In a command and control culture, leading is characterized by direction with a focus on short-term goals and results.

5.3.2.2 **ACTIONS**

The competent technical leader leading well in a senior role:

• Guides, directs, and motivates mid-level leaders in a dignifying and empowering way;
• Provides guidance, direction, and motivation to superiors, peers, and customers in the suborganization and organization;
• Motivates and rewards mid-level leaders, including celebrating mid-level leaders’ accomplishments, as well as protecting them and the suborganization during failures;
• Works well with mid-level leaders, superiors, stakeholders, and internal peers from many different cultures, backgrounds and countries;
• Builds the team and suborganization with a diverse representation, to avoid using people with a similar demographic, personality type, educational background, program experience, or technical background;
• Creates environment of empowerment and expression, allowing all voices and constituencies to be heard, and listens to all voices and constituencies;
• Possesses a strong set of personal and organizational values and ethics (such as making ethical decisions in large system sign-offs under risk, time and client pressures);
• Works and communicates in a transparent manner to executive-level leaders, mid-level leaders, peers, and customers;
• Sends memorable messages informing mid-level leaders about the values, norms, and expectations of the organization’s culture;
• Sets priorities and expectations for mid-level leaders and their suborganizations, measures performance and accountability;
• Creates an environment where the team of mid-level leaders feel valued and appreciated, are committed to their work and want to excel;
• Provides motivation for the suborganization or mid-level leaders to coalesce around common goals;
• Acts through and with other people, through formal mechanisms such as goal setting and performance measurement, and informal mechanisms such as building trust and influencing others.

5.3.2.3 Technical Rationale

Leading people is important as a technical enabling competency because, at the senior level, the technical work takes place through their direct reports (mid-level leaders who have people responsibility) and associated teams, that the senior leaders are responsible to guide, direct and motivate. Technical work is creative at its core, and because its success is dependent on the creative performance of its practitioners, the technical leader understands how to lead people to obtain maximum performance from a team consisting of diverse members, rather than having the diversity create problems and prevent performance.

5.3.2.4 Leadership Rationale

Leading people is an important leadership skill because guiding, directing, and motivating others is synonymous with leading them. The care of the team and the individual is a foundational concept in the theory of Servant Leadership advanced by Jim Autry (2001). It is also eloquently advocated by Kouzes and Posner in their book “The Leadership Challenge” (2006) where they introduce the idea of “encouraging the heart” (Kouzes & Posner, 2006, pp. 187-238). This competency reflects three of Bossidy et al’s seven essential leadership behaviors (knowing your people, rewarding the doers, expanding people’s capabilities), and two of Gebelein et al’s (2000) 28 leadership competencies. Blank (1995) also incorporates leading people (pp.217-218).

5.3.2.5 Why This Competency is Important For Technical Leadership

Leading people is important for technical leadership because senior and mid-level technical leaders are responsible to guide, direct, and motivate their direct reports, who either perform the technical work, or themselves guide, direct and motivate their own direct reports.

5.3.2.6 Technical Source

• Gavito’s Technical Leadership Development Program, 2010 (contains leadership)
• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015 (contains building and orchestrating a diverse team)
• Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (contains understands the human dynamics of a team, equivalent to leading people)
5.3.3 THINKING CRITICALLY

5.3.3.1 DEFINITION

The thinking critically competency is defined as using logic and analysis to identify and evaluate the strengths, weaknesses, and implications of different courses of action (Mumford, Campion, & Morgeson, 2007), as well as analyzing a situation objectively. Gebelein et al (2010, p. 8) highlights objectivity, defining critical thinking as the capability of analyzing a situation objectively, as well as evaluating the strengths, weaknesses, and implications of courses of action. Squires, et al. (2011) define critical thinking as consisting of a rigorous analytical approach to thinking, including strategic and essential thinking. They further define strategic thinking as focusing on long-term organizational interests and essential thinking as the ability to quickly identify the most relevant concepts to the problem or solution.

5.3.3.2 ACTIONS

The competent senior technical leader demonstrates critical thinking skills through:

- Utilizes mid-level leaders’ diversity of thought, experiences, and approaches to develop alternative solutions and explanations for observed phenomena and problems, and actively considers them routinely;
- Provides mid-level leaders with a wide ranging library of ideas, frameworks, and models suitable for application in many areas;
- Applies analytical thinking across a large scope or wide range of problems and functions, and coaches mid-level leaders to do the same for their realm of responsibility;
- Supports mid-level leaders with problem discovery and identification accurately (across a wide range of system of systems problems and functions);
- Challenges mid-level leaders to make inferences or draw conclusions that are justified by evidence;
- Expands his or her thinking by actively requesting new ideas and feedback from others, and constantly requests and collects new information;
- Uses critical thinking to generate alternative courses of action and a recommendation for superiors to problems, decisions and requests identified by them.

5.3.3.3 TECHNICAL RATIONALE

Critical thinking is important as a technical enabling competency because many technical products and processes are neither standard nor routine, therefore requiring a higher level of critical thinking. The result is a higher level of technical product quality or technical process quality. Even for those technical products or processes that are standard or routine, something may change, initiated by a client request or changing technology, and the higher the level of critical thinking around the change, the better the resulting decision regarding the changed technical product or process.
5.3.3.4 LEADERSHIP RATIONALE

Critical thinking is important to leadership because decisions made using critical thinking, such as during technical review meetings, provide guidance and direction to the entire system (and people involved) in the review. Kouzes and Posner (2006) incorporate critical and analytical thinking in their discussion of challenging the process, Gebelein et al (2000) include it in two of their 28 competencies.

5.3.3.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Critical thinking is important for technical leadership because many technical decisions, such as those occurring during technical review meetings, benefit from critical thinking, improving the product. Such decisions provide guidance and direction to the people responsible for the technical product under review.

5.3.3.6 TECHNICAL SOURCE

- Squires and Wade’s Systems Engineering Experience Accelerator, 2011

5.3.4 BUILDING TRUST AND CREDIBILITY

5.3.4.1 DEFINITION

The building trust and credibility competency is defined as relating to others in such a way that they believe the leader. To trust or believe a person or organization is to rely on a person or organization’s authenticity without possessing knowledge or other assurance of that reliance (Fairholm, 1995, p. 11). To trust a person or organization is to believe their words, decisions, or actions. Trust between a leader and a member of a group increases through positive evaluations of their integrity, ability, benevolence, and ability to keep one’s promises (Bass & Bass, 2008, p. 258).

5.3.4.2 ACTIONS

A technical leader at the senior level generates personal trust, and therefore improves their personal and organizational reputation and image, when doing the following:

- Explains decisions clearly, including their motives and character as well as the logic of the decision, to mid-level leaders, executive-level leaders, and peers;
- Delegates responsibility and relies on the ability of the mid-level leaders to achieve their goals and objectives;
- Shares control and increases the participation of the mid-level leaders in decision making;
- Shares personal experiences and makes connections with mid-level leaders’ experiences;
- Keeps promises to mid-level leaders, executive-level leaders, and peers;
- Leads ethically and models high levels of integrity;
• Uses resources responsibly;
• Has the courage to do the right thing, even when there may be negative repercussions;
• Takes action in spite of risk or discomfort;
• Nurtures an environment that results in team and organizational credibility and trust;
• Listens carefully to executive-level leaders, mid-level leaders, and peers, and communicates clearly, openly, and transparently to executive-level leaders, mid-level leaders, and peers.

5.3.4.3 TECHNICAL RATIONALE

Trust is important as a technical enabling competency because it increases the effectiveness and efficiency of the technical and enabling competencies, ultimately resulting in organizational reputation and credibility. For example, in technical planning, when the senior leader conveys the technical plan up to his or her superiors, the superiors can trust that the best effort was put forward to develop the plan and errors were not the result of sloppy work or lack of effort. Of course, superiors will conduct their own verification on that technical plan, but in general superiors simply do not have the time to conduct verification on every work item of all of their subordinates, and therefore select key activities and deliverables to verify. In conditions of low trust, superiors will spend substantially more of their time on verification than in conditions of high trust. In transition, the receiving organization can trust that the product received meets the expected quality level, or not accept delivery of the product due to inadequate quality, and does not have to guess whether they are being gamed by the process.

5.3.4.4 LEADERSHIP RATIONALE

Trust is important as a leadership competency for a many reasons. A select few include research showing that effective teamwork depends on the trust between the leader and team members (D. V. Day, 2001). Nurturing the organizational image embodies Bossidy et al’s essential behavior of knowing yourself and Kouzes and Posner’s leadership practice of modeling the way. It is also reflected in Gebelein et al’s (2000) competencies and Autry’s (2007) competencies.

5.3.4.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Building trust and credibility is important for technical leadership because it increases the effectiveness and efficiency of the technical and enabling competencies, ultimately resulting in organizational reputation and credibility. While it is important for superiors to verify subordinate’s work, in practice key deliverables are selected due to time constraints. Whether the competency is technical (such as technical planning or product transition), or whether the competency is enabling (such as leading people or critical thinking), trust enables team members to know they are not being taken advantage of by the system.

5.3.4.6 TECHNICAL SOURCE

• Gavito’s Technical Leadership Development Program, 2010 (contains ethics)
• Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (contains gains respect, credibility, and trust)

5.3.5 COMMUNICATING EFFECTIVELY

5.3.5.1 DEFINITION

The communicating effectively competency is defined as clearly expressing information and meaning to another person or group using verbal, written, and nonverbal skills. Verbal skills include speaking and listening, written skills include reading and writing, and nonverbal skills include interpreting body language (Guffey & Loewy, 2008, p. 4). In an organization, communication occurs through the upward, downward, or lateral information exchange or transmission of meaning, through either formal or informal channels and mechanisms, to a particular audience (R. Bell & Martin, 2008, p. 130). Technical communication can be distinguished as expressing a meaning about scientific, technological, or engineering components, products, systems, processes, or programs (R. L. Bell & Muir, 2014, p. 111).

5.3.5.2 ACTIONS

A technical leader at the senior level who communicates well does the following:

• Speaks articulately, delivering a well-crafted message oriented toward a specific audience, and adapts messages to different audiences having a variety of viewpoints;
• Actively listens (understands what is meant, in addition to what is said), clarifies what has been heard, and conveys genuine interest, to executive-level leaders, mid-level leaders, peers, and all stakeholders, not just those having the louder voice;
• Writes clearly and effectively, to executive-level leaders, mid-level leaders and peers;
• Translates non-technical requirements and ideas to technical staffs;
• Uses a variety of communications media to communicate technical information clearly and understandably to both technical and non-technical audiences;
• Communicates through framing and interpreting experience to mid-level leaders;
• Communicates persuasively to mid-level leaders, executive-level leaders, and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their mid-level leaders, executive-level leaders, and peers;
• Coaches mid-level leaders on how to do the above communication actions effectively;
• Fosters a culture of open and transparent communication in their organization by example;
• Requires mid-level leaders to evaluate their communication plans (i.e. communication goals, requirements, challenges, message, media, and audiences).
5.3.5.3 TECHNICAL RATIONALE

Clear communication is a critical leadership skill for technical leaders because the nature of the job is to provide clear and articulate information to technical staff so technical goals are met on time and budget. Additionally, technical leaders serve as a bridge to non-technical readers and listeners and ensure they understand technical issues and challenges. Business managers not versed in technology, will want to know what the technical product or process means from a business perspective, and the technical leader is responsible for making this translation. Frequently, this also includes cause and effect discussions, rather than the detailed technical conversations with technical staff. Clients and stakeholders of technical work tend to be those with little exposure to, or knowledge of, technical subjects, so the ability to listen, speak, and write effectively and efficiently is a key talent for successful technical leaders.

5.3.5.4 LEADERSHIP RATIONALE

Communication is a key leadership enabler for the technical leader, because many of the technical competencies require deliverables associated with that competency to be communicated upwards to superiors, downwards to subordinates, across to peers, and/or outside to stakeholders, including the technical plan, technical requirements definition and analysis, product transition, and technical risk management. For example, the technical leader who cannot communicate the technical plan is less able to lead technical planning. Communication is included in four competencies by Gebelein et al (2000), and is a primary subject in How to Win Friends and Influence People in the Digital Age (Carnegie & Cole, 2011). Research has demonstrated the linkage between “competence in articulation and effectiveness as a leader.”

5.3.5.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Communicating effectively is important for technical leadership because mid-level and senior level leaders need to communicate clearly to technical staff so that technical goals are met successfully within budget and schedule. Additionally, technical leaders frequently need to communicate to clients and stakeholders having a nontechnical background, and it is the technical leader who is responsible for translating technical information into nontechnical, business language.

5.3.5.6 TECHNICAL SOURCE

- Gavito’s Technical Leadership Development Program, 2010
5.3.6 ESTABLISHING AND MAINTAINING STAKEHOLDER RELATIONSHIPS

5.3.6.1 DEFINITION

The establishing and maintaining stakeholder relationships competency is defined as building and sustaining partnerships with other internal or external groups who can impact or are impacted by the technical leader. A stakeholder is 1) any individual or group who can impact or is impacted by an organization’s goals, operations, policies, or decisions, and 2) any individual or group with whom an organization has interdependencies or interactions. The importance that a particular stakeholder has to an organization is dependent on whether the organization views the stakeholder’s claim as legitimate, the extent to which the stakeholder’s claim is urgent, and the degree to which the stakeholder has power to influence the organization. A primary stakeholder has a contractual, official, or formal relationship with an organization, while a secondary stakeholder consists of all others. The interest that the individual or group has in the organization may span moral to economic interests. Stakeholders may either benefit or harm an organization (Achterkamp & Vos, 2008; Gibson, 2000; McElroy & Mills, 2007; Mitchell, Agle, & Wood, 1997).

5.3.6.2 ACTIONS

A technical leader at the senior level who establishes stakeholder relationships well does the following:

• Builds new stakeholder relationships, by identifying and understanding their requirements, expectations, and needs; meeting or handling their expectations; and ensuring the right processes (including communication processes) are in place to sustain stakeholder relationships;
• Identifies stakeholder issues which are appropriate to be escalated to superiors;
• Balances competing stakeholder values, goals and interests, making subjective judgments and decisions about rights and accountability;
• Manages conflict constructively, both conflict between the stakeholder and the organization, and conflict between multiple stakeholders, and negotiates effectively with stakeholders;
• Identifies and involves mid-level leaders in building new stakeholder relationships;
• Coaches mid-level leaders on maintaining effective existing stakeholder relationships, conflict management, and negotiation;
• Develops a unified approach to stakeholder care throughout the organization that helps meet stakeholder expectations.

5.3.6.3 TECHNICAL RATIONALE

Building stakeholder relationships is a particularly important enabler for technical leaders, because technical products are not developed in isolation, but in the context of a stakeholder. The more effective that a technical leader is at moving from the science, technology and
engineering perspective to the stakeholder’s perspective will better enable that technical leader to promote a particular current or future technical idea or product.

5.3.6.4 LEADERSHIP RATIONALE

Building and maintaining stakeholder relationships is an important enabler for technical leadership because without developing and sustaining partnerships it is not possible to lead in those spheres of influence. Additionally, as customers are an important subset of stakeholders, then this competency is one of the oldest tenets of leadership, reflected in the general leadership literature from Carnegie (1936) and Drucker (1973) to Gebelein et al.

5.3.6.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Establishing and maintaining stakeholder relationships is important for technical leadership because technical products are developed for stakeholders. Without developing and sustaining stakeholder relationships, it is not possible to lead in those spheres of influence.

5.3.6.6 TECHNICAL SOURCE

- Gavito’s Technical Leadership Development Program, 2010 (contains external relationships)
- Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015 (contains managing stakeholders and their needs)
- Williams, et al., Executive Leadership at NASA: A Behavioral Framework, 2010 (contains one component of stakeholders in manages multiple demands / opportunities)

5.3.7 INFLUENCING OTHERS

5.3.7.1 DEFINITION

The influencing others competency is defined as persuading others to accept a particular view as expressed in an idea, proposal, initiative or decision (Gebelein, et al, 2010, p. 299). Influence is defined as persuasion through noncoercive means; it is the art of getting others to desire to hold a position or follow a course of action that the leader is convinced should be held or followed. Influence can also be specified in terms of attention, specifically, influence occurs when one or more people focus their attention on another person. The idea of influence acknowledges that individuals differ to the degree that their words, decisions, or actions impact an individual or group (Bass & Bass, 2008; Birnbaum, 2013; Yukl, 2010).

5.3.7.2 ACTIONS

A technical leader at the senior level who influences well does the following:
• Uses rational persuasion, including explanations, logical arguments, and factual evidence, to advocate a position, decision, request, proposal, or task, with mid-level leaders, executive-level leaders, peers and stakeholders;
• Utilizes inspirational appeals through an emotional or value-based request, to advocate a position, decision, request, proposal or task, with mid-level leaders, executive-level leaders, peers and stakeholders;
• Employs consultation, by requesting the team of mid-level leaders to provide suggestions on a particular issue, or collaboration, by offering the team of mid-level leaders the necessary resources to accomplish a task or proposal;
• Identifies and utilizes mid-level leaders’ shared vision and values to generate support for views.

5.3.7.3 Technical Rationale

Influencing others is important as a enabling competency because it increases the effectiveness and efficiency of the all other competencies, both technical and enabling. For example, a technical leader, through the application of the technical competencies, will have developed a compelling technical vision that may not be shared by others, such as subordinates, superiors, or various external stakeholders. The ability to sell that approach effectively to a skeptical audience is not only dependent on communication skills, but is greatly moderated by the technical leader’s ability to influence while communicating that vision. This makes influencing a particularly important enabling skill for technical leaders.

5.3.7.4 Leadership Rationale

Influence is the essential general leadership skill because leadership is defined as guiding and directing people, and guiding and directing people is more effective the greater one’s influence. Some researchers go so far as to define leadership in terms of influence. As early as 1929, Nash defined leadership as: “leadership implies influencing change in the conduct of people” (as cited by Bass, 2008, p. 18). Others subsequently followed, such as Katz and Kahn (1966), who defined leadership as, “the influential increment over and above mechanical compliance with routine decisions of the organization (pp. 302-303). Influence is a bedrock competency in the leadership literature (Gebelein et al, Autry, Kouzes and Posner, and Carnegie).

5.3.7.5 Why this Competency is Important for Technical Leadership

Influencing others is important for technical leadership because it increases the effectiveness and efficiency of the all other competencies, both technical and enabling. For example, whether the competency is technical planning, product transition, developing people, or thinking critically, the greater the leader’s ability to influence, the greater the leader’s ability to guide, direct and motivate leaders subordinate to themselves in technical planning, product transition, developing people, and thinking critically.
5.3.7.6 **TECHNICAL SOURCE**

- Gavito’s Technical Leadership Development Program, 2010 (influence is contained as part of the leadership competency)
- Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015 (contained in influence, persuasion and negotiation competency)
- Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (possesses influencing skills competency)

5.3.8 **DEVELOPING STRATEGY AND VISION**

5.3.8.1 **DEFINITION**

The developing strategy and vision competency is defined as setting the long-term organizational goals, and evaluating and adopting the courses of action and allocating resources to achieve those goals. Chandler (1962) and Porter (1980) defined modern business strategy. Chandler (1962) defines strategy as “the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals” (p. 13). Similarly, Porter (1980) specifies strategy as a “broad formula for how a business is going to compete, what its goals should be, and what policies will be needed to carry out those goals” (p. xvi). Lipton (1996) defines an organizational vision as a vivid picture that centers on the long-term future of the enterprise, and connects it to strategy by observing that vision provides the foundation for the business strategy (p. 85). Some researchers (Avery, 2005; Hamel & Prahalad, 1989; Kouzes & Posner, 2006; Wheatley, 2006; Zaccaro & Banks, 2004) advocate that vision is fundamental to effective leadership and that it may result in sustained competitive advantage. Others focus on vision as a central concept in vision-based leadership theories (Bass & Bass, 2008; Conger, 1989; Conger & Kanungo, 1987; Tichy & Devanna, 1990; Westley & Mintzberg, 1989).

5.3.8.2 **ACTIONS**

The competent senior technical leader provides the following strategy and vision skills:

- Develops and articulates the vision for their suborganization, generates support for that vision from mid-level leaders, executive-level leaders, and peers, and aligns the vision to the organization and enterprise vision;
- Enables mid-level leaders to create vision for their own teams, which supports the mission and values of the superior suborganization;
- Creates, understands, and executes a strategy that encompasses stakeholder expectations, industry trends, and emerging technologies;
- Connects strategy with day-to-day mid-level leader’s objectives; ensures that their mid-level leaders can see how their mid-level leaders’ teams’ actions/outputs/products align to the organizational strategy;
• Develops suborganizational structures that support strategy and promotes knowledge sharing, clear accountability, and coordination;
• Develops strategy execution processes and employs incentives to support those processes and decisions;
• Modifies or creates effective controls and feedback mechanisms to allow mid-level leaders to assess performance of strategy and associated execution.

5.3.8.3 TECHNICAL RATIONALE

Strategy and vision are important because they are the tools to align product conceptualization and long-range planning to those activities that further the organization’s long-term focus. They are also critical to ensure that the technical workforce has the right technical skills in place to make the vision happen. Vision also enables technical leaders to visualize the technical products and processes before they are designed and built. Vision and strategy also allows them to frame the technical problem and understand which approaches, solutions and techniques will and will not bear fruit.

5.3.8.4 LEADERSHIP RATIONALE

The leadership aspect of strategy and vision is clear from the definitions section: determining the goals and objectives of the enterprise, and evaluating policies and courses of action to attain such goals, is inherently a leadership task. Peter Drucker, the legendary management theorist, recognized vision and strategy as what he referred to as top management tasks, a term he used to refer to what we would consider organizational leadership (Drucker 2008). Bossidy et al (2011) include setting clear goals as one of their seven essential leadership behaviors. Gebelein et al (2000) identify acting strategically as an important competency for leading successfully. (See also, Autry (2007) and Kouzes and Posner (2006)).

5.3.8.5 WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP

Developing strategy and vision is important for technical leadership because determining the goals and objectives of the enterprise, organization, and suborganization, and evaluating different courses of action to achieve such goals and objectives, is an important task for technical leaders. In addition, vision enables technical leaders to visualize the technical products and processes before they are designed and built.

5.3.8.6 TECHNICAL SOURCE

• Gavito’s Technical Leadership Development Program, 2010 (vision is contained as part of the leadership competency)
• Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015 (vision is contained in the foresight and vision competency)
• Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (creates vision and direction competency)
5.3.9  FOSTERING AGILITY

5.3.9.1  DEFINITION

The fostering agility competency is defined as adapting quickly, learning, responding, and thriving when work tasks, the environment, context, or conditions change; also adapting quickly when work procedures or structures change. Agility implies a more intentional, proactive position, than just flexibility and adaptability, which imply a more passive, reactive position. Agility includes the ability to leverage the opportunities and setbacks realized during normal operations, as well as during program development and execution, and turn these into a positive event (Atkinson & Moffat, 2005; Holbeche, 2015; Joiner & Josephs, 2006; Meyer, 2015; Worley, Williams, & Lawler, 2014).

5.3.9.2  ACTIONS

The agile technical leader operating in a senior role:

- Reorganizes, regroups, and renews personal energy in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;
- Adapts quickly and effectively to shifting demands and changing priorities from executive-level leaders or stakeholders, and other unexpected and unplanned events
- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Fosters and encourages resiliency and responsiveness in mid-level leaders;
- Introduces practices to help mid-level leaders do effective adaptive planning;
- Modifies their own role and mid-level leader’s roles to incorporate agility;
- Establishes standard operating procedures and implementing knowledge management tools to increase their own learning, mid-level leaders’ learning, and organizational learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.

5.3.9.3  TECHNICAL RATIONALE

Agility is important as an enabling technical competency because of the need to adapt to change, and much change is driven by new technologies. The reality of the information revolution is that the pace of change – changes driven by new technologies and changing threats (enemy, type of threat, etc) and impacting requirements – far outpaces the ability of organizational processes to deal with it. Fostering agility throughout the organization in terms of structure, culture and processes promotes the ability to keep up with technological and threat change.

5.3.9.4  LEADERSHIP RATIONALE

Agility is an important leadership skill because it is the leader’s privilege and responsibility to lead personal and organizational change. The inability to respond to change can render a
leader ineffective. Agility, also described as flexibility in the leadership literature, is a standard element of leadership theory and practice (Gebelein et al., 2010; Holbeche, 2015; Joiner & Josephs, 2006).

5.3.9.5 **WHY THIS COMPETENCY IS IMPORTANT FOR TECHNICAL LEADERSHIP**

Agility is important for technical leadership because change in the external environment may require a change in the enterprise, organization, or suborganization, and it is the technical leader’s privilege and responsibility to lead personal and organizational change.

5.3.9.6 **TECHNICAL SOURCE**

- Pyster’s Atlas: The Theory of Effective Systems Engineers, Version 0.5, 2015 (contained in flexible comfort zone competency)
- Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (adapts to change and uncertainty competency)
- Williams, *et al.*., Executive Leadership at NASA: A Behavioral Framework, 2010 (accepts change and is resilient competency)

5.3.10 **PROMOTING INNOVATION**

5.3.10.1 **DEFINITION**

The promoting innovation competency is defined as creating new or significantly improved products or processes, as well as developing original approaches to handle challenges and opportunities. At its highest level, innovation is defined as change, technological change, or producing new things (Drucker, 1985, p. 31) (Miller & Thomas, 2013, p. vii). Innovation is delineated as consisting of new or significantly improved products or processes (Eurostat, 2005, p. 47) (Crossan & Apaydin, 2010). Significant improvements in product innovation are further specified as advancements in technical specifications, materials or components, supporting software, or other functionality (Eurostat, 2005). Improvements can be yet further categorized as incremental or sustaining changes, which enhance the performance of existing products in a gradual manner, or major or disruptive change, which creates new products or substantially advances the values proposition of an existing product (Christensen, 2003).

5.3.10.2 **ACTIONS**

The competent technical leader operating innovatively in a senior role:

- Nurtures and champions a culture of technological innovation and promotes effective team interaction regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to superiors, and coaches mid-level leaders to do the same;
• Supports and guides mid-level leaders as they implement processes that support innovation;
• Protects mid-level leaders when their innovations fail;
• Creates and implements innovation strategies, and provides input to enterprise-level innovation strategy;
• Contributes to advancement in their own technical domain through innovation (including patentable inventions).

5.3.10.3 Technical Rationale

Innovation is important as an enabling competency for the technical workforce because innovation is the underlying basis for technical advancement, whether that is creating new technologies or supporting deployed technologies requiring new functionality. Innovation is categorized as an enabler competency rather than a key technical competency because innovation occurs in both technical and nontechnical areas.

5.3.10.4 Leadership Rationale

The great leader possesses the ability to innovate and support innovation: the ability to see the world differently distinguishes great leaders in every field – art, science, business, politics, sport, philosophy and literature. Finding the new way out of a dilemma, paradox or challenge, requires innovation and is a fundamental leadership trait (Gebelein et al. 2000).

5.3.10.5 Why This Competency Is Important for Technical Leadership

Innovation is important for technical leadership because innovation (both technical and nontechnical) is the foundation for technical advancement. Technical leaders who generate new ideas, methods, products, and processes enable their suborganization, organization, and enterprise to lead.

5.3.10.6 Technical Source

• NASA’s Leadership Model (contains creativity and innovation in the cognitive skills competency, which is in the personal effectiveness dimension).

5.3.11 Building Government Acumen

5.3.11.1 Definition

The building government acumen competency is defined as making good judgments and managing human, financial, technological, and information resources in a federal, state, or local context, that consists of both federal, state, or local employees and external contractors. It includes financial management skills (such as budgeting for a particular program), as well as deep contracting skills (such as the knowledge of what it is about how contracts are written...
that causes companies to act in certain ways), and the skills to execute the technical vision. A savvy technical leader will understand how federal contractors are motivated by various features of accounting and contractual practices.

5.3.11.2 Actions

The competent technical leader operating in a senior role possesses government acumen as follows:

- Understands accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA);
- Sets program budgets and defends them effectively;
- Understands the impact that business procedures have on the successful accomplishment of technical work;
- Works within the structures of the law, congressional directives, OMB and DoD policy directives and guidance, the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) to chart a program course that leads to technical success, while respecting and dealing with the many obstacles involved;
- Organizes and plans for success in an uncertain and changing financial and regulatory environment.

5.3.11.3 Technical Rationale

Building government acumen is important as an enabling competency because interruption due to inadequate knowledge of funding, regulation, and political realities can be fatal for a technical program.

5.3.11.4 Leadership Rationale

The financial, organizational and planning skills that make up this competency are widely acknowledged to be fundamental to the exercise of leadership in all organizations.

5.3.11.5 Why This Competency Is Important for Technical Leadership

Building government acumen is important for technical leadership because the ability to manage human, financial, technological, and information resources in a federal, state, or local context is particularly important when leading in a DoD context.

5.3.11.6 Technical Source

- Gavito’s Technical Leadership Development Program, 2010 (contains business acumen [which contains budget and full cost management, capital management, business engineering])
- Williams and Derro, NASA Systems Engineering Behavior Study, 2008 (contains is able to deal with politics, financial issues, and customer needs competency)
5.3.12 Possessing a Macro Perspective

5.3.12.1 Definition

The possessing a macro perspective competency is defined as understanding the political, economic, and social aspects or context or landscape, and managing effectively in such a context. It also incorporates the notion of managing a broader portfolio than one specific program. In government, the macro view occurs at the Program Executive Office (PEO) level. In business, the macro perspective is characterized by profit and loss responsibility, which translates to budget responsibility in a government context, that is, conducting activities (to meet the mission, vision, and strategy) within an authorized budget. The key nature of the macro perspective is to include a wide portfolio of specialist, support functions assigned to the executive leader (such as general counsel office, security, facilities, foreign sales, and IT). Possessing a macro perspective includes understanding the impact that a program has on all the functions of an organization or agency.

5.3.12.2 Actions

• Understands, appreciates, and appropriately utilizes the role of each organization and suborganization in the DoD enterprise;
• Understands how the senior-level leader’s suborganization, along with its budgetary, political, mission and support aspects, fits within the larger context at the organization and enterprise levels;
• Understands how the senior-level leader’s suborganization is impacted by the political, economic, and social aspects or context or landscape;
• Builds a supportive, collaborative and respectful relationship with peer senior-level leaders within the organization and enterprise;
• Champions the role of their suborganization as a trusted business partner across the organization and enterprise levels;
• Capitalizes on the value and worth of one suborganization’s intellectual property, personnel, development efforts and products;
• Aligns the senior-level leader’s suborganization’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the organization and enterprise.

5.3.12.3 Technical Rationale

Possessing an enterprise-wide perspective is important as an enabling competency because in order for a technical product to be successful, it must be successful in the context of the suborganization, organization and enterprise and their associated mission and goals. The role
of the technical leader is to align the technical leader’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the organization and enterprise.

5.3.12.4 Leadership Rationale

As mentioned, the single most important differentiating skill for all senior leaders, whether technical or not, is the ability collaborate with peers in the same organization and enterprise. A mid-level leader can succeed by playing a zero-sum game with their peers – senior leaders cannot do so.

5.3.12.5 Why This Competency is Important for Technical Leadership

Possessing a macro perspective is important for technical leadership because understanding the political, economic, and social context or landscape increases the ability of the technical leader to manage effectively. For example, the technical leader will be able to evaluate different courses of action more effectively when taking into account the political, economic, and social context.

5.3.12.6 Technical Source

• Williams, et al., Executive Leadership at NASA: A Behavioral Framework, 2010 (contains maintains an agency-wide view, understands broad implications of activities at multiple levels)

5.4 Key Competency Indicators

This section identifies key competency indicators at the junior, mid, and senior levels, in Table 5 and Table 6.
### Table 5 Key Competency Indicators for Technical Leadership Competencies

<table>
<thead>
<tr>
<th>Career Stage</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Competency Class 1: Technical Leadership Competencies</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>1.1 Technical Planning</strong></td>
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</tr>
<tr>
<td>• Understands system-level technical plans;</td>
<td>• Understands system of systems technical plans</td>
<td>• Develops overall technical plans, for a large (or complex) system, or system of systems, that:</td>
<td></td>
</tr>
<tr>
<td>• Develops technical plan for a specialized item;</td>
<td>• Develops and details out the technical plan for a system to fit into the overall technical plan for a large (or complex system) or system of systems;</td>
<td>• Support the strategy, vision, mission and long range goals (which recognize needs) of the organization or enterprise;</td>
<td></td>
</tr>
<tr>
<td>• Relays convincing, clear and relevant information from the specialized item technical plan to mid-level leaders.</td>
<td>• Reviews technical plans for specialized items developed by junior-level leaders;</td>
<td>• Provide direction to mid-level leaders;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Relays convincing, clear and, relevant information from the system-level technical plan to senior-level leaders;</td>
<td>• Are consistent with plans and objectives of peer organizations, both technical and non-technical;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Provides clear direction from the system-level technical plans down the hierarchical levels to junior-level leaders;</td>
<td>• Reflect the technical impact of the superior organization’s strategies and missions.</td>
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<tr>
<td></td>
<td>• Coordinates the system-level technical plan and obtains consensus among peer internal suborganizations (both technical and non-technical);</td>
<td>• Guides and directs mid-level leaders to detail out the overall technical plan for a large (or complex) system into the appropriate detailed plans;</td>
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<tr>
<td></td>
<td></td>
<td>• Reviews and approves technical plans for a product or a system developed by subordinate suborganizations;</td>
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<td></td>
<td></td>
<td>• Represents and communicates the overall technical plan in the larger technical and non-technical community;</td>
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<tr>
<td></td>
<td></td>
<td>• Relays convincing, clear and, relevant information from technical planning up the hierarchical levels in the enterprise;</td>
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</tr>
<tr>
<td><strong>1.2 Technical Requirements Definition and Analysis</strong></td>
<td><strong>levels to subordinate suborganizations and their leaders;</strong></td>
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<td>---</td>
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<tr>
<td>• Understands requirements at the system level</td>
<td>• Coordinates the technical plan and obtains consensus among peer internal suborganizations (both technical and non-technical);</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Provides input to requirements at the system level under the coaching and direction of mid-level leaders;</td>
<td>• Communicates clear, relevant technical plan information to external organizations, including partners in other agencies, industry, academia and perhaps internationally.</td>
<td></td>
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</tr>
<tr>
<td>• Analyzes requirements documents</td>
<td>• Defines technical requirements at the system level</td>
<td></td>
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</tr>
<tr>
<td>• Writes a technical requirement at the component level under the coaching and direction of mid-level leaders</td>
<td>• Makes decisions regarding the requirements definition and analysis process</td>
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</tr>
<tr>
<td></td>
<td>• Makes strategic, technical decisions</td>
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<tr>
<td></td>
<td>• Makes a global change to existing, defined requirements</td>
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<tr>
<td></td>
<td>• Verifies and reviews system-level requirements</td>
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<tr>
<td></td>
<td>• Defines and negotiates technical requirements at the system level, under the coaching of senior-level leaders;</td>
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<tr>
<td></td>
<td>• Transforms stakeholders’ inputs into system requirements, translates potentially non-technical requirements into technical language, and evaluates their subsequent development into lower level requirements and specifications under the coaching and direction of senior-level leaders;</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Provides input to requirements at the system of systems level to senior-level leaders</td>
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<tr>
<td></td>
<td>• Understands stakeholder’s role in setting requirements, and balances needs of a broad range of stakeholders at all levels and the essential (and necessary) inconsistency in the requirements they express;</td>
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<tr>
<td></td>
<td>• Negotiates technical requirements with stakeholders;</td>
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<tr>
<td></td>
<td>• Coaches mid-level leaders in gathering and negotiating technical requirements with stakeholders;</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 1.3 Logical Decomposition

| • Understands a decomposition            | • Performs a logical decomposition at the system level, under the guidance and direction of senior level leaders; | • Decomposes or segments system of systems (including large distributed system-of-systems of national importance) so that: | • Provides clear explanations regarding inconsistencies; |
| • Performs a logical decomposition at the component or product level, under the guidance and direction of mid-level leaders; | • Provides input to logical decomposition at the system of systems level; | • the resulting decomposition is technically suited to ensure success of the system design and development; and | • Coaches mid-level leaders in transforming stakeholder inputs into system requirements, in translating potentially non-technical requirements into technical language, and in evaluating their subsequent development into lower level requirements and specifications; |
| • Provides input to logical decomposition at the system level | • Guides, directs, reviews and approves component-level decompositions developed by junior leaders, and integrates them into system-level logical decompositions; | • the resulting decomposition takes into account of the resources, capabilities and workload of the executing organization(s); | • Understands and balances the hierarchical importance of requirements, i.e., key performance parameters (KPPs), with top-level goals, both functional and non-functional; |
| | • Provides input to strategies for system decomposition to senior level leaders. | • Guides, directs, reviews and approves | • Enforces discipline in managing and documenting the immediate and cascading impact to requirements, particularly at the system level. |
system decompositions developed by mid-level leaders, and integrates them into system of systems logical decompositions;

- Develops strategies for system decomposition for review by executive-level technical and non-technical management.

### 1.4 Product Verification and Validation

- Understands product verification and validation, and associated requirement flow-down;
- Identifies from the verification and validation whether the original requirements were met, under the guidance and direction of mid-level leaders;

- Understands the difference between building the thing right, and building the right thing;
- Conducts verification and validation at the system level, and end user verification and validation, under the guidance and direction of senior-level leaders;
- Guides, directs, reviews and approves verification and validation at the component level by junior leaders;

- Understands that verification and validation is not just something that comes into play at the developmental and operational test phases of a program, but that it is part of every step in the system lifecycle;
- Coaches peers on the understanding and associated implications that product verification and validation is a part of every step in the system lifecycle;
- Understands that allocating resources to verification and validation is a powerful tool for reducing lifecycle cost, and budgets accordingly;
- Coaches mid-level leaders in understanding the difference between building the thing right, and building the right thing;
- Enforces process discipline and accountability among subordinate suborganizations with regard to verification and validation policy and practice;
- Advocates strongly for verification and
75

validation with superiors, and if in a programmatic role, strongly supports verification and validation budgets even if this has a negative impact on other aspects of the program, including potential loss of control by the leader over the formal test of the program.

### 1.5 Product Transition

- Transitions individual products or components, under the guidance and direction of senior-level leaders;
- Documents the product transition;
- Learns process discipline and accountability enforced by mid-level leaders;
- Transitions a few technical products (or a system) with full understanding by the receiving organization, under the guidance and direction of senior-level leaders;
- Understands the transition process, effectively accepts incoming work, and provides high quality technical products for transition outside the organization, under the coaching, guidance and direction of senior-level leaders;
- Adheres to process discipline and accountability enforced by senior-level leaders, with regard to product transition policy and practice, and enforces this among junior level leaders;
- Learns to communicate effectively how to operate and maintain the technical product to technical and nontechnical people;
- Supports senior level leaders as they transition the product to the external client.
- Coordinates all aspects of transition requirements for:
  - Operations
  - Maintenance
- Fields the transition by handling different users, dealing with multiple agencies and multiple services;
- Coaches mid-level leaders to ensure that technical products are transitioned with full understanding by the receiving organization;
- Effectively coaches mid-level leaders in their understanding of the transition process, and ensures that they are prepared to effectively accept incoming work, and provide high quality technical products for transition outside the organization;
- Enforces process discipline and accountability among subordinate suborganizations with regard to product transition policy and practice;
- Provides input to enhance product transition policy and procedures to superiors;
<table>
<thead>
<tr>
<th>1.6 Lifecycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Understands the lifecycle</td>
</tr>
<tr>
<td>- Learns to manage a product at the appropriate stage in the lifecycle, under the coaching and direction of mid-level leaders;</td>
</tr>
<tr>
<td>- Understands the lifecycle, and learns to identify whether work is complete or not</td>
</tr>
<tr>
<td>- Begins to develop collaborative relationships with peer junior level leaders “upstream” and “downstream;”</td>
</tr>
<tr>
<td>- Learns to understand the relationships and impacts of decisions from definition to retirement to disposal under the coaching from mid level leaders;</td>
</tr>
<tr>
<td>- Learns to understand the interdependencies of different stages of the product lifecycle on the quality of the final product under the coaching of mid level leaders;</td>
</tr>
<tr>
<td>- Manages products and systems at the appropriate stage in the lifecycle, under the coaching and direction of senior level leaders;</td>
</tr>
<tr>
<td>- Provides input to senior level leaders on the criteria by which the technical product may be evaluated (and therefore pass from one stage to the next), striking an appropriate balance among product quality, product risk, and product cost and schedule;</td>
</tr>
<tr>
<td>- Understands the lifecycle process, and is prepared to effectively accept incoming work, and provide high quality technical plans and activities to the next stage in the lifecycle, under the coaching, guidance and direction of senior level leaders;</td>
</tr>
<tr>
<td>- Learns to understand the relationships and impacts of decisions from definition to retirement to disposal under the coaching from senior level leaders;</td>
</tr>
<tr>
<td>- Learns to understand the condition of all technical products moving from one stage of the lifecycle to the next in the lifecycle;</td>
</tr>
<tr>
<td>- Communicates effectively how to operate and maintain the technical product to technical and nontechnical people;</td>
</tr>
<tr>
<td>- Effectively leads the transition to the external client, handling both technical and nontechnical users and clients with diverse expectations.</td>
</tr>
</tbody>
</table>
stage to another, including full knowledge of any unfinished technical work;

- Begins to develop collaborative relationships with peer mid level leaders “upstream” and “downstream;”
- Learns to view the temporal dimension of a problem under consideration;
- Understands the interdependencies of different stages of the product lifecycle on the quality of the final product under the coaching of senior leaders;
- Learns to effectively negotiate product movement through the lifecycle, resulting in a win for both the acquiring and transitioning organizations, under the coaching of senior level leaders;
- Learns to avoid the temptation to take advantage of the other party, whether by passing a poorly performing product down the line, or by attributing product shortfalls to the organization making the handoff, even when the product is technically sound, under the coaching of senior level leaders.

- Understands the condition of all technical products moving from one stage to another, including full knowledge of any unfinished technical work;
- Maintains strong collaborative relationships with peer senior level leaders “upstream” and “downstream;”
- Provides input to enhance lifecycle policy and procedures to executive-level leaders;
- Views the temporal dimension of a problem under consideration;
- Coaches mid-level to understand the interdependencies of different stages of the product lifecycle on the quality of the final product;
- Effectively negotiates product movement through the lifecycle, resulting in a win for both the acquiring and transitioning organizations;
- Avoids the temptation to take advantage of the other party, whether by passing a poorly performing product down the line, or by attributing product shortfalls to the organization making the handoff, even when the product is technically sound.

### 1.7 Risk Assessment

- Understands risk assessment;
- Identifies risks, under the coaching from mid-level leaders;
- Communicates identified risks to mid-
- Quantifies technical risks and develops appropriate risk mitigation strategies under the coaching of senior level leaders;
- Coaches mid-level leaders to quantify technical risks and to develop appropriate risk mitigation strategies;
- Accepts or recommends acceptance of
• Assesses the cost to reduce or mitigate risks;
• Communicates quantified risk results and costs to reduce risk to senior level leaders;
• Any residual risk;
• Understands organizational risk tolerance and appropriately mitigates to acceptable levels;
• Mentors mid-level leaders, both probing them on their own assessments of risk, and providing them with “top cover” allowing them to be comfortable with their own risk taking;
• Effectively articulates and communicates the technical risk profile to superiors and sometimes non-technical stakeholders, and obtains support for risk assessment and risk management decisions;
• Uses persuasion and reassurance to align the technical risk profile with organizational risk tolerance, and ensures that both subordinates and superiors are comfortable with the risk profile advocated by a technical leader.

1.8. Systems Thinking

• Learns to focus on and understand the connections and interfaces among the subsystems in the system, under the coaching from mid level leaders;
• Learns to consider the product or component, its place in the system, and the interfaces between components, under the coaching and direction from mid level leaders;
• Learns to seek out holistic explanations, descriptions, and relationships when examining technical problems;
• Learns to focus on and understand the connections and interfaces among the subsystems in the system, under the coaching from senior level leaders;
• Learns to consider the system, its place in the system of systems, and the connection and interfaces between components, under the coaching and
• Seeks out holistic explanations, descriptions, and relationships when examining technical problems;
• Focuses on connections and interfaces among the subsystems in the system;
• Envisions and articulates system relationships among existing systems, and extrapolates individual system characteristics into attributes of a system of systems;
• Informs mid-level leaders, executive-
<table>
<thead>
<tr>
<th>1.9 System Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Understands the complexity of a product, component, assembly, or system under the coaching of mid level leaders;</td>
</tr>
<tr>
<td>- Understands system complexity, and the resulting impact on system design and architecture decisions, under the coaching of senior level leaders;</td>
</tr>
<tr>
<td>- Coaches mid-level leaders to understand system complexity, and the resulting impact on system design and architecture decisions;</td>
</tr>
<tr>
<td>- Recognizes the impact that system interdependence, data flows among systems, and the virtually infinite number of potential system states have on the design, development, test and operation of complex systems;</td>
</tr>
<tr>
<td>- Ensures (through coaching and mentoring) that junior level leaders are trained to recognize product designs that have the potential for emergent behavior, and take steps to mitigate that potential through thoughtful design strategies;</td>
</tr>
<tr>
<td>- Coaches junior level leaders to understand product and system complexity</td>
</tr>
<tr>
<td>- Recognizes the impact that system interdependence, data flows among systems, and the virtually infinite number of potential system states have on the design, development, test and operation of complex systems;</td>
</tr>
<tr>
<td>- Ensures (through coaching and mentoring) that mid-level leaders take system complexity into account, are trained to recognize system designs that have the potential for emergent behavior, and take steps to mitigate that potential through thoughtful design</td>
</tr>
<tr>
<td>- Direction from senior level leaders;</td>
</tr>
<tr>
<td>- Provides guidance to mid-level leaders as they design and develop technical products to consider the system, its place in the system of systems, and the connections and interfaces between components;</td>
</tr>
<tr>
<td>- Provides advice and guidance to executive-level leaders as they develop effective organizational strategies and support of organizational missions based on systems thinking.</td>
</tr>
</tbody>
</table>

- Level leaders, peers, and stakeholders, where the structural connections in a system can be found, and coaches them on how to do the same;
strategies;
• Ensures that superiors, both technical and non-technical, are cognizant of the special risks associated with the highly distributed and digitally rich systems, particularly when they are embedded in a complex socio-technical environment, and are supportive of efforts to provide for mitigation of potential emergent behavior of a negative type;
• Leads by example in learning the rapidly changing science of complexity.

1.10 Big Picture Thinking

- Understands how the product or component fits into the system (e.g. how the valve fits in the engine), along with its budgetary, political, mission and support aspects, at the mid-level context.
- Identifies the overall context of the immediate product.
- Focuses on external connections rather than internal structure in a product.
- Understands how the system fits into the system of systems (e.g. how the engine fits in the vehicle), along with its budgetary, political, mission and support aspects, at the senior level context.
- Identifies the overall context of the immediate system.
- Focuses on external connections rather than internal structure in a system, and coaches junior level leaders on how to do so in a product.
- Relays the context of why a decision was made a particular way to junior level leaders, providing mentoring and coaching of why a decision was not accepted;
- Illuminates the context for both junior level and senior level leaders.

- Understands how the technical system or system of systems, along with its budgetary, political, mission and support aspects, fits within the executive-level context.
- Identifies the overall context of the immediate system of systems.
- Focuses on external connections rather than internal structure in a system of systems, and coaches mid-level leaders on how to do so in a system.
- Relays the context of why a decision was made a particular way to mid-level leaders, providing mentoring and coaching of why a decision was not accepted.
- Understands how the system fits in the context external to the agency, that is, in the Congressional context or landscape, and the national technical
<table>
<thead>
<tr>
<th>1.11 Abstraction</th>
<th>1.11 Abstraction</th>
<th>1.11 Abstraction</th>
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</thead>
<tbody>
<tr>
<td>- Recognizes patterns or abstractions across similar domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain;</td>
<td>- Recognizes patterns or abstractions across somewhat divergent domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain;</td>
<td>- Recognizes patterns or abstractions across very divergent domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain;</td>
</tr>
<tr>
<td>- Discerns patterns and structures in the relationships among a few similar systems;</td>
<td>- Discerns patterns and structures in the relationships among a few somewhat diverse systems;</td>
<td>- Discerns patterns and structures in the relationships among multiple diverse systems;</td>
</tr>
<tr>
<td>- Provides recommendations to mid level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level;</td>
<td>- Provides recommendations to senior level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level;</td>
<td>- Provides recommendations to executive level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level;</td>
</tr>
<tr>
<td>- Understands how concepts and tools can be applied in situations and domains having some degree of variety;</td>
<td>- Guides junior level leaders in identifying connections and new opportunities (including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;</td>
<td>- Understands how concepts and tools can be applied in varied situations and domains;</td>
</tr>
<tr>
<td>- Guides junior level leaders in identifying connections and new opportunities (including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;</td>
<td>- Guides mid-level leaders in identifying connections and new opportunities (including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;</td>
<td>- Guides mid-level leaders in identifying connections and new opportunities (including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;</td>
</tr>
<tr>
<td>- Leads multidisciplinary teams in subordinate suborganizations across multiple technical fields;</td>
<td>- Leads multidisciplinary teams in subordinate suborganizations across multiple technical fields;</td>
<td>- Leads multidisciplinary teams in subordinate suborganizations across multiple technical fields;</td>
</tr>
<tr>
<td>context or landscape.</td>
<td>- Illuminates the context for both executive level and mid-level leaders;</td>
<td>- Effectively represents the system in relevant Congressional committees, providing advice and guidance to relevant national standards boards.</td>
</tr>
</tbody>
</table>
### 1.12 Paradoxical Mindset

- **Guides mid-level leaders in the right direction with regard to scientific, mathematical and engineering insights.**

<table>
<thead>
<tr>
<th>• Guides mid-level leaders in the right direction with regard to scientific, mathematical and engineering insights.</th>
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</thead>
<tbody>
<tr>
<td>• Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment, while:</td>
</tr>
<tr>
<td>• Providing reassurance and direction to mid-level leaders during resolution of the resulting challenges;</td>
</tr>
<tr>
<td>• Nurturing divergent views among mid-level leaders and coaching them on how to do so with their colleagues;</td>
</tr>
<tr>
<td>• Ensuring that executive-level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.</td>
</tr>
<tr>
<td>• Is comfortable with apparent paradox and can examine technical problems from higher dimensions in which paradoxes may be resolved;</td>
</tr>
<tr>
<td>• Understands how to bring divergent technical approaches to resolution at the appropriate time in the system lifecycle;</td>
</tr>
<tr>
<td>• Sustains mid-level leaders’ motivation, because paradoxical thinking injects an uncomfortable level of uncertainty for technical professionals who typically-thrive on clarity, certainty, and solutions. In addition, one’s technical</td>
</tr>
</tbody>
</table>

- **Learns to keep divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment;**

- **Learns to be comfortable with apparent paradox and how to examine technical problems from higher dimensions in which paradoxes may be resolved.**

- **Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment,** while:

  - Providing reassurance and direction to junior level leaders during resolution of the resulting challenges;
  - Nurturing divergent views among junior leaders and coaching them on how to do so with their colleagues;
  - Ensuring that senior level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.

- **Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment,** while:

  - Providing reassurance and direction to mid-level leaders during resolution of the resulting challenges;
  - Nurturing divergent views among mid-level leaders and coaching them on how to do so with their team members;
  - Ensuring that executive-level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.

- **Is comfortable with apparent paradox and can examine technical problems from higher dimensions in which paradoxes may be resolved;**

- **Understands how to bring divergent technical approaches to resolution at the appropriate time in the system lifecycle;**

- **Sustains junior level leaders’ motivation, because paradoxical thinking injects an uncomfortable level of uncertainty for technical professionals who typically thrive on clarity, certainty, and solutions. In addition, one’s technical**
| Thrive on clarity, certainty, and solutions. In addition, one’s technical subordinates must be motivated and encouraged to engage in multiple divergent views of a problem simultaneously; • Reassures senior and junior level leaders that the presence of multiple divergent and possible contradictory views is a good thing. | Subordinates must be motivated and encouraged to engage in multiple divergent views of a problem simultaneously; • Reassures executive level leaders that the presence of multiple divergent and possible contradictory views is a good thing. |
## Table 6 Key Competency Indicators for Enabling Leadership Competencies

<table>
<thead>
<tr>
<th>Career Stage</th>
<th>Competency Class 2: Enabling Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior</td>
<td>2.1. Developing People - Self</td>
</tr>
<tr>
<td></td>
<td>• Understands their role and contribution in a technical team, communicating effectively with team members and not working in isolation;</td>
</tr>
<tr>
<td></td>
<td>• Expresses appropriate appreciation and recognition of others;</td>
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<tr>
<td></td>
<td>• Receives constructive feedback and coaching and mentoring guidance in a nondefensive manner, given their typically strong technical expertise;</td>
</tr>
<tr>
<td></td>
<td>• Undertakes training and learning opportunities provided by mid-level leaders;</td>
</tr>
<tr>
<td>Mid-level</td>
<td>2.1. Developing People - Team</td>
</tr>
<tr>
<td></td>
<td>• Develops junior level leaders personally through coaching and mentoring, enabling them to both lead and conduct their technical work more effectively;</td>
</tr>
<tr>
<td></td>
<td>• Establishes relationships with technical team members (in part to understand their personality and characteristics to assign them the right roles);</td>
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<tr>
<td></td>
<td>• Participates in selecting technical team members, with a balanced view of technical competencies and people skills;</td>
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<tr>
<td></td>
<td>• Represents the technical team effectively (e.g. budget requests, recognition of accomplishments, accepts responsibility and does not fingerpoint for technical inadequacies) to the senior level;</td>
</tr>
<tr>
<td></td>
<td>• Leads diversity at the junior and mid-levels, encouraging or accepting differing views. (Beyond recognized demographics, diversity also includes different personality types, educational backgrounds, program experiences, and other factors, to offer a variety of viewpoints and approaches to solutions);</td>
</tr>
<tr>
<td>Senior</td>
<td>2.1. Developing People - Managers</td>
</tr>
<tr>
<td></td>
<td>• Develops mid-level leaders personally through coaching and mentoring, enabling them to both lead and conduct their technical work more effectively;</td>
</tr>
<tr>
<td></td>
<td>• Leverages rotational assignments of mid-level leaders to provide developmental opportunities where there may be a large domain knowledge divide, potentially accepting short-term inefficiencies (due to learning curve effects of wide rotations) for long-term gains (of building cross-functional skills, breadth of experiences, systemic knowledge);</td>
</tr>
<tr>
<td></td>
<td>• Leads diversity at the mid-level and the senior levels, encouraging or accepting differing views. (Beyond recognized demographics, diversity also includes different personality types, educational backgrounds, program experiences, and other factors, to offer a variety of viewpoints and approaches to solutions);</td>
</tr>
<tr>
<td></td>
<td>• Leads and shapes mid-level leaders’ roles, encouraging additional breadth and/or depth in the role (and therefore the associated skill set), while aligning it to the organizational vision and strategy;</td>
</tr>
<tr>
<td></td>
<td>• Helps mid-level leaders define and develop their own careers;</td>
</tr>
<tr>
<td></td>
<td>• Provides training and learning</td>
</tr>
</tbody>
</table>
2.2. **Leading People – Leading Self**
- Provides guidance, direction, and motivation to mid-level leaders, peers, and customers;
- Works well with mid-level leaders, stakeholders, and internal peers from many different cultures, backgrounds and countries;
- Possesses a strong set of values and ethics, to provide recommendations regarding risk, time, and client pressures to the mid level leaders;
- Understands and resolves conflicting views;
- Understands the importance of participating well in meetings;
- Works and communicates in a transparent manner to mid level leaders, peers, and customers;

2.2. **Leading People – Leading the Team**
- Guides, directs, and motivates junior level leaders in a dignifying and empowering way;
- Provides guidance, direction, and motivation to senior level leaders, peers, and customers;
- Motivates and rewards junior level leaders, including celebrating junior level leaders’ accomplishments, as well as protecting them and the suborganization during failures;
- Works well with junior level leaders, senior level leaders, stakeholders, and internal peers from many different cultures, backgrounds and countries;
- Builds the team and suborganization with a diverse representation, to avoid using people with a similar demographic, personality type, educational background, program

2.2. **Leading People – Leading Managers**
- Guides, directs, and motivates mid-level leaders in a dignifying and empowering way;
- Provides guidance, direction, and motivation to executive level leaders, peers, and customers;
- Motivates and rewards mid-level leaders, including celebrating mid-level leaders’ accomplishments, as well as protecting them and the suborganization during failures;
- Works well with mid-level leaders, superiors, stakeholders, and internal peers from many different cultures, backgrounds and countries;
- Builds the team and suborganization with a diverse representation, to avoid using people with a similar demographic, personality type, educational background, program experience, or
| Experience, or technical background; |
| • Learns to delegate, rather than doing the technical task themselves; |
| • Builds team cohesion (overcoming introversion and task orientation); |
| • Learns to represent the team well in peers’ meetings and senior level meetings, knowing when and what to speak and when to refrain from speaking; |
| • Understands when to and is able to raise a different view for discussion, rather than following a strictly conflict-avoidance strategy; |
| • Possesses a strong set of values and ethics, to provide recommendations regarding risk, time, and client pressures to the senior level leaders; |
| • Works and communicates in a transparent manner to senior level leaders, junior level leaders, peers, and customers; |
| • Sets priorities and expectations for junior level leaders, measures performance and accountability; |
| • Creates an environment where the team of junior level leaders feel valued and appreciated, are committed to their work and want to excel; |
| • Provides motivation for the junior level leaders to coalesce around common goals; |
| • Acts through and with other people, through formal mechanisms such as technical background; |
| • Creates environment of empowerment and expression, allowing all voices and constituencies to be heard, and listens to all voices and constituencies; |
| • Possesses a strong set of personal and organizational values and ethics (such as making ethical decisions in large system sign-offs under risk, time and client pressures); |
| • Works and communicates in a transparent manner to executive-level leaders, mid-level leaders, peers, and customers; |
| • Sends memorable messages informing mid-level leaders about the values, norms, and expectations of the organization’s culture; |
| • Sets priorities and expectations for mid-level leaders and their suborganizations, measures performance and accountability; |
| • Creates an environment where the team of mid-level leaders feel valued and appreciated, are committed to their work and want to excel; |
| • Provides motivation for the suborganization or mid-level leaders to coalesce around common goals; |
| • Acts through and with other people, through formal mechanisms such as goal setting and performance measurement, and informal mechanisms such as building trust and influencing others. |
### 2.3 Thinking Critically

<p>| • Applies analytical thinking across a narrow scope or range of problems and functions, and learns to do so at an intermediate scope; | • Utilizes junior level leaders’ diversity of thought, experiences, and approaches to develop alternative solutions and explanations for observed phenomena and problems, and actively considers them routinely; |
| • Emphasizes the recognition and prioritization of problems and analysis of courses of action | • Provides junior level leaders with a moderate-scope library of ideas, frameworks, and models suitable for application in many areas; |
| • Possesses a balance between logical thinking and holistic thinking (e.g. IQ and emotional intelligence EI), important for technical leaders who have a natural tendency for ‘left brain’ thinking | • Applies analytical thinking across an intermediate scope or range of problems and functions, and coaches junior level leaders to do the same for their realm of responsibility; |
| • Efficiently budgets time, balancing workload and schedule against completeness of work | • Supports junior level leaders with problem discovery and identification accurately (across an intermediate range of systems problems and functions); |
| | • Challenges junior level leaders to make inferences or draw conclusions that are justified by evidence; |
| | • Learns to utilize the team to solve problems |
| | • Efficiently provides oversight of junior leaders work while giving them sufficient free rein to make decisions on |
| | • Utilizes mid-level leaders’ diversity of thought, experiences, and approaches to develop alternative solutions and explanations for observed phenomena and problems, and actively considers them routinely; |
| | • Provides mid-level leaders with a wide ranging library of ideas, frameworks, and models suitable for application in many areas; |
| | • Applies analytical thinking across a large scope or wide range of problems and functions, and coaches mid-level leaders to do the same for their realm of responsibility; |
| | • Supports mid-level leaders with problem discovery and identification accurately (across a wide range of system of systems problems and functions); |
| | • Challenges mid-level leaders to make inferences or draw conclusions that are justified by evidence; |
| | • Expands his or her thinking by actively requesting new ideas and feedback from others, and constantly requests and collects new information; |
| | • Uses critical thinking to generate alternative courses of action and a |</p>
<table>
<thead>
<tr>
<th>2.4 Building Trust</th>
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<tbody>
<tr>
<td>• Explains own decisions clearly, including their motives and character as well as the logic of the decision, to mid-level leaders;</td>
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<tr>
<td>• Uses own ability to achieve mid-level leader’s goals and objectives;</td>
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<tr>
<td>• Contributes to and participates in decision-making;</td>
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<tr>
<td>• Understands the personal experiences and connections that the mid-level leader makes;</td>
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<tr>
<td>• Keeps promises to mid-level leaders, and peers;</td>
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<tr>
<td>• Operates ethically and with high levels of integrity;</td>
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<tr>
<td>• Uses own resources responsibly;</td>
</tr>
<tr>
<td>• Has the courage to do the right thing, even when there may be negative repercussions;</td>
</tr>
<tr>
<td>• Takes action in spite of risk or discomfort;</td>
</tr>
<tr>
<td>• Listens carefully to mid-level leaders and peers, and communicates clearly, openly, and transparently to mid-level leaders, and peers.</td>
</tr>
<tr>
<td>• Explains decisions clearly, including their motives and character as well as the logic of the decision, to junior level leaders, senior-level leaders, and peers;</td>
</tr>
<tr>
<td>• Delegates responsibility and relies on the ability of the junior level leaders to achieve their goals and objectives;</td>
</tr>
<tr>
<td>• Shares control and increases the participation of the junior level leaders in decision making;</td>
</tr>
<tr>
<td>• Shares personal experiences and makes connections with junior level leaders’ experiences;</td>
</tr>
<tr>
<td>• Keeps promises to junior level leaders, senior level leaders, and peers;</td>
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<tr>
<td>• Leads ethically and models high levels of integrity;</td>
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<td>• Uses resources at the mid-level responsibly;</td>
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<td>• Has the courage to do the right thing, even when there may be negative repercussions;</td>
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<tr>
<td>• Takes action in spite of risk or discomfort;</td>
</tr>
<tr>
<td>• Nurtures an environment that results in the mid-level team credibility and trust;</td>
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<tr>
<td>• Listens carefully to senior level leaders, junior level leaders, and peers, and their own</td>
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<tr>
<td>• Encourages diverse technical solutions to avoid the “my way is best” engineering bias.</td>
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<tr>
<td>recommendation for superiors to problems, decisions and requests identified by them.</td>
</tr>
<tr>
<td>• Explains decisions clearly, including their motives and character as well as the logic of the decision, to mid-level leaders, executive-level leaders, and peers;</td>
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<tr>
<td>• Listens carefully to executive-level.</td>
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</table>
### 2.5 Communicating Effectively

| • Speaks articulately to mid-level leaders and peers; | • Speaks articulately, delivering a well-crafted message oriented toward a specific audience (including mid and senior level leaders), and adapts messages to different audiences having a variety of viewpoints (includes a flexible communication style using story telling and analogies); |
| • Listens effectively and interprets information and translates it into work tasks | • Actively listens (understands what is meant, in addition to what is said), clarifies what has been heard, and conveys genuine interest, to senior level leaders, mid-level leaders, peers, and all stakeholders, not just those having the louder voice; |
| • Writes nontechnical documents concisely, clearly, and with crispness, rather than just using technical language | • Social perceptiveness: being aware of others' reactions; effectively interprets intent, influence, and nonverbal communication of mid-level and senior level leaders; |
| • Understands non-technical requirements and ideas communicated by mid-level leaders; | • Writes clearly and effectively, to senior level leaders, junior level leaders and peers; |
| • Communicates persuasively to mid-level leaders and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their mid-level leaders and peers; | • Translates non-technical requirements and ideas to technical staffs; |
| • Communicates openly and transparently; | • Uses a variety of communications |

- Communicates clearly, openly, and transparently to senior level leaders, junior level leaders, and peers.
- Contributes to program-level reputation, avoiding the tendency to focus on own team.
- Communicates clearly, openly, and transparently to executive-level leaders, mid-level leaders, and peers.
### 2.6 Establishing and Maintaining Stakeholder Relationships

| Builds internal relationships; | Maintains existing stakeholder relationships, by identifying and understanding their requirements, expectations, and needs; meeting or handling their expectations; and ensuring the right processes (including communication processes) are in place to sustain stakeholder relationships; | Builds new stakeholder relationships, by identifying and understanding their requirements, expectations, and needs; meeting or handling their expectations; and ensuring the right processes (including communication processes) are in place to sustain stakeholder relationships; |
| Supports maintaining effective stakeholder relationships; | Anticipates and reacts to changing clients and changing client needs; | Identifies stakeholder issues which are appropriate to be escalated to executive level leaders; |
| Identifies stakeholders, and distinguishes among different stakeholder roles | Identifies prospective new clients; | Balances competing stakeholder values, |
| Identifies stakeholder issues which are appropriate to be escalated to mid-level leaders; | Identifies stakeholder issues which are | |
| Learns how to maintain effective stakeholder relationships, conflict management, and negotiation; | | |
| Joins professional societies (e.g. INCOSE). | | |

- Media to communicate technical information clearly and understandably to both technical and non-technical audiences;
- Communicates through framing and interpreting experience to junior level leaders and peers;
- Communicates persuasively to junior level leaders, senior level leaders, and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their junior level leaders, senior level leaders, and peers;
- Coaches junior level leaders on how to do the above communication actions effectively;
- Fosters a culture of open and transparent communication in their suborganization by example.

- Communicates through framing and interpreting experience to junior level leaders and peers;
- Communicates persuasively to junior level leaders, senior level leaders, and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their mid-level leaders, executive-level leaders, and peers;
- Coaches mid-level leaders on how to do the above communication actions effectively;
- Fosters a culture of open and transparent communication in their suborganization by example;
- Requires mid-level leaders to evaluate their communication plans (i.e. communication goals, requirements, challenges, message, media, and audiences).
appropriate to be escalated to senior level leaders;

- Learns to balance competing stakeholder values, goals and interests, making subjective judgments and decisions about rights and accountability;
- Learns to manage expectations of technical and nontechnical stakeholders;
- Learns to manage conflict constructively, both conflict between the stakeholder and the suborganization, and conflict between multiple stakeholders, and negotiates effectively with stakeholders;
- Learns to build new stakeholder relationships with senior level leaders;
- Coaches junior level leaders on maintaining effective existing stakeholder relationships, conflict management, and negotiation;
- Contributes to developing a unified approach to stakeholder care throughout the organization that helps meet stakeholder expectations;
- Participates in professional societies (e.g. INCOSE).

### 2.7 Influencing Others

<table>
<thead>
<tr>
<th>Uses rational persuasion, including explanations, logical arguments, and factual evidence, to advocate a position, decision, request, proposal, or task, with</th>
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</tr>
</thead>
<tbody>
<tr>
<td>goals and interests, making subjective judgments and decisions about rights and accountability, and coaches mid-level leaders on how to do so;</td>
<td>Manages conflict constructively, both conflict between the stakeholder and the suborganization, and conflict between multiple stakeholders, and negotiates effectively with stakeholders;</td>
<td>Identifies and involves mid-level leaders in building new stakeholder relationships;</td>
</tr>
<tr>
<td>Coaches mid-level leaders on maintaining effective existing stakeholder relationships, conflict management, and negotiation;</td>
<td>Develops a unified approach to stakeholder care throughout the organization that helps meet stakeholder expectations.</td>
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</tbody>
</table>
mid-level leaders, peers and stakeholders;
• Utilizes inspirational appeals through an emotional or value-based request, to advocate a position, decision, request, proposal or task, with mid-level leaders, peers and stakeholders;
• When consulted by mid-level leaders (or taking own initiative), provides suggestions on a particular issue;

• Defines vision and strategy for own self;
• Supports the mid-level leader’s vision;
• Understands how junior level leader’s actions/outputs/products align to the organizational strategy;
• Actively contributes to knowledge sharing, using any technical tools provided;
• Uses controls and feedback mechanisms provided by mid level or senior level leaders to assess their (junior level

2.8 Developing Strategy and Vision

• Develops and articulates the vision for their team, generates support for that vision from junior level leaders, senior level leaders, and peers, and aligns the vision to the suborganization, organization, and enterprise vision;
• Enables junior leaders to create their own vision, which supports the mission and values of the mid-level suborganization;
• Contributes to creating, understanding,
leaders’) performance of strategy and associated execution.

and executing a strategy at the senior level that encompasses stakeholder expectations, industry trends, and emerging technologies;

- Connects strategy with day-to-day junior level leader’s objectives; ensures that their junior level leaders can see how their junior level leaders’ actions/outputs/products align to the strategy;

- Utilizes suborganizational structures that support strategy and promotes knowledge sharing, clear accountability, and coordination;

- Uses controls and feedback mechanisms provided by senior level leaders to assess their (mid-level leaders’) performance of strategy and associated execution.

strategies that encompass stakeholder expectations, industry trends, and emerging technologies;

- Connects strategy with day-to-day mid-level leader’s objectives; ensures that their mid-level leaders can see how their mid-level leaders’ teams’ actions/outputs/products align to the organizational strategy;

- Develops suborganizational structures that support strategy and promotes knowledge sharing, clear accountability, and coordination;

- Develops strategy execution processes and employs incentives to support those processes and decisions;

- Modifies or creates effective controls and feedback mechanisms to allow mid-level leaders to assess performance of strategy and associated execution;

- Contributes to organizational vision and strategy at the executive level.

<table>
<thead>
<tr>
<th>2.9 Fostering Agility</th>
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</thead>
<tbody>
<tr>
<td>- Reorganizes, regroups, and renews own personal energy at the junior leader level in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;</td>
<td>- Reorganizes, regroups, and renews own personal energy at the mid level leader in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;</td>
<td>- Reorganizes, regroups, and renews own personal energy at the senior leader level in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;</td>
</tr>
<tr>
<td>- Adapts quickly and effectively to shifting demands and changing priorities from mid-level leaders or stakeholders, and</td>
<td>- Adapts quickly and effectively to shifting demands and changing priorities from mid-level leaders or stakeholders, and</td>
<td>- Adapts quickly and effectively to shifting demands and changing priorities from executive level leaders or stakeholders, and</td>
</tr>
</tbody>
</table>
other unexpected and unplanned events

- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Uses practices introduced by mid-level leaders to do effective adaptive planning;
- Modifies their own role to incorporate agility;
- Adheres to standard operating procedures and uses knowledge management tools to increase their own learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.

priorities from senior level leaders or stakeholders, and other unexpected and unplanned events

- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Fosters and encourages resiliency and responsiveness in junior level leaders;
- Uses practices introduced by senior level leaders to do adaptive planning, and introduces practices to help junior level leaders do effective adaptive planning;
- Modifies their own role and junior level leader’s roles to incorporate agility;
- Adheres to standard operating procedures and uses knowledge management tools to increase their own learning, junior level leaders’ learning, and suborganizational learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.

and other unexpected and unplanned events

- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Fosters and encourages resiliency and responsiveness in mid-level leaders;
- Introduces practices to help mid-level leaders do effective adaptive planning;
- Modifies their own role and mid-level leader’s roles to incorporate agility;
- Establishes standard operating procedures and implementing knowledge management tools to increase their own learning, mid-level leaders’ learning, and organizational learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.

### 2.10 Promoting Innovation

- Contributes to the culture of technological innovation and interacts effectively with other junior level leaders regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to mid level

- Nurtures and champions a culture of technological innovation and promotes effective junior level leader team interaction regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to senior

- Nurtures and champions a culture of technological innovation and promotes effective mid-level leader team interaction regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to executive level
leaders;
• Implements and/or follows processes that support innovation;
• Contributes to advancement in their own technical domain through innovation.

leaders, and coaches junior level leaders to do the same;
• Supports and guides junior level leaders as they implement and/or follow processes that support innovation;
• Protects junior level leaders when their innovations fail;
• Contributes to advancement in their own technical domain through innovation.

leaders, and coaches mid-level leaders to do the same;
• Supports and guides mid-level leaders as they implement processes that support innovation;
• Protects mid-level leaders when their innovations fail;
• Creates and implements innovation strategies, and provides input to organization-level innovation strategy;
• Contributes to advancement in their own technical domain through innovation (including patentable inventions).

<table>
<thead>
<tr>
<th>2.11 Building Government Acumen</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Is aware of accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA);</td>
</tr>
<tr>
<td>• Is aware of the impact that business procedures have on the successful accomplishment of technical work;</td>
</tr>
<tr>
<td>• Is aware that the law, congressional directives, OMB and DoD policy directives and guidance, the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) impact technical success;</td>
</tr>
<tr>
<td>• Organizes and plans for success at the junior level in an uncertain and changing financial and regulatory environment.</td>
</tr>
</tbody>
</table>

| • Learns accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA); |
| • Understands program budgets and operates within them effectively; |
| • Learns to understand the impact that business procedures have on the successful accomplishment of technical work; |
| • Understands how the law, congressional directives, OMB and DoD policy directives and guidance, the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) impact a program course that leads to technical success; |
| • Organizes and plans for success at the |
2.12 Possessing a Macro Perspective

- Is aware of the role of each organization and suborganization in the DoD enterprise;
- Understands how the junior level leader fits into the larger context at the mid-level leader’s suborganization;
- Understands how the junior level leader is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer junior level leaders within the suborganization;
- Aligns the junior level leader’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the suborganization, organization and enterprise.

mid-level in an uncertain and changing financial and regulatory environment.

- Understands the role of each organization and suborganization in the DoD enterprise;
- Understands how the mid-level leader’s suborganization, along with its budgetary, political, mission and support aspects, fits within the larger context at the suborganization, organization and enterprise levels;
- Understands how the mid-level leader’s suborganization is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer mid-level leaders within the suborganization;
- Champions the role of their suborganization as a trusted business partner across the suborganization and organization levels;
- Capitalizes on the value and worth of one suborganization’s intellectual property, personnel, development efforts and products;
- Aligns the mid-level leader’s suborganization’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the suborganization, organization and enterprise.

senior level in an uncertain and changing financial and regulatory environment.

- Understands, appreciates, and appropriately utilizes the role of each organization and suborganization in the DoD enterprise;
- Understands how the senior-level leader’s suborganization, along with its budgetary, political, mission and support aspects, fits within the larger context at the organization and enterprise levels;
- Understands how the senior-level leader’s suborganization is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer senior-level leaders within the suborganization, organization and enterprise;
- Champions the role of their suborganization as a trusted business partner across the suborganization, organization and enterprise levels;
- Capitalizes on the value and worth of one suborganization’s intellectual property, personnel, development efforts and products;
- Aligns the senior-level leader’s suborganization’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the organization and enterprise.
6 FRAMEWORK ELEMENT (3) – DEVELOPMENT METHODS

6.1 INTRODUCTION

The literature identifies, and we have chosen, six different development techniques that have proven more or less effective (with more or less rigorous evidence for this effectiveness) in the development of leadership skills in general, and technical leadership skills in particular. These are:

• Education
• Training
• Experience
• Rotational assignments
• Mentoring
• Coaching

Note that while mentoring and coaching are frequently lumped together, we choose to address them separately because they are in fact different techniques and should be applied differently for different purposes. We provide in depth definitions, descriptions and examples of these six techniques below, but in general, education refers, in this context, only to university level academic coursework. Training is divided into formal technical leadership training provided by the Defense Acquisition University, and all other training. The definitions of the other techniques are as found in ordinary English usage.
### Table 7 Definitions of Development Approaches

<table>
<thead>
<tr>
<th>Leadership Development Approach</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>The formal instruction received from academic or government institutions, typically resulting in a Bachelor, Master or Doctoral degree.</td>
</tr>
<tr>
<td>Training</td>
<td>The formal instruction received from government, corporate, or academic institutions, spanning multiple weeks to multiple years, such as DAWIA Levels I – III, focusing on technical and/or leadership instruction.</td>
</tr>
<tr>
<td>Experience</td>
<td>The process of gaining work knowledge and skills from performing in a specific role directly.</td>
</tr>
<tr>
<td>Rotational Assignments</td>
<td>Allows the leader to broaden their skills by providing different experience in terms of function, role, or geographic location.</td>
</tr>
<tr>
<td>Coaching</td>
<td>Coaching is distinguished by a focus on applied, goal-oriented learning and behavioral change, also in a one-to-one context.</td>
</tr>
<tr>
<td>Mentoring</td>
<td>Mentoring consists of formal or informal advising or developmental relationship with a more senior leader, in a one-to-one context.</td>
</tr>
</tbody>
</table>

It is important to recognize that no one development methodology is required as part of this Framework. Although it is recognized that certain development techniques may be more effective in imparting certain KCIs, it is the application of a wide portfolio of techniques over the full spectrum of methods that leads to successful achievement of all the KCIs at a given career stage, resulting in full technical leadership competency at that stage.

A comprehensive discussion of the application of each technique at each career level follows. Additionally, for job rotations, we include a discussion of job rotations from a program perspective, to identify attributes suited for developing technical leaders. Similarly, for coaching and mentoring, we discuss them from a program perspective, to identify proven and transferrable attributes to develop technical leaders.

Mentoring and coaching have traditionally been combined into a general catchall category and are generally thought of in terms of the benefit (in leadership development at least) to the junior partner of the mentoring/coaching pair. In fact, as recognized in the nuclear power navy, for example, they are two quite different techniques and in each case benefits (different ones, to be sure) flow to both the senior and junior members of a pair. Therefore, we will consider them separately, and under each heading we will explore the tools and techniques applicable to each career stage for recipients of the mentoring/coaching and as the provider of the same. We are thus dealing with four topics:
• Receiving Mentoring
• Receiving Coaching
• Providing Mentoring
• Providing Coaching

Since the two techniques are commonly confused with each other, we provide the following definitions.

Mentoring involves a relationship between a senior and a junior in which the more seasoned partner provides an opportunity for informal discussion; for observation by the less seasoned partner of the senior’s management style and techniques; for experiences they might not otherwise enjoy, for help in networking with the senior’s peers; for removal of barriers through the senior’s intercession; and for unstructured advice in an informal (and emotionally comfortable) setting. In its best incarnation, mentoring is unforced, a natural friendship across levels of the hierarchy that provides guidance and opportunity to the junior member.

Coaching is a structured relationship between a subject matter expert and a recipient, in which the SME, through focused discussion and application of various learning tools and techniques, helps the trainee to learn and apply a variety of leadership and management concepts. The coach is not necessarily senior to the recipient of the coaching, simply more knowledgeable about the subject matter involved. Confusion exists because a supervisor may act as a coach (the best ones always do!) but as we use the term here, we intend “coaching” to be a practice where the coach need not be the direct line superior of the party receiving the coaching.

A closely related concept is “shadowing.” Management development programs frequently use shadowing as a developmental tool. The difference between mentoring and shadowing is that the former is a long term formal or informal relationship, while the latter is usually very short term (although any period less than three days is likely to be of limited utility) and is merely intended to give the shadower a sense of the rhythm and flow of the senior’s work day. The best shadowing practice requires that the shadower and senior leader being shadowed sit down at the outset and discuss the shadower’s learning objectives clearly. In the best case, the shadower will maintain a daily journal addressing the manner in which the senior leader executes the skills of interest to the shadower. At the end of each day, the two sit down for a review of the day’s events, and discuss the purposeful manner in which the senior applied the techniques of interest to the shadower. For example, if the shadower is concentrating on conflict resolution as a KSA, or communication skills, then the senior leader can point to their strategies in these areas, helping the shadower to see how the senior leader’s actions in the situations observed during the shadowing event purposefully served to illuminate the relevant skills.

Viewed in this context, shadowing is a highly useful technique that demands a significant amount of preparation, work, and introspection on the part of both participants. It is, sadly, hardly ever conducted in this manner.
As described here, shadowing is a blend of both mentoring and coaching, but because of its structure, it is best thought of as a sort of “speed mentoring” we will include it under the heading of “mentoring.” Shadowing is most useful at the junior level, although some structured development programs at the mid-level (ELP and EPP both employ this technique) do make use of it. Since shadowing is typically a “skip level” tool, it is not appropriate to the senior career level, the analogous benefits at the senior level are best derived from the richer rotational assignment environment at that level.

An interesting question about the practice of mentoring involves the motivation to serve as a mentor, as well as the acquisition of mentoring skills. It is often assumed that a leader will be an adequate mentor, no effort is usually made to ensure the quality of mentoring, and mentor skills are almost unknown as a topic in leadership development training. In our recollection, every leadership development program in our experience has focused exclusively on getting mentoring for its participants – none have devoted energy to having the participants act as mentors. This is a serious shortfall.

As intimated in the earlier discussion on shadowing, the proper execution of a mentoring program is very important. As found by Gavito et al. (2010) most mentoring programs appear to consist of a mandate for junior employees to sign up, followed by assignment to a senior mentor, finally followed by the expectation “that a miracle will happen.” This expectation is generally not met.

In practice a well-designed mentoring program provides top management encouragement through the most senior executives’ active and effective participation in the program (“walking the walk”); provides incentives for mentors and mentees through performance review; and provides a gentle and flexible structure that promotes connections among senior leaders and junior employees that results in natural and unforced mentoring relationships.

Additionally, each emerging leader needs to cultivate multiple mentors in different areas and over time.

Although we have made the point here that the “skip level” nature of the mentoring process reduces its utility for the most senior leaders, this does not mean that mentoring necessarily ends upon elevation to executive rank. We are aware of more than one mentoring relationship that has continued after the mentee’s promotion to executive rank, and then after the mentor’s retirement, with periodic lunch sessions lasting for years until the eventual death of the mentor. In one such instance, the mentee “returned the favor” by engaging in a similar relationship with his own mentees, effectively stretching a beneficial chain of relationships over two or more generations of leadership.

Effective mentoring, and its shorter term cousin, shadowing, requires engagement by both the mentor and the individual receiving the mentoring. Simply following a senior executive around

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5 As related by Mike Pennotti about the work that went into this reference.
for a day or two has little benefit. To be really useful, this type of experience requires thoughtful preparation, active involvement, and follow-up involving reflection and discussion. The process needs to be a closed-loop cycle in which pre-work establishes learning goals, and in which the participant is required to take notes and review lessons learned at the end of the shadowing opportunity, or periodically during mentoring. A useful approach is to tie the mentoring experience to competencies identified as areas of weakness, concern, or interest by the participant. During the shadowing/mentoring period, the participant makes note of the mentor’s use of techniques related to the competencies identified as being of interest to the participant. Following the shadowing experience, or periodically during mentoring, the participant prepares a written reflection identifying the salient points from their observations, which then serves as the basis for a reflective discussion with the mentor.

6.1.1 Learning Styles

Another aspect that relates to leadership development is a person’s learning style. Some people learn more effectively from one approach than from another. Some people learn better through being instructed by others; we identify this as “learning through instruction.” Learning through instruction includes the leadership development approaches of education, training, and coaching. Other people learn better through experience; we identify this as “learning by doing.” Learning by doing includes the leadership development approaches of experience and job rotation. Yet others learn on their own through self-development; we identify this as “learning on one’s own.” Additionally, there is “learning through observation,” where a person learns by watching and noticing others, and reflecting on what they saw and heard. As new leadership development techniques are designed, it is possible to view them as consisting of one or more learning styles. For example, experiential learning includes both learning through instruction as well as learning by doing. Still others learn better through reflection and personal feedback. This can be mapped to mentoring, although feedback is provided in both learning through instruction approaches and learning by doing approaches. Learning style is important because it is something to be considered when designing a career model.

6.2 Education

6.2.1 Senior Level

Completion of a Master’s level academic degree is essential to this career level; pursuit of a PhD or other Doctoral program appropriate to the technical leader’s field of scientific or engineering specialty is highly desirable. Aspiration to an executive position may require doctoral level expertise as evidenced by the achievement of the metrics described below. A doctoral degree is one way to achieve proficiency across a number of key competency indicators, and provides the incumbent not only with depth, but also allows the incumbent to understand a broad variety of technical challenges outside the leader’s own original specialist field. Tenure of
technical KLPs by individuals with the doctoral degree is also highly effective in fostering respect for the institution.

6.3 EXPERIENCE

6.3.1 INTRODUCTION

At each career level the development actions taken to build technical leadership skills should be aspirational: that, they should have as their primary purpose the qualification for the next level up. We presume that an individual already meets the qualifications for their current level. If they do not, then we are talking about remedial training, not development, and that is not our objective here.

The goal of experiential development, then, is to expose the trainee to a series of assignments that provide exposure to a variety of professional challenges of increasing difficulty, culminating in qualification for promotion to the next level.

6.3.2 JUNIOR LEVEL

When we consider the development of technical leadership skills, a critical early goal is to provide the individual with a chance to apply the basic technical knowledge acquired as part of a baccalaureate degree program. Since the essence of the junior level experience is “management of self,” learning to manage one’s own workload, and producing excellent technical product is an essential goal for this level.

Once an individual has demonstrated the ability to execute individual technical tasks efficiently and at a high level of quality, the next important experiential learning objective involves the ability to handle multiple assignments simultaneously.

Two other concepts need to be introduced at the earliest stage of the junior career level. First, since we are dealing with the acquisition workforce, even the most junior technical professionals should be given an opportunity to interact with contractors, vendors, and suppliers, through attendance at program reviews, site visits, and technical interchange meetings, and by participating in the review of deliverables and proposals relevant to their own technical specialty. Proposal review is rightly seen as a rotational assignment opportunity, and is dealt with in more detail under that heading: what we envision here is ad hoc review of proposal materials as part of the technical professional’s regular duties and under the supervision of their permanent line supervisor, not by temporary assignment to a proposal review team.
Second, as early as possible, individuals should have the opportunity to work as part of a team, possibly in concert with other members of their discipline, possibly as members of a multi-disciplinary team.

Halfway through the junior career stage, having demonstrated proficiency in the KCIs related to the elements discussed above, the tone and tenor of assignments should change significantly. In this latter stage the technical professional is preparing for their first formal supervisory assignment, and should be given the opportunity to build strong leadership skills by being offered the following experiential roles. First, the most senior individuals in the junior career stage should be seen as local experts – “go-to people” – in some particular aspect of their technical discipline. Second, they should be given the chance to lead teams through negotiation, example, and persuasion (leading without formal authority). Third, as they approach the end of this career stage, they should be given the responsibility to provide technical direction to contractors, under the supervision of a designated COR. Each of these three experiences serves to habituate the emerging technical leader to provide inspiration and direction, the combination of these experiences ensures that the emerging leader has the right mix of technical management, and acquisition experiences required to succeed at the mid-career stage.

6.3.3 MID-LEVEL

At the mid-career level, a technical leader’s experiences are focused on the leadership of individuals. For the first time, the technical leader has both formal and informal authority, and the focus of experience at this career level should be to re-emphasize the power of informal authority while illuminating the shortfalls of formal authority.

With elevation to first level supervisory status comes a wide variety of new administrative responsibilities. Although these are extremely important, they are not unique to technical leadership, and so we do not emphasize this aspect here, beyond making the obvious point that a technical leader must be, first of all, a good leader in general, and adequate experiential exposure to the nuts and bolts of first level supervision is essential. The variety of assignments at the mid-career level should include the following experiences in this sequence.

1. First, line management of a team of technical specialists in the leader’s field of discipline;
2. Second, supervisory management of a project team or IPT including the leader’s discipline but also including complementary functions;
3. Third, assignment as a contracting officer’s technical representative with responsibility over some portion of an acquisition program.

Having had assignments in these three areas a mid-level technical leader should then be assigned to a technical staff position working with a second level manager. The specific staff assignment is not important, but it is preferable that the organization have both technical and
acquisition responsibilities, and that the emerging technical leader should be afforded the opportunity to act “in stead” of the second level manager in performing these duties. The key benefit from this is learning to handle problems across disciplines outside the leader’s own area.

6.3.4 Senior Level

The distinctive difference at the senior career level involves diversity of technical field and functionality. Senior level technical leaders manage suborganizations, not individuals: they are “managers of managers.” Since the suborganizations that they manage include multiple technical disciplines, and include non-technical elements (such as contracts, HR, facilities, and the like), a senior technical leader is exposed to a wide range of ideas and processes.

To prepare the senior level for executive leadership, assignments at this level should concentrate on several types of experiences. First, experiences at this level should begin to emphasize application of technical knowledge broadly at some depth well outside the leader’s own technical field. The key learning in this process is that “the laws of physics never change, just the jargon” so that senior technical leaders can prepare themselves for the eventual executive leadership of highly diverse technical organizations of broad scope, such as Test ranges or National Laboratories, where a variety of activities in science, engineering, test and evaluation, and research co-exist, and where the senior leader must be able to “speak the language” of all the disciplines credibly enough, and to sufficient depth, to be able to provide cogent critical review to all the programs under the organization’s direction.

Second, experiences at this level should permit the senior leader to build familiarity with, and knowledge of, the set of staff functions normally associated with General Management; namely: finance, contract, facilities, human resources, public affairs, legal, and security, among others. This is best achieved where the senior technical leader is given “dotted line” supervisory responsibility for specialist staff functions that report directly to their own functional management at a geographically remote location. The senior leader in this position shares performance review responsibilities with the “home room” manager, and serves as the day-to-day supervisor for the staff functions assigned. Learning the nuances of this role is best achieved through on the job experience, and is absolutely critical for anyone who will later be called upon to lead a large and diverse national enterprise.

Third, senior technical leaders are at a career stage where program management of large, multi-year projects of national visibility and importance is a critical experiential element.

The ideal sequence of assignments at this career level should focus on each of these elements in turn, to permit solid learning and to build on experience productively. Anecdotal data suggests that there is a preferred sequence for these assignments: the order in which they are introduced above, with the first, more technically oriented role coming first, followed by exposure to general management skills, because these two experiences build on one another
and are together, essential prerequisites to successful program management at the highest levels.

In addition to the line management assignments described above, technical leaders at the senior level can also benefit from staff positions with important responsibilities. These would include positions with titles such as Chief of Staff, Technical Director, or Deputy, where the senior leader serves in a direct reporting relationship to an Executive – preferably an executive filling one of the technical KLPs.

In light of the increasingly important interconnections among communities in the defense establishment, one or more of these senior level assignments might well be in a joint, interagency, or whole of Government position. Since, however, these opportunities tend to be limited in availability, this aspect of experiential learning is probably best handled through the mechanism of rotational assignments.

6.4 ROTATIONAL ASSIGNMENTS

6.4.1 INTRODUCTION

The above comment allows us to make an extremely important point; in the best of all possible worlds, the series of positions occupied by a technical leader over an entire career should suffice to support the entire list of requisite KSAs. This is not possible, therefore, there is a close relationship between regular assigned positions and rotational assignments: at each career stage, care should be taken by the technical leader’s superiors to identify those KSAs that have not been addressed by regular on the job experience, and arrange to fill these through carefully selected rotational assignments. In the anecdotal data about technical leadership development, it is clear that one of the most powerful tools available is the rotational assignment. Almost every successful technical leader we have spoken to has a story about one or more such assignments that have had extra ordinary impact on their own development as a leader.

Unfortunately, we could also point to a large body of data that shows that most rotational assignments that are part of a formal career development plan end up being a waste of time. It is worth discussing the reasons for this before laying out the parameters for successful rotational assignments at each career stage.

In contemplating dozens of rotational assignments familiar to us over almost a combined century of technical leadership career experience, the following attributes of a successful rotational assignment emerge. First, it must be “for real.” What this means is that the assignment must not be contrived as a rotational assignment invented for career development purposes, but must instead be in fulfillment of an actual, no-kidding operational need of the organization, a meaningful leadership assignment with important consequences for the organization. Some have referred to this factor as the “shark tank” approach to leadership development, where the presumed “high potential” leader is thrown into the tank, and the
result is either a pool of blood, or the emergence of the leader wearing a shark’s tooth necklace.

Second, and this may seem obvious, but is not, the assignment needs to involve a real challenge outside the leader’s comfort zone, preferably involving multiple elements that go beyond the leader’s previous experience. They should have received the appropriate training and education for the role, and may even have had the opportunity to observe others perform that role (up close and personal if possible) but the challenge has to be a quantum step in difficulty for the assignee.

Third, someone should have the leader’s back during this process (so there is also a close connection to both mentoring and coaching as well): an emerging technical leader in the right kind of rotational assignment needs a shoulder to cry on. This is not a metaphor: we are personally aware of very successful rotational assignments in which real tears were shed (privately, between the emerging leader and their mentor), and that’s OK. In any event, a trusted advisor is critical to this technique, and in fact, if a rotational assignment can be completed without recourse to such an advisor, it probably wasn’t adequate.

It is perhaps worth noting here that in our conception “rotational assignment” we also include both collateral duty and volunteer positions. Thus a “rotational” assignment need not involve a complete disengagement from the regular flow of work, but might instead involve longer term, periodic service as part of an ad hoc committee or in a designated ex officio role. Parenthetically, some of these part time rotational duties can be very good for resume polishing.

Volunteer service, falling as it does under this general category, is an opportunity for the technical leader to take ownership of their own career development. For a technical professional, serving as an officer in their professional society typically permits them to try out techniques of management, build a technical network, and bank goodwill at no career risk (whereas the “tears” aspect of high pucker factor rotational assignment can be highly stressful.) Volunteer assignments are not in the scope of this framework, however, we strongly recommend that supervisors of technical professionals make sure that their emerging leader subordinates are well aware of the value of such opportunities.

### 6.4.2  Junior Level

We imagine a junior level technical professional happily beavering away at their assigned duties, and at some point the supervisor thinks: “this person could be a good technical leader.” How should the supervisor now proceed?

Fortunately, before any of the other techniques discussed in this Framework come into play, the availability of short term and informal rotational assignments is widespread: every organization has numerous opportunities to staff pop-up task teams, proposal evaluations, tiger
teams, external reviews, and many other demands for support from its assigned technical personnel. Each of these is a chance for the supervisor to send a potential emerging technical leader on a rotational assignment.

The possibilities are so diverse that we will not enumerate them. Instead, let’s list several key attributes of a good rotational assignment at the junior level. First, rotational assignments at the junior level should be of short duration. At this point, we don’t want rotational assignments to drag on or grow into permanent commitments of indeterminate duration. Important growth is underway in the technical professional’s regular assignment, so such rotational duties should be limited and brief.

Second, the rotational assignment should involve a different supervisor: “let’s you and I go work this redesign thing together” is not a valuable choice: part of the learning experience at this career stage is precisely about working for a different supervisor. This is how junior folks start to build the extremely important network of their supervisors, from which future promotional opportunities are built.

Third, it is highly advantageous for the junior technical professional if the leader of the rotational assignment is senior to their permanent supervisor. There are many reasons for this: a higher premium on excellent performance; visibility at a higher management level; the learning that comes from a “stretch” assignment; the chance to see how the more experienced folks do things, and many others.

Of course, the junior technical professional’s supervisor, in selecting such rotational assignments for junior subordinates, should bear in mind the general requirements outlined in the introduction to this section, notably that the assignment has to be “for real” and it should target KSAs that might be hard to experience in the assignee’s regular job.

The White House Fellows program is both a rotational experience and a training program that serves junior career stage leaders.

6.4.3 MID-LEVEL

Rotational assignments at the mid-career level have the same basic purpose as do those at the junior level – namely, making up for inevitable shortfalls in the experience obtained through regular job assignments, reinforcing the learning of key KSAs, and providing seasoning and rounding out of experience in general.

The nature of the rotational duties, however, will change at this career stage, as it necessarily involves management and supervision as a fundamental component. Thus, where rotational assignments at the junior level place technical professionals in the role of performers (leadership of self), those at the mid-level should be chosen so as to put the emerging leaders in a leadership position.
Since a mid-career stage leader’s first supervisory role is very typically as the manager of a group of team members in the manager’s own technical specialty, the rotational assignments chosen at this point should very purposefully put the leader in a position of having to lead specialists in other areas.

To the extent possible, mid-level technical leaders should also be exposed to rotational assignments outside the boundaries of their home organizations. For example, a mid-career leader could fill in as section head or branch chief for a supervisor from another division who is out on maternity leave. Such an assignment would fulfill several important criteria: exposure to a different management and work culture; exposure (potentially) to a different technical specialty; and the potential for building a network with peers and managers across the broader organization.

The question arises here as to whether a mid-career leader should undertake rotational assignments farther afield, for example, a leave of absence to take an IPA at a University, FFRDC or similar institution; legislative fellowships; or perhaps an exchange appointment with a foreign Government. Selection for this kind of opportunity depends on the level of preparation of the candidate, and also, on whether the fundamental achievement of the basic KSAs for this level is proceeding on track or ahead of schedule. These rotational assignments are broadening in the most general sense, but tend to have more limited applicability to building the specific KSAs required.

Nonetheless, such out of scope assignments can have a profound positive effect on the best technical leaders. We are aware of a case in which a young mid-career leader at an Army laboratory was given the chance to serve as the program manager for a relatively low budget but very high impact research project at DARPA. The experience gained during this rotational assignment allowed this mid-career technical leader to gain invaluable insight, hone her research skills, and propel her to the top ranks of technical leadership within the Army acquisition establishment.

Congressional Fellowships are another training opportunity/rotational assignment that is available to mid-career leaders.

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### 6.4.4 Senior Level

It is at the senior level that rotational assignments become most meaningful. At this point, the goal of these assignments is to build perspective, a broad base of understanding, wide technical scope, and a pervasive network of contacts that will serve the leader well in their executive career.

Rotational assignments at this level should carry titles such as “Chair,” “SSO,” “Study Director,” “Designated Federal Official,” and the like. As a manager of managers the senior technical
leader should begin to be comfortable acting as leader of interagency peers, contributing to multi-agency interdisciplinary teams in high stakes, high intensity activities such as source selections, red teams, and blue ribbon panels. The senior technical leader should use these rotational opportunities for building the capacity to survive a room full of elephants, or the breakup of the ice floes, without being crushed in the process.

While senior leaders as we have defined them, are never subject to congressional testimony, they should nonetheless be given rotational assignments that involve service as the principal point of contact for congressional staff, GAO, IG and other fact finding and audit organizations of similar nature.

### 6.4.5 Type of Job Rotation

Viewed from a program perspective, the different types of job rotational assignments may be characterized by a number of parameters, which can be used to define a rotation program, as summarized in Table 8.

<table>
<thead>
<tr>
<th>Job Rotation Program Design Parameter</th>
<th>Job Rotation Program Design Parameter Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Number of rotations</td>
<td>1 (1); Few (2-3); Several (&gt;=4)</td>
</tr>
<tr>
<td>2 Rotation duration</td>
<td>Short (4 weeks - 9 months); Typical (1 year); Long (2-5 years)</td>
</tr>
<tr>
<td>3 Rotation scope</td>
<td>Narrow (within technical function/discipline); Intermediate (across technical functions/disciplines); Broad (across technical and non-technical functions/disciplines)</td>
</tr>
<tr>
<td>4 Rotation location</td>
<td>On-site; Off-site (but within same country); International</td>
</tr>
<tr>
<td>5 Person’s career stage</td>
<td>Junior; Mid-level; Senior</td>
</tr>
<tr>
<td>6 Rotation selection</td>
<td>Non-selective (all employees in the population set defined); Selective (subset of employees in the population set defined)</td>
</tr>
<tr>
<td>7 Rotation extent</td>
<td>Partial (part-time); Full (full-time)</td>
</tr>
</tbody>
</table>
6.4.5.1 Number of Rotations

The number of rotations in a rotation program may vary, from one rotation, to a few rotations (two to three), to many rotations (four or more). While a rotation program may typically consist of a few rotations, it is important to note that at a single company, there may be multiple rotation programs, which means at the aggregate level there could be the opportunity for many rotations within the same company. For example, at BP there are two rotations in the Future Leaders Program, and two rotations in the First Level Leaders Program, so it is possible for a person to experience a total of four rotations at BP.

It is suggested that a larger number of rotations is more beneficial to developing technical leaders than a fewer number of rotations. For example, a larger number of rotations across the system development lifecycle ensures that a person understands the ramifications of decisions throughout the lifecycle phases, such as the implications of a particular requirement or design decision on the build and test phases.

6.4.5.2 Rotation Duration

The duration of the job rotation depends on the objective of the job rotation program. Some job rotations are short, ranging from weeks to months, but less than one year. This is generally used for socialization or orientation where new or junior employees are exposed to various parts of the organization before identifying the department or division they would be assigned to (Garretson, 2007; United Technologies, 2016; Wexley, Latham, Kettering, Rivaldo, & Christensen, 1991). The typical length of job rotations, particularly at the junior level, is one year. Other job rotations are long, spanning from two to five years where mid-level employees are provided a broader view of the business, preparing them for senior technical positions within the organization (Sweeney, 2007).

It is suggested that rotation duration is partially dependent upon a person’s career stage. For example, job rotations occurring during the entry-level stage be a year or two, while job rotations occurring during the mid-level stage be two or three years. The rationale underlying this suggestion is that for the first while, there is an increasing rate of knowledge and experience gained, but that this declines over time. At the mid-level, this duration is longer, because the decisions that the mid-level leader is responsible for typically have longer time horizons and therefore visible consequences, than the junior-level leader.

6.4.5.3 Rotation Scope

The scope of the rotation may have a narrow focus, an intermediate focus, or a broad focus. For a rotation having a narrow scope, the rotation will occur within the specific technical function or discipline. A rotation with an intermediate scope will occur in a different technical function or discipline, while a rotation with a wide scope will cross from technical to non-technical or vice versa.
It is suggested that the higher the person wants to go in the career stages, the broader the rotations should be. For example, for someone who aspires to a senior career stage role, it is suggested that wide rotations provide the appropriate experience necessary to perform well in this role, including rotations spanning technical to nontechnical areas. Because the senior career stage is responsible for a broad range of functions, including nontechnical functions such as HR and budget, as well as technical functions, gathering nontechnical experience through job rotations (assuming previous technical experience) is quite valuable.

6.4.5.4 Rotation Location

The location of the rotation may be one-site at the same location, off-site at a different location but within the same country, or international (a different country). The rotation location may or may not be correlated with rotation scope. For example, it is possible to have an international relocation with a different technical function or discipline, or a rotation which is off-site at a different location (within the same country) combined with a shift from a technical function to a nontechnical function.

It is suggested that the higher the person wants to go in the career stages, that the wider the location rotation should be. That may translate to different geographic regions within the U.S., or it may translate to an international relocation. A person learns things by working in an international relocation that are unique to international relocations, and that is why international relocations are a part of some global companies’ leadership development programs.

6.4.5.5 Person’s Career Stage

Some job rotation programs are intended for new hires or junior employees to provide them with a quick and broad introduction to the organization. Other job rotation programs are intended for mid-level employees, in preparation for senior technical positions in the organization.

Career stage is an integral part of any job rotation program design, and is typically incorporated as a factor together with one or more of the other job rotation attributes, as discussed in the appropriate section.

6.4.5.6 Rotation Selection

Another type of job rotation is characterized by the presence or absence of selection criteria. For some entry-level job rotations, there may be no selection criteria, while for mid-level job rotations, there may be selection criteria that a potential program participant is required to meet prior to entry in the program.

It is suggested that at the junior level that several rotations be conducted with minimal entrance requirements, so that the entire technical workforce gathers both breadth and depth.
At the mid-level, if the goal is to build the entire workforce’s breadth and depth, it is suggested to have moderate entrance requirements.

6.4.5.7 Rotation Extent

Yet another type of job rotation is characterized by the extent of the rotation. In most job rotation assignments, a person is fully rotated. In a few cases a person is partially rotated. This means that individuals take up rotation jobs part-time, while still continuing to work on their primary jobs. This could be implemented as spending a few hours a day on the rotation job, or as spending one day of the week on the rotation job.

It is suggested that the program consist of both partial and full job rotations, so that as many people can participate in a rotation as possible.

6.4.5.8 Rotation Sequence

At the program level, another factor to consider is the sequence or order that the job rotations occur in. The sequence is linked to some of the above parameters, namely, scope, location, and career stage. The sequence of rotations is suggested to be structured as first having a narrow scope, then intermediate scope, and then a broad scope. The rationale underlying this suggestion is to first focus on building depth, and then breadth. Depth is required at the junior level, while the expansion to breadth is required at the senior level.

6.5 Training

6.5.1 Introduction

“Education” implies a formal degree program (including such courses of study as Engineering certificates that do not lead directly to a degree although they may form part of one) “Training” is everything else.

“Training” refers to technical leadership training that is part of the DAU curriculum or offered by other government or corporate organizations or enterprises. Training includes courses taught by Service Schools, non-technical accredited degree programs, business training, and organizations such as community colleges, the Federal Executive Institute, and the Graduate School USA. Some of these institutions package this training into programs such as the Graduate School’s ELP and EPP programs.
6.5.2 TRAINING

6.5.2.1 JUNIOR LEVEL

For any given KSA at the Junior level, there are targeted courses of training – events that are specifically designed to deliver the content relevant to the KSA, and at the appropriate level. Thus, under the heading of “communications,” at the Junior level, training opportunities described as “basic” are the most appropriate: we are thinking about “basic presentation skills,” or “introduction to persuasive argumentation.”

There are 24 KSAs at each level, with potentially multiple KClIs associated with them. Each of these has at least one training course available with that qualifier “basic” attached to it. This is the training universe for the junior level technical professional.

6.5.2.2 MID-LEVEL

Since there are an almost infinite number of training opportunities available at every career level, our approach here has to be to reduce the list to those appropriate for technical leaders in particular, and at each career level specifically.

While the junior technical professional can best benefit from training focused on “management of self” – such course material as handling difficult people, stress management, basic English writing, and participation in toastmasters club are excellent choices – at the mid-level, skills associated with team leadership – management of individuals – is more appropriate. At this level, courses with titles like “handling difficult conversations, “getting to yes – basic negotiation” and “please understand me” are the right level. The Successful Managers Handbook by Gebelein, et al. (2010) is an excellent resource for finding training ideas at this level. We have already mentioned the ELP and EPP programs run by the Graduate School USA, which are precisely targeted at this career level.

Another training opportunity at this level involves volunteer service, as earlier discussed in the rotational assignment discussion. Serving in volunteer organizations, including community service, religious, political, youth sports, emergency services and charity organizations can give an emerging leader the chance to serve in a leadership position at one or two notches higher up in the responsibility scale that their day job makes possible. A leader who has served as a political Precinct Captain; church elder, or a Scout leader, is much more comfortable in their first formal supervisory role than one who has not.

In the present context, volunteer service also exposes the leader to training opportunities associated with their volunteer roles. Learning about the Myers-Briggs Type Indicator tool as a charity board member is every bit as effective as doing so in job sponsored training.
Finally, the leadership opportunity afforded though military service cannot be discounted: service in the Reserve and Guard also brings the advantage of leadership training (of the highest quality, by the way) and, unlike volunteering, actually involves monetary compensation.

**6.5.2.3 Senior Level**

As at the junior and mid-career levels, the opportunities for training at the senior level are almost infinite.

In the context of this framework, Service Schools fall under the category of “training” and are most appropriately encountered at the senior level.

At the senior level, there are three training experiences that are of the utmost importance – to the point that it would not be a stretch to demand that every senior technical leader be given a shot at all three.

The first is media training, which goes beyond the advanced speaking and writing skills we should see at the mid-career level and focuses on how the senior leader performs on television, understanding of how to deal with “investigative journalism” invitations (“no thanks”) and how to “do” the six-o’clock news.

Second, is the “executive MBA,” which comes in many guises, but in its essence involves exposing senior leaders to general management level concepts of finance (ROI, balance sheet, income statement), debt and equity, export regulation, diversity, and many other important topics, including ethics and liability. This requirement could be satisfied through a regular MBA program, however, for most senior technical leaders, it is more important to apply limited academic degree funding and time commitments to their technical education instead, and use the more informal executive MBA program for this purpose.

The third is attendance at a widely focused residential training program that involves interagency, whole-of-Government, and joint participation. A joint service school program, such as the JFCS planner’s course, the MIT Seminar XXI program, or a similar high level course such as the FEI’s basic executive leadership course is an almost mandatory element of the technical leader’s seasoning.

Also at this point, the senior technical leader, upon reaching promotion to GS-15 at the latest, should make a habit of attending at least one course annually at the Federal Executive Institute, preferably at the FEI’s Charlottesville, VA, campus. These courses expose the senior leader to peers at agencies across the government. The focus is on deep understanding of key leadership concepts, coupled with a return to those “management of self” truths that a senior leader may have lost track of over the long years of a successful career: stress management, work/life balance, respect for diversity, honoring the workforce, personal health.
Finally, technical leaders at the Senior level should be encouraged to take advantage of one of the many Congressional familiarization workshops that introduce participants to the legislative process, and typically include briefings by members and legislative staff. An understanding of how Congress works is vital to a senior technical leader in the acquisition community.

6.6 MENTORING

6.6.1 JUNIOR LEVEL

Our questions here are two-fold: what kind of mentoring should a future technical leader be getting at the junior level; and what kind of mentoring should they be giving?

Organizations periodically pass through periods where mentoring for junior employees becomes a “management flavor of the month” obsession. Such campaigns are usually fruitless and short lived. But both management and junior employees should take the mentoring requirement far more seriously, and having junior employees in mentoring relationships is, or ought to be, a key metric for all technical organizations. Since you get what you measure, it is important for managers to ask “who is your mentor?” in all performance reviews, and performance reviews of supervisors should always ask “who are you mentoring?” One hopes that the respective lists match up! However, even in the absence of management attention, it is possible for junior employees to take this matter into their own hands: we are familiar with the practice of “Dragon clubs,” a system whereby junior employees mentor each other, thereby “dragging” their careers forward.

A junior technical professional can also find mentoring opportunities outside of work, using former professors, supervisors, and community leaders to provide the shoulder to cry on, sage advice, and networking outlet missing in the absence of an effective mentoring system on the job, which, by the way is best effected not through a formal “mentoring program”, but in a culture where it is understood that one key role of management is to encourage the success of the next generation by actively participating in the mentoring process.

So, what should junior technical professionals be doing to build in themselves the habit of “dragging” their own juniors along? Fortunately, technical professionals, of all people, are best suited to being mentors, because by their very nature they have a store of knowledge to be imparted. Young technical professionals should retain the membership in their professional society that they likely acquired as a student; attend those society meetings of their local chapter or sections: get involved in STEM outreach at local high schools and other K-12 venues; serve as science fair judges and robotics team advisors. And, as soon as a few months of experience put them in a position to do so, reach out to the new person on the floor and begin to share the tricks of the trade they have learned on the job. You don’t have to be anointed by management to be a mentor: there is always someone less experienced than you are!
6.6.2 Mid-level

A technical professional who enters the mid-career stage should do so with one or more well-established mentoring relationships in hand. In a common situation, one of those mentors might be the person who promoted or hired them into their first supervisory position. This is not always the case, of course. But a successful promotion always involves references – professional references – and among those a mentor is likely to be found.

At the same time, the newly minted technical leader should have already established the habit of mentoring their juniors, and so they enter the mid-career stage with a “tail” of mentees who will benefit from the leader’s mentoring, and who perhaps more importantly, will afford the leader the opportunity to hone their own mentoring skills as they progress toward the senior career stage.

Conspicuously absent from the previous discussion is any mention of organizational structure related to mentoring. This once again illustrates an important element about mentoring, namely at its “best practice” state, it is an organic feature of the organizational culture, not a formal program.

Which begs the question: what should the organizational role be in the nurturing of this organic best practice? There are of course things that every organization can do to enshrine the importance of mentoring in their formal organizational culture, by formulation of policy, public pronouncement, and other means, but fundamentally, there are really only two actions that top management must take to make effective mentoring a reality:
• First “walk the walk” by taking on mentees and doing well by them, and
• Second, through the pervasive encouragement of grass roots mentorship practice.

6.6.3 Senior Level

If the formal mentorship infrastructure is weak at the mid-career level, it is surely nonexistent at the senior level.

At this level it is the responsibility of the senior leader’s immediate supervisor to determine whether the senior leader is adequately supplied with mentorship, and then either provide it directly or see that it is provided. The latter is not a hopeful situation, since by this time, a technical leader should have realized the importance of this factor, which alone among all the development techniques encompasses both the giving and the taking. And if you have achieved the senior level having done your part in mentoring others, how could you have failed to provide mentors for yourself? In particular since, as we have seen, this factor is from the start best achieved as a “do it yourself” activity.
On the other hand, it is at the senior level that the other side of mentoring – that is, service in role of “mentor” – is most important.

We hope that the leader reaching the senior career level will have developed a lifelong habit of mentoring, and that whether or not an individual has done so, management will be assiduous in ensuring that active mentoring is a feature of the senior leader’s performance that receives serious scrutiny.

Senior leaders, being managers of managers, should be required to maintain a mentoring program in their own organizations, along the lines discussed. If need be, they should receive training in the development and operation of such a program, as well as being given training in mentoring itself. Furthermore, they should be required to deliver such training to their staffs (under the premise that there is no better way to learn about a topic than by teaching it yourself!)

6.6.4 Mentoring Transferrable Attributes

Plamondon (2007) has identified three attributes of effective mentoring programs, summarized in Table 9.

<table>
<thead>
<tr>
<th>Attribute</th>
<th>Specifics</th>
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</thead>
<tbody>
<tr>
<td>Develop an encouraging and supportive culture</td>
<td>• Foster second-generation mentoring, in which past mentees become mentors, to build a sustainable mentoring program.</td>
</tr>
<tr>
<td>and structure.</td>
<td>• As mentoring does require some time commitment from both the mentor and mentee, it is important that top management value and express support for the mentoring program through organizational mechanisms.</td>
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<tr>
<td></td>
<td>• Confidentiality protects both the mentor and mentee’s interactions and relationship, enhancing their trust. Confidentiality is best ensured through defined policy.</td>
</tr>
<tr>
<td></td>
<td>• Formally recognize mentoring in the organization, to acknowledge it as one of the organization’s values.</td>
</tr>
<tr>
<td>Select, match, and train mentors and mentees.</td>
<td>• Set criteria to identify mentors to ensure that they have the right competencies (i.e. communication, interpersonal skills).</td>
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<tr>
<td></td>
<td>• Match mentors and mentees in respectful ways, allowing for a dual process of informal and formal mentoring.</td>
</tr>
<tr>
<td></td>
<td>• Train mentors on subjects including developing collaborative relationships, building observational skills, facilitating reflective practice, comprehending professional needs of mentees, and comprehending and assessing mentoring relationships.</td>
</tr>
<tr>
<td>Evaluation</td>
<td>• Identify or measure the outcomes of the mentoring relationships and the mentoring program.</td>
</tr>
</tbody>
</table>
Schooley (2010) observes that successful mentoring programs are characterized by organized mentor/mentee profiles, mentoring training, and mentoring software and associated training.

Mentoring may be characterized by a number of parameters, which can be used to identify transferrable attributes, as summarized in Table 10.

<table>
<thead>
<tr>
<th>Table 10 Mentoring Transferrable Attributes</th>
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<tbody>
<tr>
<td>Mentoring Attributes</td>
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<tr>
<td>-----------------------</td>
</tr>
<tr>
<td>1 Mentor-to-mentee ratio</td>
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<tr>
<td>2 Mentor/mentee matching</td>
</tr>
<tr>
<td>3 Job function distance</td>
</tr>
<tr>
<td>4 Career stage distance</td>
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<tr>
<td>5 Demographic distance</td>
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<tr>
<td>6 Mentor-mentee duration</td>
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<tr>
<td>7 Mentoring communication method</td>
</tr>
<tr>
<td>8 Meeting Frequency</td>
</tr>
<tr>
<td>9 Mentor Criteria</td>
</tr>
</tbody>
</table>

### 6.6.4.1 Mentor-to-Mentee Ratio

The mentor-to-mentee ratio may vary. The typical ratio between a mentor and mentee is individual, that is, one-to-one. There are some situations in which it may be beneficial to have mentoring occur in a group situation, with one mentor and two or more mentees at one time. It may be even more beneficial, for a many-to-many mentor-to-mentee ratio, that is, one mentee has multiple mentors, and a mentor has multiple mentees.

It is suggested that the mentoring program have a one-to-one or many-to-many mentor-to-mentee ratio, because the conversations regarding a person’s professional development are better conducted in a one-to-one environment, and both mentors and mentees can benefit from multiple counterparts.
6.6.4.2 Mentor-Mentee Matching

A key part of any mentoring program is how the mentors and mentees are matched up. There are at least three possible design alternatives. One way is to have the mentee select the mentor themselves. A second alternative is for a pre-selection to take place, allowing for mentees to have some discretionary choice. In this alternative, a mentee would select a mentor from a subset of the total number of available mentors. The subset could be based on a number of criteria, such as closeness in terms of profile, or matching a mentee’s weaknesses to a mentor’s strengths. In a third alternative, mentees have no choice, but are assigned to a particular mentor.

It is suggested that the best alternative is for the mentee to select the mentor, because this corresponds to informal mentoring which is typically associated with more success than mentoring programs. However, if certain mentors are popular and oversubscribed, then a pre-selection algorithm may be helpful.

6.6.4.3 Job Function Distance

The job function distance between the mentor and mentee is simply the logical (not physical or geographic) distance in terms of job function similarity and dissimilarity between the mentor and the mentee. When the distance is close, the degree of closeness spans a range of possibilities, from working in the same function, to different job functions in the same speciality, to different job functions across specialties but in the same field. These three possibilities are all relatively close, with the first option being closest. An example of different job functions in the same specialty refers to the mentor working in the requirements phase in electrical engineering and the mentee working in the build phase in electrical engineering. An example of different job functions across specialties in the same field would be the mentor working in the requirements phase in electrical engineering, while the mentee is working in the build phase in computer engineering.

When the job function distance is intermediate, the mentor and the mentee are in different technical fields. For example, one is in engineering and the other is in information technology. When the job function distance is far, one is working in a technical area, such as engineering, science and technology, or test and evaluation, while the other is working in a nontechnical area, such as finance or human resources.

It is suggested that the job function distance is dependent upon the career stage of the mentee. With a mentee in the junior career stage, it is suggested that the job function proximal distance be close or intermediate to the mentor. The rationale for this is that if the job function is far, the mentee may not perceive that the mentor is able to relate to the specific job that they are doing (regardless of the mentor’s ability to do so). The option between a close distance and an intermediate distance is partially dependent upon the mentee’s individual choice and preference. Some may prefer a mentor who has a close job function, while others may be fine with a mentor whose job function is an intermediate distance away.
With a mentee in the mid-level career stage, it is suggested that the job function distance be intermediate or far. With a mentee at the mid-level career stage, they will either be familiar with other fields, or should be getting familiar with other fields, and consequently a mentor with a broader scope is applicable.

6.6.4.4 Career Stage Distance

The career stage distance refers to the number of career stages (or hierarchical levels) between the mentor and the mentee. In peer mentoring, the career stage distance is zero, as both the mentor and the mentee are at the same career stage. The next alternative is one in which the career stage distance is an intermediate distance. In an intermediate distance, the mentor and mentee are in different career stages, but only separated by a single stage. For example, the mentee is at the junior career stage, and the mentor is at the mid-level stage, or the mentee is at the mid-level stage, and the mentor is at the senior stage. The third alternative is one in which the career stage distance is far. In a far distance, the mentor and mentee are in different career stages, separated by two career stages. For example, the mentee is at the junior career stage, and the mentor is at the senior career stage, or the mentee is at the mid-level career stage, and the mentor is at the executive career stage.

It is suggested that the career stage distance be intermediate or far, if possible. While a mentee can receive insights from a mentor at their same career stage, they can receive greater insights from a mentor who is one or two career stages beyond them, because the mentor one or two career stages beyond the mentee would have greater depth and breadth than a mentor at the same career stage.

6.6.4.5 Demographic Distance

Demographic distance refers to the distance in demographics between the mentor and mentee, that is, how different the demographics are between the mentor and the mentee, where the primary demographics considered are gender and race. When the demographic proximal distance is zero or close, it reflects the same demographics (i.e. the same gender and race). When the demographic proximal distance is intermediate, it reflects some similarity and some difference (i.e. the same gender and a different race, or a different gender and the same race). When the demographic proximal distance is far, it reflects a large difference (i.e. a different gender and different race).

It is suggested that the demographic proximal distance between mentor and mentee is partially dependent on the mentee’s personal choice, and may be close or intermediate. Because professional and career development is personal, the closer the distance the easier the conversation between mentor and mentee. However, with respect to women in science, technology, engineering, and mathematics, because there is still a gender imbalance in the senior career stage, it may be suggested that women mentees would benefit from having both female and male mentors.
6.6.4.6 Mentor-Mentee Duration

The duration of the mentor-mentee relationship may be short, which is defined as anything less than one year, may be an intermediate length, which is defined as one year, or it may be long, which is defined as anything greater than one year. A good mentor-mentee relationship may last for a number of years.

It is suggested that if it is a formal mentoring program, the mentor-mentee duration start at one year. A one year duration ensures that it will include any and all of the organization’s internal career and professional development processes, such as setting performance objectives, and semi-annual or annual reviews, are included which form natural conversation topics. A one-year time frame also means that there is a need for an active renewal, rather than the potential for an awkward discussion by either the mentor or the mentee who would prefer not to continue the relationships the following year.

6.6.4.7 Mentoring Communication Method

With today’s communication technologies, there are at least three primary mechanisms for actually conducting the mentor-mentee meetings: in-person, any variation of video-conference, or telephone conferencing. In-person meetings are defined as face-to-face communication. Video-conferencing consists of traditional video-conferencing equipment (i.e. large screens and projection) as well as individual video-conferencing such as Facetime and Skype. Telephone conference is self-defining.

It is suggested that the mentoring meetings be conducted in-person, because much communication is nonverbal. In order for both the mentee and mentor to communicate and be heard effectively, in-person communication provides the greatest bandwidth (allows for verbal and nonverbal). If, however, a mentor is unavailable to meet in-person for a particular meeting, it is better to use video-conferencing than to miss a meeting. The phone is the last technique recommended, because it only supports verbal communication.

6.6.4.8 Meeting Frequency

The mentor-mentee meeting frequency may range from frequent (biweekly) meetings, to a typical frequency (monthly), to infrequent (bimonthly) meetings.

It is suggested that the meeting frequency is dependent on the career stage of the mentor and the mentee. If the mentee is in the junior career stage and the mentor is in the mid-level career stage, a monthly meeting frequency is recommended, because that is good to progress the professional development of the mentee. If the mentee is in the mid-level career stage and the mentor is in the executive career stage, a bimonthly frequency may be recommended, partially because of the executive’s busy schedule, and partially because the action items arising out of such a meeting typically require longer time frames in which to accomplish.
In addition to the regular meetings, the mentor might volunteer to be available in case something urgent arises from the mentee.

6.6.4.9 Mentor Criteria

Establishing criteria to identify mentors is controversial in the literature. Plamondon (2007) advocates setting criteria for mentor selection to help ensure that they have a good set of competencies prior to any training received. In other organizations, anyone can be a mentor.

6.6.5 Best Practices Transferrable Mentoring Attributes

The following best practices are derived from the set of best practices assembled by the NSF ADVANCE Program at the University of Rhode Island (NSF Advance Program, 2005). It is a subset because some best practices are unique to the university setting and not applicable to the government setting (e.g., research and teaching are the primary job functions at university, and many suggested mentee questions to ask mentors were on these topics in a university setting). The ADVANCE program was a five-year project funded by the NSF with the goal of promoting women faculty in science, technology, engineering, and math.

Mentee Guidelines – Suggestions to Enhance the Mentoring Experience
• Before the initial meeting, have the mentee identify and prioritize three things they would like to gain through the mentoring relationship.
• Some mentees feel anxious because of the power differences between the mentor and mentee. If this is the case, the mentee may want to identify three concerns about meeting with their mentor before their initial meeting. If the issues continue to weigh on the mentee’s mind, they may want to discuss this with their mentor.
• The mentee is to identify three things they would like the mentor to provide.
• The mentee is to prepare a short autobiography to share with the mentor, including vision and mission.
• The mentee is suggested to ask the mentor about their background and decision points.
• The mentee is to prepare for each specific meeting by being focused about their needs. This shows respect for the mentor’s time.
• Many mentor-mentee relationships use a written agreement. Such an agreement includes information on who will do what by when. It may also include the mentoring purpose as well as career goals. The mentee should determine the mentor’s view of such agreements.
• The mentee is to schedule regular meetings with the mentor. It is important to ensure the relationship is active.

Mentor Guidelines
• The mentor is to treat all communication as confidential.
• The mentor is to identify what they can provide to the mentee. They are to discuss expectations and time commitment. Mentors are not expected to meet every mentoring function.
• Mentors are to provide feedback, including both praise for accomplishments as well as constructive criticism.
• In discussions with colleagues, informally promote the mentee.
• Develop an agenda for each meeting.

6.7 Coaching

Of all the leadership development techniques, coaching is at once the most revered, and the least understood. Everyone wants to be a coach. However, when used in this particular sense of leadership development, that is not the kind of coach we are talking about: coaching in leadership development is less about the type of leadership delivered by the coach of a sports team, and more like the training delivered by a singer’s voice coach, namely, targeted instruction in a specific skill delivered by a subject matter expert to a recipient in need of strengthening (or maintenance) of that particular skill. As previously mentioned, the coach in this relationship need not be, and frequently is not, senior to the trainee in an organizational sense. For example, it is quite common for senior executives to receive coaching in such skills as public speaking and media relations, very often from consultants or staffers who may be quite junior to the executives concerned, but who are specialists in these areas. Not all skills are suitable for coaching: in general it is those that have a fairly limited or constrained set of practices the use of which is best learned through guided application.

As also mentioned earlier, coaching, like mentoring, involves both the giving and receiving of training, so that at each level leaders can gain valuable leadership skills by coaching others, as well as learning skills by being coached.

6.7.1 Junior Level

At the junior level, the new employee is coached by many others on an almost continuing basis: how the time keeping system works, where the cafeteria is, how to get a credit union membership form. We are specifically concerned here about how and where such novice employees are coached in the practice of technical leadership, and in this case, there are two principal sources for such coaching: first, the new employee’s direct supervisor, who best coaches by demonstrating good leadership, and then explicitly explains to the new employee, during frequent private sessions, what is going on; and second, through the assignment of an ever so slightly more experienced peer, who has absorbed some of the early lessons about technical leadership and can demonstrate them to the more junior partner in real life application.

Of course, it would be nonsensical to pretend that the skills and lessons of leadership in general can be separated from those of technical leadership in particular during the course of any given work day. Much of the knowledge about “the ropes” that a slightly more senior employee might impart to the new person falls more under the category of mentoring, as described
earlier, so here we attempt to draw a distinction both between mentoring and coaching, and between general leadership and technical leadership, and we do so by suggesting that the coaching understood under this section is:

1. Specifically assigned to the coach to be delivered to the trainee;
2. Aligned to a particular KSA under this specific career stage (i.e., are the related KCIs for that KSA at the career stage);
3. Tracked in terms of progress; and
4. Evaluated as to its success by the responsible supervisor.

In most instances this type of coaching might involve follow-up to a new employee’s training: “OK, you’ve had the training course on briefing preparation, now for the next few months someone will work with you to make sure you’ve got it down pat, and coach you through the next three monthly reviews...”

The roles of coach and trainee are intimately connected at the junior level: here, it doesn’t take long for the new employee to quickly become a subject matter expert on a variety of key skills, which can then be imparted through coaching to the next new person coming through the door. So, the junior leaders will spend some time being coached, will progress to a mix of coaching and being coached, and as they approach elevation to their first formal supervisory assignment, will find that they spend most of their time coaching others.

6.7.2 Mid-level

While the emerging leader at the junior level spends more time being coached than coaching, at the mid-level this balance reverses. As leaders of individuals, mid-level leaders actually spend almost all their efforts coaching, because at this career stage, the leader is responsible for seeing that all the other techniques have “stuck” by reinforcing the lessons taught there via continuous monitoring of individual performance, and continuous adjustment through one-on-one sessions.

This is probably the level at which the general image of leader-as-coach emerged.

Note that in both phases of the mid-level experience, this element is true: at the lower phase of the mid-level, where the leader is the first level supervisor of a team of individuals, they carry the responsibility for coaching the team members on every aspect of the job; in the more senior phase of this career stage, where the leader has transitioned to a staff support role, they are equally a subject matter expert with the primary charge (or they should at least view this as

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It should be noted that the term “learning the ropes” has its origin aboard sailing ships, where a raw crew member’s first duty was, quite literally, to learn the name, location, and use of each of the many hundreds of lines used to control the sails. This knowledge was imparted to the new crew member by a more seasoned (“saltier”) shipmate through the coaching process.
their primary charge) of coaching their direct supervisor’s entire workforce (including those who are the mid-level leader’s peers) on the subject in which they are the expert.

Notably, this latter phase of the mid-level experience is a template for the exercise of technical leadership without formal supervisory authority: it is in this role that we can most clearly differentiate leadership from supervision, and the delivery of coaching, which does not imply a junior/senior relationship between coach and trainee, makes this distinction even clearer.

It is also preferably during the mid-level career stage that aspiring technical leaders should seek out coaching in a wide range of areas related to the KSAs at this level. There is some question as to how pro-active the organization should be in this area: we prefer the model in which the mid-level leader’s supervisor “suggests” that the leader avail themselves of help in whichever to the KSAs they are weaker.

The ELP/EPP programs, by the way, do this very well by asking participants to identify those executive skills in which participants self-identify as areas of weakness, and then use their shadowing opportunities to focus on those elements.

6.7.3 S E N I O R  L E V E L

Coaching, both as recipient and as coach, reaches its maximum intensity at the mid-level. At the senior level, the flavor changes significantly in both roles.

The senior level leader, as trainee, will find that this is the career stage where their coaches will tend to be junior – many times these are outside consultants who have been retained to impart specific KSA related skills, which at the senior level are likely to be related to preparation for executive grade.

What kind of coaching scenarios do we envision here (with the senior leader as a recipient, that is): these could include GAO interviews in which the senior leader is put on the spot, while the executive “coach” monitors and later reflects on the proceedings; major speeches, given by the senior leader with the executive coach in the audience. Also, specific coaching by management SMEs deigned to help the senior leader deal with leadership challenges in the wide variety of personnel and staff specialty subjects that are usually unfamiliar to the technically trained professional: legal, HR, finance, public affairs, and the like.

6.7.4 C O A C H I N G  T R A N S F E R R A B L E  A T T R I B U T E S

Coaching may be characterized by a number of parameters, which can be used to identify transferrable attributes, as summarized in the following table.
Thach & Heinselman (2000) present a coaching model or framework which is specifically targeted to leadership development, based on best practices derived from consulting experience. It consists of four phases: assessment, development plan, public announcement, and implementation. In the assessment phase, a person’s leadership competencies are evaluated to obtain a baseline. In the next phase, the developmental plan, it is the leader who identifies specific areas to target, and the associated goals. The role of the coach in this phase is to provide support, particularly regarding feedback received that the leader disagrees with, and validation. In the third phase, public announcement, the leader makes the goals public. Announcing the goals does two things: 1) it increases the person’s commitment to the goals as well as the resulting course of action, and 2) provides the basis for receiving feedback from observers. The final phase, implementation, consists of the leader’s developmental action items. In this phase, the role of the coach is to provide support and tools to enable the leader to achieve their goals.

The different types of coaching may be characterized by a number of parameters, similar to the mentoring program design parameters, which can be used to define a coaching program, summarized in Table 11 (NHS Leadership Center, 2005).

<table>
<thead>
<tr>
<th>Coaching Attributes</th>
<th>Coaching Attribute Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Coach-to-coachee ratio</td>
<td>Individual</td>
</tr>
<tr>
<td>2 Coach type</td>
<td>External</td>
</tr>
<tr>
<td>3 Coach criteria</td>
<td>None</td>
</tr>
<tr>
<td>4 Coach selection and coach/coachee matching</td>
<td>Coachee has total discretionary choice</td>
</tr>
<tr>
<td>5 Coaching style</td>
<td>Directive</td>
</tr>
<tr>
<td>6 Coach-coachee duration</td>
<td>Short</td>
</tr>
<tr>
<td>7 Coaching communication method</td>
<td>In-person</td>
</tr>
<tr>
<td>8 Meeting frequency</td>
<td>Frequent</td>
</tr>
</tbody>
</table>

6.7.4.1 **COACH-TO-COACHEE RATIO**

The coach-to-coachee ratio may vary. The typical ratio between a coach and a coachee is individual, that is, one-to-one. There are some situations in which it may be beneficial to have coaching occur in a group situation, such as in a time of organizational transition or change.

It is suggested that for leadership development, the coach-to-coachee ratio be individual rather than in a group. At all career stages, particularly the senior level and the executive level, the
coachee may want to discuss a particular work situation, or request particular feedback, or engage in particular role playing exercises, in a confidential context, and therefore the individual approach is suggested.

6.7.4.2 COACH TYPE

There are two types of coaches: external and internal. An external coach is one who is outside of the organization or enterprise, while an internal coach is one who is inside of the organization or enterprise.

It is suggested that the coach type is dependent upon the coaching purpose. For example, if the purpose of coaching is to build social media skills, it may be more cost effective to identify an internal coach rather than an external one. In addition, one study suggests that internal coaches are more appropriate if either a quick solution or detailed corporate knowledge are required. In contrast, if the purpose of coaching is to build leadership skills, it may be more effective to identify an external coach, to support confidential conversations. Similarly, if there are other issues that require confidentiality, or if deep or diverse experience is needed, an external coach may be more effective than an internal one.

6.7.4.3 COACH CRITERIA

Coach criteria may include their knowledge and experience, as well as their fit with the person and organization.

It is suggested that the coach criteria be identified prior to selecting and engaging a coach.

6.7.4.4 COACH SELECTION AND COACH/COACHEE MATCHING

Coach selection is developed based on a person’s development needs, as well as any organizational requirements.

It is suggested that the coachee have some discretionary choice in selecting a coach, such as through interviewing a few coaches which have been preselected. The preselection can occur through matching the coachee with the desired coach profile consisting of both the coachee and organization’s requirements.

6.7.4.5 COACHING STYLE

There are two styles of coaching: directive and nondirective. In directive coaching, it is the coach who takes the initiative to identify appropriate coaching exercises, feedback, and even teaching. In nondirective coaching, it is the coachee who takes the initiative and drives the agenda. In this case, the role of the coach is to actively listen and ask questions to enable the coachee to identify solutions and action items to various situations.
It is suggested that the coaching style is dependent on the career stage of the person being coached. In the junior stage, it may be more effective for the coach to use a directive style, whereas in the mid-level and senior career stage it may be more effective for the coach to use a non-directive style.

### 6.7.4.6 Coaching Duration

The coaching duration is typically shorter than the mentoring duration. A short coaching duration would be for one quarter, i.e. three months; an intermediate coaching duration would be for two to three quarters, i.e. six to nine months, while a long coaching duration would be for one year or longer.

It is suggested that the coaching duration be dependent on the coaching task. If it is for a specific leadership skill, the duration could be short; if it is for leadership development, including action items, the duration could be intermediate or long.

### 6.7.4.7 Coaching Communication Method

The different methods for delivering coaching services are very similar to those for mentoring: in-person, online coaching, and via telephone conference.

Online coaching encompasses a wider variety of mechanisms than electronic video-conferencing through Facetime or Skype. It includes, for example, email and chat capability.

It is suggested that the coaching communication method be dependent on the coaching task. If the coaching task is regarding leadership development, then a high bandwidth communication method, such as meeting in-person, is preferred. If the coaching task is less personal and more task-oriented, then it is possible to use lower bandwidth communication mechanisms such as video-conferencing or telephone conferencing.

### 6.7.4.8 Meeting Frequency

The coaching meeting frequency is similar to the mentoring meeting frequency.

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### 6.7.5 Best Practices Transferrable Coaching Attributes

#### 6.7.5.1 Coach Attributes

The best practice coach competencies include generating mutual understanding and trust; remaining open; asking exploratory and deep questions; asking reflective questions; identifying “blind spots” and assumptions; and providing feedback.
6.7.5.2 Coaching Program Attributes

Killion, Harrison, Bryan, & Clifton (2012) identify a number of best practices for designing coaching programs. These best practices include specifying the coaching program’s goals and purpose, setting expectations by defining the coach’s role and responsibilities, ensuring that corporate policies are consistent with and support the coaching program, identifying the attributes of productive coaches, developing a coach selection process, effectively matching coaches and coachees, determining a coach champion, specifying any coach data requirements, and conducting an evaluation of the coach and the coaching program.
7 FRAMEWORK ELEMENT (4) – COMPETENCY ATTAINMENT METRICS

7.1 A PROOF-OF-COMPETENCY MODEL

The Technical Leadership Development Framework we have presented in this report is an example of a “framework based competency development” scheme, for which there is good precedent in the development and training literature. Generally, these approaches, however, stop at the identification of the development methods to be used (which we call Framework element 3, and describe in the Section 6 immediately above). In our last two Framework elements, however, we will be adding two additional concepts that seek to answer the following questions:

1. How do we know that an individual has achieved the desired competency? And,
2. How do we know that a particular development method is effective?

In this section, we address the first question using competency attainment metrics, and in Section 8 we address the second question.

We are all familiar with the aphorism that “some people have twenty years of experience; some just have one year of experience repeated twenty times...” It is the goal of Framework element 4 to differentiate between these two extremes through the application of objective metrics.

We conducted an extensive literature search (academic articles and industry reports) on leadership development approaches which contained a comment or remark on an evaluation, metric, or benefit of the leadership development approach. The results of this literature search are used in two Framework elements: competency attainment metrics (Framework element (4)) and method validation (Framework element (5)). In this section, we describe the results of the literature search that are relevant to measuring competency attainment.

Measuring competency attainment is important for a number of reasons. First, competency attainment metrics provide an important feedback mechanism for a person themselves, so they are aware of their competence level in a specific area. Some people overestimate their competence levels, while others underestimate theirs. A competency measurement sheds light on the person to themselves of the level of their competency. Second, competency attainment metrics can then be used either by the person themselves, or their superiors. When used by the person themselves, the competency attainment metrics can serve as a benchmark for planning and development. When used by superiors, they can also be used as a benchmark for planning and development, and/or be used as an input to the performance measurement and objectives process.

Competency attainment metrics themselves may be evaluated, with some competency attainment metrics being of a higher quality than others. For example, self-assessment
competency attainment ratings are of a lower quality than 360 degree competency attainment ratings, because a person may have an incentive to rate themselves higher than they think they are, or they may simply believe they have a higher competency level than they do. In contrast, a 360 degree competency attainment rating has a higher quality because a person does not have an incentive to rate someone else higher than they are, and is more likely to provide an unbiased opinion of the person’s competency than the person themselves. Therefore, we developed a set of criteria by which to differentiate higher quality competency attainment metrics than lower quality ones, as follows.

First, we distinguish between the two types of metrics measuring the impact of training and development activities: subjective outcomes or perceived effectiveness metrics, and objective outcomes or performance metrics. Second, we set quality criteria on each of the two types of metrics.

The first criteria sets a cutoff on the subjective outcomes or perceived effectiveness continuum. If a competency attainment metric is purely a self-assessment rating, this is a low quality metric, and we do not include it as a competency attainment metric. Examples of self-assessment ratings include statement such as “My communication skills improved from a moderate rating (3 on a 5 point scale) to an excellent rating (5 on a 5 point scale)” or “I develop my people well.” If a competency attainment metric incorporates the assessment of others, including assessments by the manager or peers, or other forms of 360 degree assessment, we deem this a higher quality subjective competency attainment metric, and we include this metric in our set of competency attainment metrics. We deem it higher quality because the assessments of others are typically less biased than self-assessments. For example, a manager rates a person as having communication skills of a moderate rating based on the person’s behavior, rather than what they say or think or believe, and this is associated with a higher quality metric.

The second criteria sets a cutoff on the objective outcomes or performance metrics continuum. If the objective outcome or performance metric is not measured, that is, if it is an unmeasured or intangible benefit, it is a low quality metric, and we do not include it. For example, if someone says that their productivity improved, or their department’s productivity improved, then this is a low quality metric. On the other hand, if there is an objective report or measurement, we deem it a higher quality objective competency attainment metric, and we include it. For example, if a person calculates that their productivity improved by 15%, or their department’s productivity improved by 15%, this is a high quality competency attainment metric. Other examples of objective reports or measurements include promotions or business outcomes.

The quality of the metrics provided in a particular article is frequently indicative of the level of rigor and critical thinking underlying the article. For example, those articles which measure perceived effectiveness using 360 degree feedback are typically a higher quality article than those articles measuring perceived effectiveness using self-assessments. Similarly, those
articles which measure objective outcomes or performance metrics are typically a higher quality article than those articles simply mentioning unmeasured benefits or intangibles.

None of the articles examined assessed the quality of the metrics that they used. In his survey of mentoring studies, Underhill (2006) found that 60% of the studies were based strictly on descriptive self-report survey results.

After developing the criteria described above, we next applied them to each article in the population of articles identified as having an evaluation component to the leadership development approach. We discuss the population of articles more fully in Section 8. For now, it is important to know that the population of articles included the six leadership development techniques containing any discussion of subjective (perceived) or objective metrics. The result is that the number of articles containing high quality metrics is greatly reduced, as shown in Figure 7. Table 12 provides summary reference information on the articles, with the full citation being provided in Appendix C: Cited and Related References. On the other hand, many of the remaining articles contained several metrics.

![Figure 7 Sources with High Quality Metrics](image-url)
<table>
<thead>
<tr>
<th>Education Metrics Sources</th>
<th>Reference</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Butler &amp; Gheorghiu</td>
<td>2010</td>
<td>Evaluating the skills strategy through a Graduate Certificate in Management: An experiential learning theory approach</td>
</tr>
<tr>
<td>While</td>
<td>1994</td>
<td>Competence versus performance: which is more important?</td>
</tr>
<tr>
<td>Training Metrics Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barling, Weber, &amp; Kelloway</td>
<td>1996</td>
<td>Effects of transformational leadership training on attitudinal and financial outcomes: A field experiment</td>
</tr>
<tr>
<td>Brown, Eagar, &amp; Lawrence</td>
<td>2005</td>
<td>BP refines leadership</td>
</tr>
<tr>
<td>de Albuquerque, Vellasco, Mun, &amp; Housel</td>
<td>2012</td>
<td>Human capital valuation and return of investment on corporate education</td>
</tr>
<tr>
<td>Snipes &amp; York</td>
<td>2006</td>
<td>Metrics That Matter in Leadership Development</td>
</tr>
<tr>
<td>Experience Metrics Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dokko, Wilk, &amp; Rothbard</td>
<td>2009</td>
<td>Unpacking prior experience: How career history affects job performance</td>
</tr>
<tr>
<td>Dragoni, Oh, Vankatwyk, &amp; Tesluk</td>
<td>2011</td>
<td>Developing executive leaders: The relative contribution of cognitive ability, personality, and the accumulation of work experience in predicting strategic thinking competency</td>
</tr>
<tr>
<td>Dragoni, Tesluk, Russell, &amp; Oh</td>
<td>2009</td>
<td>Understanding managerial development: Integrating developmental assignments, learning orientation, and access to developmental opportunities in predicting managerial competencies</td>
</tr>
<tr>
<td>Leonard &amp; Lang</td>
<td>2010</td>
<td>Leadership development via action learning</td>
</tr>
<tr>
<td>Pyster</td>
<td>2014</td>
<td>Atlas: The Theory of Effective Systems Engineers, Version 0.25</td>
</tr>
<tr>
<td>Job Rotation Metrics Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Campion, Cheraskin, &amp; Stevens</td>
<td>1994</td>
<td>Career-related antecedents and outcomes of job rotation</td>
</tr>
<tr>
<td>Ichniowski, Shaw, Pennushi</td>
<td>1997</td>
<td>The effects of human resource management practices on productivity: A study of steel finishing lines</td>
</tr>
<tr>
<td>Ortega</td>
<td>2001</td>
<td>Job rotation as a learning mechanism</td>
</tr>
<tr>
<td>Sargent</td>
<td>1952</td>
<td>A 10-year evaluation of a job rotation executive development program</td>
</tr>
<tr>
<td>Sweeney</td>
<td>2007</td>
<td>The effects of job rotation patterns on organizational outcome indicants of inter-organizational boundary spanner performance</td>
</tr>
<tr>
<td>Coaching Metrics Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bernard</td>
<td>2006</td>
<td>ROI and Coaching: Applying Metrics to Measure the Effectiveness of Coaching Programs</td>
</tr>
<tr>
<td>Source</td>
<td>Year</td>
<td>Title</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------</td>
<td>-------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Bono, Purvanova, Towler, Paterson</td>
<td>2009</td>
<td>A survey of executive coaching practices</td>
</tr>
<tr>
<td>Bowles, Cunningham, De La Rosa, &amp; Picano</td>
<td>2007</td>
<td>Coaching leaders in middle and executive management: Goals, performance, buy-in</td>
</tr>
<tr>
<td>Cohen</td>
<td>2009</td>
<td>Linking coaching to business results</td>
</tr>
<tr>
<td>Franze</td>
<td>2011</td>
<td>Creating a Coaching Culture</td>
</tr>
<tr>
<td>Olivero, Bane, Kopelman</td>
<td>1997</td>
<td>Executive coaching as a transfer of training tool: Effects on productivity in a public agency</td>
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<td>1997</td>
<td>Executive coaching as a transfer of training tool: Effects on productivity in a public agency</td>
</tr>
<tr>
<td>Mentoring Metrics Sources</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dinolfo &amp; Nugent</td>
<td>2010</td>
<td>Making mentoring work</td>
</tr>
<tr>
<td>Eby, Durley, Evans, &amp; Ragins</td>
<td>2006</td>
<td>The relationship between short-term mentoring benefits and long-term mentor outcomes</td>
</tr>
<tr>
<td>Parise &amp; Forret</td>
<td>2008</td>
<td>Formal mentoring programs: The relationship of program design and support to mentors’ perceptions of benefits and costs</td>
</tr>
<tr>
<td>Ragins, Cotton, &amp; Miller</td>
<td>2000</td>
<td>Marginal mentoring: The effects of type of mentor, quality of relationship, and program design on work and career attitudes</td>
</tr>
<tr>
<td>Scandura</td>
<td>1992</td>
<td>Mentorship and career mobility: An empirical investigation</td>
</tr>
<tr>
<td>Viator &amp; Scandura</td>
<td>1991</td>
<td>A study of mentor-protégé relationships in large public accounting firms</td>
</tr>
</tbody>
</table>
For each paper represented in Figure 7 and listed in Table 12, we identified the high quality metric. The next step was to identify what career stage or leadership level the metric was applied to in the article. While not necessarily mentioned in the abstract or introduction, the career stage was frequently referred to when the methodology or data was described. If no career stage or leadership level could be identified, the metric was assigned to an overall category. The metrics in the overall category were not applied across all the stages because that would have obscured those metrics applying only to specific stages. Instead, we listed the metrics which had no career stage identified separately. Figure 8 shows the number of competency attainment metrics or metric sets by career stage and leadership development approach in terms of the Framework diagram. The specific competency attainment metrics by career stage and leadership development approach are listed in Appendix A: High Quality Metrics by Leadership Development Approach and Career Stage. Finally, the chart in Figure 9 shows a graphical summary of the number of metrics collected for each combination of leadership level and career stage.

![Figure 8 Number of Metrics or Metric Sets](image)
From the graphical summary shown in Figure 9, there is a disproportionate amount of coaching metrics. This may be due to a lot of coaching is done by external coaches, who have a greater incentive to show effectiveness, when compared to mentoring, which is typically conducted by internal employees with less incentive to show effectiveness.

In addition, there is a large gap on the measurement of the organizational impact of education, which is our focus, although there has been measurement of other impacts of education. In other words, most studies which measure education do so from the viewpoint of the academic institution, and not from the viewpoint of the organization or enterprise that will hire the person receiving the education.

There is also a gap in metrics found in studies measuring the impact of experience on leadership development, considering the common wisdom of the 70-20-10 model (70% of learning is from on-the-job; 20% from others; 10% from formal development). The gap in metrics found in academic studies measuring the impact of experience on leadership development may mirror the practical world. A recent book (McCauley et al. 2013) supports this: “Experience-driven [leadership] development is less visible. It is hard to quantify.” (p. xxvi). Commenting on the efficacy of a related leadership development technique, job rotations, Dragoni, Tesluk, Russell, and Oh (2009) note that, “Although a few studies have examined the relationship between job assignments and self-reported learning... none have
examined whether developmental job assignments are actually associated with the observable and meaningful development of managerial competencies critical for effective performance” (p. 731).

An alternative way to conceptualize the metrics was proposed by Kirkpatrick (1975, 2006). He identified the first four levels of the diagram below, while Phillips (1996) extended it to include ROI. The Kirkpatrick Model is the first four levels: reaction, learning, behavior, and results. Phillips extended the four levels to include the 5th: ROI. In addition to identifying whether a metric is subjective, i.e. participants’ perception, and objective outcomes, i.e. job or task performance at the individual level, he identified that there were higher levels of analysis in which to observe outcomes: that is, at the departmental, division, or enterprise level.

The Kirkpatrick Model and Phillips extension can be mapped to the Technical Leadership Development Framework as follows. The behavior level, consisting of job-task performance, corresponds to measuring competency attainment, while the learning level corresponds to method validation, which we discuss in Section 8.

![Figure 10 An Alternative Model; Sources: Kirkpatrick (1975), Phillips (1996)](image)

7.2 COMPETENCY HEURISTICS

In addition to the evidence-based metrics described in the foregoing discussion, and to provide additional competency evidence as those metrics continue to be defined and refined, it is also useful to have general heuristic based evidence for competency attainment. We will give several suggestions for such metrics here. The first example involves rotational assignments. Traditionally, these have involved a short-term assignment for familiarization purposes. Thus, a high potential candidate might spend three to six months in a different geographical location, in
Professional certifications and peer recognition are important examples of competency attainment metrics. In some ways, professional certifications integrate the results over several of the leadership development approaches, providing independent and objective measurement of the effectiveness of the individual technical leader’s accomplishment through training and experience. For example, achievement of an independent certification such as the CSEP (INCOSE’s Certified System Engineering Professional), and similar certifications, independently confirms that training received at DAU, education, and on-the-job learning through experience, has resulted in measurable learning. Because Professional Engineer (PE) registration requires successful completion of the Engineer in Training (EIT) and Principles and Practice exams, the PE fulfills a similar role for technical professionals in engineering fields where registration is supported. Other independent affirmations of accomplishment include certain types of honors and awards, notably, elevation to the grade of Associate Fellow or Fellow within a technical professional society; receipt of competitive lectureships and similar awards; and publication in peer-reviewed journals. It should be noted that all these competency attainment metrics primarily relate to the technical side of technical leadership. However, there are also measures that are strictly leadership-based, which include such things as election to office within a professional society, and honors and awards specifically intended to recognize outstanding leadership itself. Care needs to be taken, however, when evaluating the independence and objectivity of some of these, as they are sometimes granted merely on the basis of notoriety, and not on real accomplishment.

As a practical matter, we have recommended in Section 11 a structured competency attainment assessment process based on a 360° feedback mechanism. While we would prefer to be able to recommend statistically rigorous metrics based on previous scholarship, that is simply not possible at this time. The development of such metrics is discussed in Section 12 as potential for further examination.
Prior to this study, no one has ever asked how it is that we know various skill building efforts to be effective. Specifically, research studies have not examined whether a particular leadership development approach is effective. Instead, it is assumed that the leadership development approach is effective, and the study is designed to determine how effective it is. We conducted an extensive search of the available academic and consulting literature, surveying almost 200 articles, from which we were able to extract meaningful data – for our intended purpose – from just a handful. Additionally, as part of our benchmarking surveys (on which we report in Section 10) we interviewed a number of technical leader subject matter experts (SMEs) to elicit their opinions on which methods are likely to be most valuable in certain circumstances. Expert opinion is valuable, but does not serve as a replacement for rigorous experimental analysis. Although both the literature survey and expert interviews provide a start at validating the use of the various methods, neither gives a comprehensive answer. A truly best-in-class development model should tackle this question using more rigorous, statistically sound methods involving human subject studies, as described in Section 12.

Both elements (4) and (5) of the Framework involve performance metrics that measure the efficacy of the Framework, however, they have slightly different orientations.

Element (4) is concerned with how successful an individual technical leader has been in attaining the competencies appropriate to a particular career stage. Element (4) is used to measure success of individual developing leaders through application of the Framework.

Element (5), on the other hand, is concerned with how well the leadership development approach functions. From this perspective, we focus on the use of different methodologies for development, and we ask how effective each method is. We ask how well the different methods perform using either competency attainment metrics or other effectiveness or efficacy measures. Element (5) is used to continuously improve delivery of the development experience.

Thus in Framework element (4) we have sought approaches that are effective in measuring individual accomplishment with regard to each competency, while in element (5), we have reviewed the scholarly literature focused on how well particular methods work.
8.2 SURVEYS LINKING LEADERSHIP DEVELOPMENT APPROACHES WITH COMPETENCIES OR CAREER STAGES

We conducted an extensive literature search (academic articles and industry reports) on leadership development approaches which contained a comment or remark on an evaluation, metric, or benefit of the leadership development approach. Figure 11 summarizes the results of this search, which resulted in identification of 166 articles. Article summaries were then written on about two-thirds of the most relevant articles. Subsequently, we identified which career stage was associated with a particular development technique (which was evaluated). This resulted in 42 sources (with some duplications, as some of the leadership development methods reported on were utilized for multiple career stages, and hence counted multiple times). Figure 12 summarizes this examination.

Our survey of the resulting population of articles shows that there has not been as much previous work on the effectiveness and efficacy of leadership development approaches as one would expect. This is mirrored in actual practice. For example, in a survey conducted by Right Management, (shown in Figure 13 (Cohen, 2009)) 46% of respondents indicated they do not track the effectiveness of coaching. Day (2014) also observes that the evaluation of leadership development often does not occur in practice.

In McCauley and McCall’s book, Using Experience to Develop Leadership Talent (McCauley & McCall, 2014), they also note that the criteria used to evaluate the candidates is less frequently specified than the evaluation of the candidates to being assigned the leadership development approach of experience (p. 9). Day (2014) also comments that the evaluation of leadership development often does not occur in practice. He also notes that “few published studies have
focused on the application of these methods in estimating the behavioral, psychological, or financial effects associated with leadership development initiatives.”

Figure 12 Application of Methods at Each Career Stage

Despite this paucity of study on the effectiveness of the leadership development approach, some early work has been conducted by researchers. The Helix project identifies three “forces” that improve systems engineers’ competencies: experience, mentoring, and education, in that order of importance (Pyster et al. 2014). With respect to experience, they find that 62% of the respondents indicated that breadth of experience is important, which is consistent with other findings that experience is responsible for about 70% of development. They also find that as systems engineers progress from junior to mid-level to senior their number of roles increased, and that the number of lifecycle phases experienced increased. Regarding mentoring, they compare formal and informal mentoring, and identify the following benefits of mentoring to the organization: gain effective knowledge transfer, identify high-potential engineers, reduce orientation time, fill workforce gaps, increase employee retention, and improve organization culture. With respect to education, data was collected by career stage and degree. Their results generally show that higher levels of education are associated with higher career stages. For example, there are more Masters degrees at the mid-level level (73%) than the junior level (56%), and more Doctorates at the senior level (12%) than the mid-level (5%).
In 2014, the Human Capital Institute and the University of North Carolina Kenan-Flagler Business School (2014) surveyed global organizations, in part to identify how different leadership development methods were used to build competencies. They analyzed four groups of competencies (capacity to lead, interpersonal, intrapersonal, and technical; each competency group being comprised of four to eleven competencies) by four different leadership development approaches (on-the-job [i.e. experience], peers, education, and self-work [i.e. self-development]). They found that the competencies of technical expertise, financial literacy, developing others, and effective communication were developed the most through education; maintaining relationships, risk-taking, and business acumen were developed the most through on-the-job experience; and tenacity/resilience, confidence, self-awareness, discipline, optimism, aspiration/ambition, and learning agility were developed the most through self-development.

In their global human resources survey, Sinar, Wellins, Ray, Abel, & Neal (2014) examined the effectiveness of different leadership development approaches at different career stages. They report that the effectiveness of developmental assignments increased as the career stage increased. In contrast, the effectiveness of formal training decreased as the career stage increased. They report mixed results from coaching. Having distinguished among three coaching methods (coaching from current manager, coaching from internal coaches, and coaching from external coaches), they find that coaching from external coaches increased as the career stage increased, while coaching from current manager increased at the middle two levels before decreasing at the final senior level, and coaching from internal coaches decreased at the mid-level, increased at the higher-level, and again decreased at the senior level. In terms of the leadership development approaches’ relative effectiveness, developmental assignments were always rated the most effective at each career stage, followed by formal training, which was followed by the three coaching variants.

8.3 Leadership Development Approaches to Develop Competencies

In order to empirically identify which key competency indicators are developed using which leadership development methods, we developed a survey allowing respondents to indicate, for an early version of the leadership competencies, whether or not that competency is developed using one or more of the leadership development methods, at the junior, mid and senior levels.

The respondents to the survey were largely, but not exclusively, a subset of the interviewees from the Huntsville interviews, with the additional potential respondents being industry contacts made through the Conference on Systems Engineering Research.

The survey results show that, across all three career stages, experience is the leadership technique that was most frequently utilized to develop the leadership competencies.
Among the different career stages, there were slightly different emphases. At the junior stage, the survey results show that experience was the most utilized leadership technique to develop the leadership competencies, followed by corporate training. At the mid-level stage, the survey results also show that experience was the most utilized leadership development technique. After experience, it was a variety of corporate training, job rotation, coaching and mentoring that were used. At the senior career stage, experience was the most utilized leadership development approach, followed by corporate training, job rotation and coaching (with mentoring being used less than those three). At the senior level, systems thinking was the exception, in which education was the most utilized technique, followed by training, experience, and job rotation.

Therefore, from the survey results, we can conclude two things: 1) that the role of experience dominates in developing leadership competencies, and 2) the complete set of leadership development approaches is applicable to developing the set of leadership competencies.
9 APPLYING THE FRAMEWORK: CURRICULUM ASSESSMENT

The Framework is useful in a number of ways, one of which is to provide a structured approach to analyzing the Defense Acquisition University curriculum. In particular, the second Framework element, the key competency indicators, can be used as a basis of comparison to analyze the content in the DAU curriculum. Please note that the focus of this analysis is not on whether a particular person in a technical area has achieved the competency by following the curriculum; rather, the focus is on whether the DAU curriculum has gaps in its offering to the technical acquisition workforce. The reason for this is based on the definition of the task: “conduct a gap analysis comparing DAU’s current technical leadership training with competency requirements.”

9.1 METHOD: CURRICULUM ASSESSMENT AT THE DAU PORTFOLIO LEVEL

The competency-based gap analysis was conducted at two levels: 1) DAU portfolio analysis, and 2) the relevant scope analysis. For the DAU portfolio analysis, all 132 training course descriptions (DAU 2016 Catalog Appendix A) were reviewed, to identify courses relevant to the competencies in nontechnical areas (e.g. ACQ 452, Forging Stakeholder Relationships, ACQ 453, Leader as Coach, ACQ 120 Fundamentals of International Acquisition, etc.).

9.2 DAU PORTFOLIO ANALYSIS RESULTS

The analysis that was done at the DAU portfolio analysis level compared the ratio of engineers to the ratio of engineering courses, i.e. 39,725 engineers in the Acquisition workforce of 152,651 (i.e. 26% of the Acquisition workforce are engineers) to 4 engineering courses in the Acquisition curriculum of 132 courses (i.e. 3% of the courses are engineering). While the question can be asked as to whether this is the right balance, a different question that also sheds light is the throughput ratio, that is, of the total number of engineers, what percentage have completed the courses? As this question was not directly addressing the DAU curriculum gap analysis, resources were spent on the questions that were.

9.3 METHOD: CURRICULUM ASSESSMENT AT THE RELEVANT SCOPE LEVEL

The relevant scope was the technical scope, defined to consist of Engineering; Information Technology; Production, Quality, and Manufacturing; Science & Technology Management, and Test & Evaluation. This resulted in a total of 19 courses, as shown in Table 13.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 101</td>
<td>Fundamentals of Systems Engineering</td>
<td></td>
</tr>
<tr>
<td>ENG 202</td>
<td>Applied Systems Engineering in Defense Acquisition, Part II</td>
<td></td>
</tr>
</tbody>
</table>
In addition, there were a number of courses in the Acquisition area that were deemed to be relevant to be included. These are listed in Table 14.

<table>
<thead>
<tr>
<th>Course Number</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACQ 101</td>
<td>Fundamentals of Systems Acquisition Management</td>
</tr>
<tr>
<td>ACQ 120</td>
<td>Fundamentals of International Acquisition</td>
</tr>
<tr>
<td>ACQ 130</td>
<td>Fundamentals of Technology Security/Transfer</td>
</tr>
<tr>
<td>ACQ 203</td>
<td>Intermediate Systems Acquisition, Part B</td>
</tr>
<tr>
<td>ACQ 315</td>
<td>Understanding Industry (Business Acumen)</td>
</tr>
<tr>
<td>ACQ 340</td>
<td>Advanced International Management Workshop</td>
</tr>
<tr>
<td>ACQ 370</td>
<td>Acquisition Law</td>
</tr>
<tr>
<td>ACQ 450</td>
<td>Leading in the Acquisition Environment</td>
</tr>
<tr>
<td>ACQ 451</td>
<td>Integrated Acquisition for Decision Makers</td>
</tr>
<tr>
<td>ACQ 452</td>
<td>Forging Stakeholder Relationships</td>
</tr>
<tr>
<td>ACQ 453</td>
<td>Leader as Coach</td>
</tr>
</tbody>
</table>

The combination of the courses in the technical scope and the courses in the acquisition scope are defined to be the relevant course scope.

The objectives were examined for all the courses in the relevant course scope, to minimize missing a competency relevant to leadership embedded in a nonleadership course. In addition,
the instructor support package of materials for ENG 301, PQM 301, and TLR 350 were reviewed, because these courses have more content related to the competencies than the others.

To identify the competency gaps between the key competency indicators and the courses, the following four steps were used. First, the relevant objectives from the courses were mapped to the relevant competencies, using both keyword and semantic mapping. Semantic mapping establishes equivalency between two concepts, allowing for synonyms, as well as disallowing the same word with a different meaning. For example, Objective 6 of ENG 301 states, “Given a system development scenario, the student will evaluate strategies to manage program uncertainty through integration of program metrics and technical measurement with program risk management in accordance with Earned Value Management standards, the DoD Risk Management Guide, and the Defense Acquisition Guidebook.” This is a description of technical planning, even though the word is not mentioned. This was confirmed on p. 275 of the ENG 301 Instructor Support Package, “This module is about technical planning, but focuses the part of technical planning that establishes the baselines, measures, and metrics that are used to track progress and manage risk and uncertainty.” Consequently, it was necessary to go beyond keyword mapping to semantic mapping.

When a match was found between a course objective and a competency, the second step was to map the objective to the relevant career stage (junior, mid-level, and senior). This was accomplished by identifying the corresponding verbs between the competency and the DAU course objective, as well as looking at the content of the competency and the objective. In this step, close attention was paid to the verbs in Bloom’s taxonomy, and sometimes a mapping was made between a course objective verb and Bloom’s taxonomy in order to enhance the mapping between the objective and the relevant career stage.

The third step was then to identify which competency item was handled by a course objective. If a competency item was handled by one or more course objectives, this was indicated by a check bullet. If a competency item was not handled by one or more course objectives, this was indicated with an open circle bullet.

The fourth step was to designate the course with an appropriate bullet. This legend is provided in Table 15.

<table>
<thead>
<tr>
<th>Bullet</th>
<th>Course Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Acquisition</td>
</tr>
<tr>
<td>E</td>
<td>Engineering</td>
</tr>
<tr>
<td>I</td>
<td>Information Technology</td>
</tr>
<tr>
<td>P</td>
<td>Production, Quality and Manufacturing</td>
</tr>
<tr>
<td>S</td>
<td>Science &amp; Technology Management</td>
</tr>
<tr>
<td>T</td>
<td>Test and Evaluation</td>
</tr>
<tr>
<td>⇒</td>
<td>Technical Leadership (the arrow designating its cross-area capability)</td>
</tr>
</tbody>
</table>
This four-step methodology resulted in an analysis at four levels. The first level of analysis is the *competency inclusion* level, which identifies whether the overall competency (irrespective of career stage or area) was covered in the relevant scope course curriculum. The second level analysis is the *competency inclusion by area* level, which identifies whether the overall competency was covered in the area (ACQ, ENG, IT, PQM, S&T, T&E). The third level analysis is the *competency inclusion by career stage* level, which identifies whether the competency at a particular career stage was covered in the relevant scope course curriculum. The fourth level analysis is the *competency inclusion by competency item and career stage*, which identifies those detailed items comprising the key competency indicator at a particular career stage are covered in the relevant scope course curriculum. Applying this methodology gave the following results.

### 9.4 Relevant Scope Level Results

#### 9.4.1 Competency Inclusion Analysis Results

The first analysis, the competency inclusion analysis, shows that most of the technical competencies and all of the enabler competencies are covered in one or more of the relevant scope courses.

![Figure 14 Technical Competency Inclusion](image-url)
The detailed list of particular competencies included and not included is provided in the table below.

<table>
<thead>
<tr>
<th>Technical Competencies Included</th>
<th>Technical Competencies Not Included</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical Planning</td>
<td>Logical Decomposition</td>
</tr>
<tr>
<td>Technical Requirements Definition and Analysis</td>
<td>Abstraction</td>
</tr>
<tr>
<td>Product Verification and Validation</td>
<td>Paradoxical thinking</td>
</tr>
<tr>
<td>Product Transition</td>
<td></td>
</tr>
<tr>
<td>Lifecycle</td>
<td></td>
</tr>
<tr>
<td>Risk Assessment</td>
<td></td>
</tr>
<tr>
<td>Systems Thinking</td>
<td></td>
</tr>
<tr>
<td>System Complexity</td>
<td></td>
</tr>
<tr>
<td>Big Picture Thinking</td>
<td></td>
</tr>
</tbody>
</table>

### Table 17 Enabler Competency Inclusion Details

<table>
<thead>
<tr>
<th>Developing People</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leading People</td>
</tr>
<tr>
<td>Thinking Critically</td>
</tr>
<tr>
<td>Attitudes and Attributes</td>
</tr>
<tr>
<td>Communication</td>
</tr>
<tr>
<td>Building Stakeholder Relationships</td>
</tr>
<tr>
<td>Influence</td>
</tr>
<tr>
<td>Vision and Strategy</td>
</tr>
<tr>
<td>Agility</td>
</tr>
<tr>
<td>Technological Innovation</td>
</tr>
</tbody>
</table>

**9.4.2 Competency Inclusion by Area Analysis**

The second analysis, the competency inclusion by area analysis, shows that the Engineering and Information Technology curriculums cover half of the technical competencies, while the Technical Leadership / Pilot covers most of the enabler competencies.
The detailed list of particular competencies included and not included by area is provided in the table below.

### Table 18 Technical Competency Inclusion by Area Details

<table>
<thead>
<tr>
<th>Technical Competency List</th>
<th>ACQ</th>
<th>ENG</th>
<th>IT</th>
<th>PQM</th>
<th>S&amp;T</th>
<th>T&amp;E</th>
<th>TLR/Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Technical Planning</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.2 Technical Requirements Definition and Analysis</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3 Logical Decomposition</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 Product Verification and Validation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.5 Product Transition</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.6 Lifecycle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1.7 Risk Assessment</td>
<td>X</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.8 Systems Thinking</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.9 System Complexity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1.10 Big Picture Thinking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.11 Abstraction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12 Paradoxical Mindset</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 19 Enabler Competency Inclusion by Area Details

<table>
<thead>
<tr>
<th>Enabler Competency List</th>
<th>ACQ</th>
<th>ENG</th>
<th>IT</th>
<th>PQM</th>
<th>S&amp;T</th>
<th>T&amp;E</th>
<th>TLR/Pilot</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Developing People</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2 Leading leaders</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3 Critical and analytical thinking</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4 Attitudes and Attributes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5 Communication</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6 Building Stakeholder Relationships</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.7 Influence</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.8 Vision and Strategy</td>
<td></td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.9 Agility</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.10 Technological Innovation</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9.4.3 **COMPETENCY INCLUSION BY CAREER STAGE ANALYSIS**

The third analysis, the competency inclusion by career stage analysis, shows that substantially more of the competencies, both technical and enabler, are included in the curriculum at the junior and mid-levels than the senior level.

This is an expected result, that is, it is expected that junior and mid-level key competency indicators are acquired more through training and senior level key competency indicators are acquired more through other leadership development techniques, such as experience.
Figure 19 Enabler Competency Inclusion by Career Stage

Table 20 Technical Competency Inclusion by Career Stage Details

<table>
<thead>
<tr>
<th>Technical Competency List</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Technical Planning</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.2 Technical Requirements Definition and Analysis</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.3 Logical Decomposition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4 Product Verification and Validation</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.5 Product Transition</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.6 Lifecycle</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.7 Risk Assessment</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.8 Systems Thinking</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.9 System Complexity</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>1.10 Big Picture Thinking</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>1.11 Abstraction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.12 Paradoxical Mindset</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 21 Enabler Competency Inclusion by Career Stage Details

<table>
<thead>
<tr>
<th>Enabler Competency List</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Developing People</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.2 Leading leaders</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.3 Critical and analytical thinking</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.4 Attitudes and Attributes</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>2.5 Communication</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.6 Building Stakeholder Relationships</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>2.7 Influence</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.8 Vision and Strategy</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>2.9 Agility</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.10 Technogical Innovation</td>
<td></td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
9.4.4 Competency Inclusion by Competency Item and Career Stage Analysis

The fourth analysis, the competency inclusion by competency item and career stage analysis, shows that many competency items are not addressed in the technical competencies or the enabler competencies.

Table 22 Technical Competency Inclusion by Competency Item and Career Stage Details

<table>
<thead>
<tr>
<th>Technical Competency List</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Technical Planning</td>
<td>1/2</td>
<td>1/3</td>
<td>0/3</td>
</tr>
<tr>
<td>1.2 Technical Requirements Definition and Analysis</td>
<td>3/4</td>
<td>1/4</td>
<td>0/5</td>
</tr>
<tr>
<td>1.3 Logical Decomposition</td>
<td>0/3</td>
<td>0/3</td>
<td>0/4</td>
</tr>
<tr>
<td>1.4 Product Verification and Validation</td>
<td>2/2</td>
<td>1/1</td>
<td>0/4</td>
</tr>
<tr>
<td>1.5 Product Transition</td>
<td>0/3</td>
<td>1/2</td>
<td>0/5</td>
</tr>
<tr>
<td>1.6 Lifecycle</td>
<td>1/2</td>
<td>0/1</td>
<td>0/3</td>
</tr>
<tr>
<td>1.7 Risk Assessment</td>
<td>3/4</td>
<td>2/4</td>
<td>0/6</td>
</tr>
<tr>
<td>1.8 Systems Thinking</td>
<td>0/4</td>
<td>0/4</td>
<td>0/4</td>
</tr>
<tr>
<td>1.9 System Complexity</td>
<td>1/2</td>
<td>2/2</td>
<td>0/3</td>
</tr>
<tr>
<td>1.10 Big Picture Thinking</td>
<td>0/3</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>1.11 Abstraction</td>
<td>0/2</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>1.12 Paradoxical Mindset</td>
<td>0/1</td>
<td>0/1</td>
<td>0/2</td>
</tr>
</tbody>
</table>

Figure 20 Technical Competency Inclusion by Competency Item and Career Stage Heat Map
### Table 23 Enabler Competency Inclusion by Competency Item and Career Stage Details

<table>
<thead>
<tr>
<th>Enabler Competency List</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1 Developing People</td>
<td>1/3</td>
<td>1/4</td>
<td>0/3</td>
</tr>
<tr>
<td>2.2 Leading leaders</td>
<td>1/3</td>
<td>1/5</td>
<td>0/3</td>
</tr>
<tr>
<td>2.3 Critical and analytical thinking</td>
<td>0/3</td>
<td>1/4</td>
<td>0/3</td>
</tr>
<tr>
<td>2.4 Attitudes and Attributes</td>
<td>0/2</td>
<td>1/2</td>
<td>0/2</td>
</tr>
<tr>
<td>2.5 Communication</td>
<td>0/2</td>
<td>1/2</td>
<td>0/2</td>
</tr>
<tr>
<td>2.6 Building Stakeholder Relationships</td>
<td>1/3</td>
<td>1/4</td>
<td>0/2</td>
</tr>
<tr>
<td>2.7 Influence</td>
<td>0/1</td>
<td>0/2</td>
<td>0/1</td>
</tr>
<tr>
<td>2.8 Vision and Strategy</td>
<td>0/3</td>
<td>1/2</td>
<td>0/2</td>
</tr>
<tr>
<td>2.9 Agility</td>
<td>1/2</td>
<td>0/1</td>
<td>0/2</td>
</tr>
<tr>
<td>2.10 Technogical Innovation</td>
<td>0/4</td>
<td>1/2</td>
<td>1/3</td>
</tr>
</tbody>
</table>

![Figure 21: Enabler Competency Inclusion by Competency Item and Career Stage Details Heat Map](image)

### 9.5 Method: Core and Core Plus Analysis

It is also possible to incorporate another aspect to the gap analysis. Specifically, the DAU courses offered are part of the DAWIA certification. In the DAWIA certification, a particular course receives a designation of Core (which means that it is required for certification) or Core Plus (which means that it is not required for certification). The challenge is that occasionally, one course may have two designations. For example, Science & Technology (STM) 304 is required for Science & Technology Level III certification (and therefore designated Core there), but it is only recommended and not required for Engineering Level III certification (and therefore designated Core Plus there). For simplicity, when this occurs, we will take its primary focus, and use that to treat its status. All courses which are Core Plus and are never Core in any of the five technical fields in scope (Engineering, Information Technology, Production Quality and Manufacturing, Science and Technology, and Test and Evaluation) have a designation of “(Core Plus)” listed after the objective in the detailed table that follows. All courses which are Core in their primary field receive no designation, because most of the courses are Core
courses, and it is redundant to keep listing “(Core)” after ENG 301 in all the objectives that it is found.

The section that follows contains the detailed competency and objective mapping.
### Table 24 Curriculum Assessment Details for Technical Competencies

<table>
<thead>
<tr>
<th>Competency Class 1: Technical Leadership Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Junior</strong></td>
</tr>
<tr>
<td>1.1 Technical Planning</td>
</tr>
<tr>
<td>✓ Understands system-level technical plans;</td>
</tr>
<tr>
<td>○ Develops technical plan for a specialized item;</td>
</tr>
<tr>
<td>○ Relays convincing, clear and relevant information from the specialized item technical plan to mid-level leaders.</td>
</tr>
<tr>
<td><strong>Career Stage</strong></td>
</tr>
<tr>
<td><strong>Mid-Level</strong></td>
</tr>
<tr>
<td>✓ Understands system of systems technical plans</td>
</tr>
<tr>
<td>○ Develops and details out the technical plan for a system to fit into the overall technical plan for a large (or complex system) or system of systems;</td>
</tr>
<tr>
<td>○ Reviews technical plans for specialized items developed by junior-level leaders;</td>
</tr>
<tr>
<td>○ Relays convincing, clear and, relevant information from the system-level technical plan to senior-level leaders;</td>
</tr>
<tr>
<td>○ Provides clear direction from the system-level technical plans down the hierarchical levels to junior-level leaders;</td>
</tr>
<tr>
<td>○ Coordinates the system-level technical plan and obtains consensus among peer internal suborganizations (both technical and non-technical);</td>
</tr>
<tr>
<td><strong>Senior</strong></td>
</tr>
<tr>
<td>○ Develops overall technical plans, for a large (or complex) system, or system of systems, that:</td>
</tr>
<tr>
<td>○ Support the strategy, vision, mission and long range goals (which recognize needs) of the organization or enterprise;</td>
</tr>
<tr>
<td>○ Provide direction to mid-level leaders;</td>
</tr>
<tr>
<td>○ Are consistent with plans and objectives of peer organizations, both technical and non-technical;</td>
</tr>
<tr>
<td>○ Reflect the technical impact of the superior organization's strategies and missions.</td>
</tr>
<tr>
<td>○ Guides and directs mid-level leaders to detail out the overall technical plan for a large (or complex) system into the appropriate detailed plans;</td>
</tr>
<tr>
<td>○ Reviews and approves technical plans for a product or a system developed by subordinate suborganizations;</td>
</tr>
<tr>
<td>○ Represents and communicates the overall technical plan in the larger technical and non-technical community;</td>
</tr>
<tr>
<td>○ Relays convincing, clear and, relevant information from technical planning up the hierarchical levels in the enterprise;</td>
</tr>
</tbody>
</table>
### 1.1 Technical Planning in Relevant Scope Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 101 Obj 14</td>
<td>“Describe the function of the Technical Planning process as part of the Systems Engineering Process.”</td>
</tr>
<tr>
<td>ENG 301 Obj 1.06</td>
<td>“Describe an example how a Systems Engineering Plan is used to manage program technical activities.” MC, AC, MA</td>
</tr>
<tr>
<td>ENG 301 Obj 6.08</td>
<td>“From engineering leadership perspective, describe the relationship of a system’s architecture to the planning and management of technical projects.” PE</td>
</tr>
<tr>
<td>SYS 202 Obj 1.06</td>
<td>“Identify principal documents used in Technical Planning.”</td>
</tr>
</tbody>
</table>

- Provides clear direction from the technical plans down the hierarchical levels to subordinate suborganizations and their leaders;
- Coordinates the technical plan and obtains consensus among peer internal suborganizations (both technical and non-technical);
- Communicates clear, relevant technical plan information to external organizations, including partners in other agencies, industry, academia and perhaps internationally.

E ENG 301 Obj 6: “Given a system development scenario, the student will evaluate strategies to manage program uncertainty through integration of program metrics and technical measurement with program risk management in accordance with Earned Value Management standards, the DoD Risk Management Guide, and the Defense Acquisition Guidebook.” “This module is about technical planning, but focuses the part of technical planning that establishes the baselines, measures, and metrics that are used to track progress and manage risk and uncertainty [p. 275].”

E ENG 301 Obj 11.01 “Recognize the role of systems engineering in establishing a cost, schedule, and performance baselines for a given project.” MC, AC, MA
### 1.2 Technical Requirements Definition and Analysis

**STM 304 Obj 3.01:** “Outline the purposes of technology roadmapping.”

**STM 304 Obj 3.02:** “Compare the types and steps of technology roadmapping.”

**STM 304 Obj 3.03:** “Analyze the best practices of technology roadmapping.”

Comment: a technology roadmap is a system of systems.

<table>
<thead>
<tr>
<th>✓ Understands requirements at the system level</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Provides input to requirements at the system level under the coaching and direction of mid-level leaders</td>
</tr>
</tbody>
</table>

| ✓ Analyzes requirements documents |

| ✓ Writes a technical requirement at the component level under the coaching and direction of mid-level leaders |

| o Verifies and reviews component-level requirements, and integrates them into system-level requirements |
| o Defines and negotiates technical requirements at the system level, under the coaching of senior-level leaders; |
| o Transforms stakeholders’ inputs into system requirements, translates potentially non-technical requirements into technical language, and evaluates their subsequent development into lower level requirements and specifications under the coaching and direction of senior-level leaders; |
| o Provides input to requirements at the system of systems level to senior-level leaders |

| o Defines technical requirements at the system of systems level |
| o Makes decisions regarding the requirements definition and analysis process |
| o Makes strategic, technical decisions |
| o Makes a global change to existing, defined requirements |
| o Verifies and reviews system-level requirements |
| o Understands stakeholder’s role in setting requirements, and balances needs of a broad range of stakeholders at all levels and the essential (and necessary) inconsistency in the requirements they express; |
| o Negotiates technical requirements with stakeholders; |
| o Coaches mid-level leaders in gathering and negotiating technical requirements with stakeholders; |
| o Provides clear explanations regarding inconsistencies; |
| o Coaches mid-level leaders in transforming stakeholder inputs into system requirements |
requirements, in translating potentially non-technical requirements into technical language, and in evaluating their subsequent development into lower level requirements and specifications;

- Understands and balances the hierarchical importance of requirements, i.e., key performance parameters (KPPs), with top-level goals, both functional and non-functional;
- Enforces discipline in managing and documenting the immediate and cascading impact to requirements, particularly at the system level.

### 1.2 Technical Requirements Definition and Analysis in Relevant Scope Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 101</td>
<td><strong>Obj 6:</strong> Describe the function of the Stakeholder Requirements Definition process as part of the Systems Engineering Process.</td>
</tr>
<tr>
<td></td>
<td><strong>Obj 6.01:</strong> Describe the purpose, inputs and outputs, and activities of the Stakeholder Requirements Definition Process.</td>
</tr>
<tr>
<td></td>
<td><strong>Obj 6.02:</strong> Explain the difference between various types of requirements.</td>
</tr>
<tr>
<td>ENG 101</td>
<td><strong>Obj 7:</strong> Describe the function of the Requirements Analysis process as part of the Systems Engineering Process.</td>
</tr>
<tr>
<td></td>
<td><strong>Obj 7.01:</strong> Describe the purpose, inputs and outputs, and activities of the Requirements Analysis Process.</td>
</tr>
<tr>
<td></td>
<td><strong>Obj 7.02:</strong> Outline the relationship of the Requirements Analysis process.</td>
</tr>
<tr>
<td>ENG 301</td>
<td><strong>Obj 12:</strong> Given a system development scenario, the student will evaluate strategies for integrating engineering risk reduction activities with requirements development and systems engineering affordability trade-off activities in Technology Maturation and Risk Reduction. CS, PE</td>
</tr>
<tr>
<td>ISA 320</td>
<td><strong>Obj 6:</strong> Given a scenario, determine if the proposed software requirements management methodology will achieve a favourable acquisition outcome.</td>
</tr>
<tr>
<td>Process to the Stakeholder Requirements Definition and Architecture Design Technical Processes.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td></td>
</tr>
<tr>
<td><strong>E</strong> ENG 101 Obj 15: “Describe the function of the Requirements Management process as part of the Systems Engineering Process.”</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong> PQM 301 Lesson 2: Requirements Analysis defined (p. 6).</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong> PQM 301 Obj 8: “Given lecture, lesson materials, classroom discussions and an exercise students will be able to demonstrate the relationship of customer requirements to engineering activities using Quality Function Deployment (QFD).”</td>
<td></td>
</tr>
<tr>
<td><strong>P</strong> PQM 301 Obj 8.02: “Develop the Requirements Matrix (House of Quality) for an assigned product.”</td>
<td></td>
</tr>
<tr>
<td><strong>S</strong> STM 304 Obj: “Explore translating S&amp;T capability requirements into development plans and actionable steps.”</td>
<td></td>
</tr>
<tr>
<td>⇒ SYS 350A Obj (Slide Deck #2): “Identifying technical and non-technical requirements and constraints.”</td>
<td></td>
</tr>
</tbody>
</table>

### 1.3 Logical Decomposition

- Understands a decomposition
  - Performs a logical decomposition at the component or product level, under the guidance and direction of mid-level leaders;
  - Provides input to logical decomposition at the system level level;
- Performs a logical decomposition at the system level, under the guidance and direction of senior level leaders;
  - Provides input to logical decomposition at the system of systems level;
  - Guides, directs, reviews and approves component-level decompositions developed by junior leaders, and integrates them into system-level logical decompositions;
  - Provides input to strategies for system decomposition to senior level leaders.
- Decomposes or segments system of systems (including large distributed system-of-systems of national importance) so that:
  - the resulting decomposition is technically suited to ensure success of the system design and development; and
  - the resulting decomposition takes into account of the resources, capabilities and workload of the executing organization(s);
  - Guides, directs, reviews and approves system decompositions developed by mid-level leaders, and integrates them into system of systems logical decompositions;
<table>
<thead>
<tr>
<th>1.3 <em>Logical Decomposition in Relevant Scope Courses</em></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ENG 301 Module 3 Architecture:</strong> mentions decomposition (p. 145 / Module 3, p. 10).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.4 <em>Product Verification and Validation</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Understands product verification and validation, and associated requirement flow-down;</td>
</tr>
<tr>
<td>✓ Identifies from the verification and validation whether the original requirements were met, under the guidance and direction of mid-level leaders;</td>
</tr>
<tr>
<td>✓ Conducts verification and validation at the <strong>system level</strong>, and end user verification and validation, under the guidance and direction of senior-level leaders;</td>
</tr>
<tr>
<td>o Guides, directs, reviews and approves verification and validation at the component level by junior leaders;</td>
</tr>
<tr>
<td>o Understands the difference between building the thing right, and building the right thing;</td>
</tr>
<tr>
<td>o Understands that verification and validation is not just something that comes into play at the developmental and operational test phases of a program, but that it is part of every step in the system lifecycle;</td>
</tr>
<tr>
<td>o Coaches peers on the understanding and associated implications that product verification and validation is a part of every step in the system lifecycle;</td>
</tr>
<tr>
<td>o Understands that allocating resources to verification and validation is a powerful tool for reducing lifecycle cost, and budgets accordingly;</td>
</tr>
<tr>
<td>o Coaches mid-level leaders in understanding the difference between building the thing right, and building the right thing;</td>
</tr>
<tr>
<td>o Enforces process discipline and accountability among subordinate suborganizations with regard to verification and validation policy and practice;</td>
</tr>
</tbody>
</table>
Advocates strongly for verification and validation with superiors, and if in a programmatic role, strongly supports verification and validation budgets even if this has a negative impact on other aspects of the program, including potential loss of control by the leader over the formal test of the program.

1.4 Product Verification and Validation in Relevant Scope Courses

- **ENG 101 Obj 11:** “Describe the function of the Verification process as part of the Systems Engineering Process.”
- **ENG 101 Obj 12:** “Describe the function of the Validation process as part of the Systems Engineering Process.”
- **ISA 101 Obj 14:** “Given an information technology system, students will apply system and software Quality, Verification and Validation (V&V), and Test and Evaluation (T&E) principles, processes, methods, and tools to produce, test, verify, and validate the system’s technical, functional, and performance characteristics (including interoperability).
- **PQM 301 Lesson 2:** Verification and validation defined (p. 12 and 13).
- **STM 101 Obj 5.04:** “Describe the use of verification and validation.”
- **ENG 301 Obj 5.08:** “Based on early systems engineering assessment of technical risk, develop a system verification approach for the next acquisition phase.” CS, PE
- **ENG 301 Obj 18.08:** “Recognize the applicability and relative effectiveness of software verification methods and techniques.” MC, AC, MA
- **ENG 301 Obj 22.09:** “Develop a tailored system verification approach to support a rapid acquisition program.” CS, PE
- **ISA 201 Obj 14:** “Given an information technology system, students will apply system and software Quality, Verification and Validation (V&V), and Test and Evaluation (T&E) principles, processes, methods, and tools to produce, test, verify, and validate the system’s technical, functional, and performance characteristics (including interoperability).
- **⇒ SYS 350A Obj (Slide Deck #2):** “Ensure that the solutions developed by their teams work as intended, that they meet
<table>
<thead>
<tr>
<th>1.5 <strong>Product Transition</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>o Transitions individual products or components, under the guidance and direction of senior-level leaders;</td>
<td>o Transitions a few technical products (or a system) with full understanding by the receiving organization, under the guidance and direction of senior-level leaders;</td>
</tr>
<tr>
<td>o Documents the product transition;</td>
<td>o Understands the transition process, effectively accepts incoming work, and provides high quality technical products for transition outside the organization, under the coaching, guidance and direction of senior-level leaders;</td>
</tr>
<tr>
<td>o Learns process discipline and accountability enforced by mid-level leaders;</td>
<td>o Adheres to process discipline and accountability enforced by senior-level leaders, with regard to product transition policy and practice, and enforces this among junior level leaders;</td>
</tr>
<tr>
<td></td>
<td>o Learns to communicate effectively how to operate and maintain the technical product to technical and nontechnical people;</td>
</tr>
<tr>
<td></td>
<td>o Supports senior level leaders as they transition the product to the external client.</td>
</tr>
<tr>
<td></td>
<td>o Coordinates all aspects of transition requirements for:</td>
</tr>
<tr>
<td></td>
<td>o Operations</td>
</tr>
<tr>
<td></td>
<td>o Maintenance</td>
</tr>
<tr>
<td></td>
<td>o Fields the transition by handling different users, dealing with multiple agencies and multiple services;</td>
</tr>
<tr>
<td></td>
<td>o Coaches mid-level leaders to ensure that technical products are transitioned with full understanding by the receiving organization;</td>
</tr>
<tr>
<td></td>
<td>o Effectively coaches mid-level leaders in their understanding of the transition process, and ensures that they are prepared to effectively accept incoming work, and provide high quality technical products for transition outside the organization;</td>
</tr>
<tr>
<td></td>
<td>o Enforces process discipline and accountability among subordinate suborganizations with regard to product transition policy and practice;</td>
</tr>
<tr>
<td></td>
<td>o Provides input to enhance product transition policy and procedures to superiors;</td>
</tr>
<tr>
<td></td>
<td>o Communicates effectively how to operate and maintain the technical product to technical and nontechnical people;</td>
</tr>
</tbody>
</table>
1.5 Product Transition in Relevant Scope Courses

- **E** ENG 101 Obj 13: “Describe the function of the Transition process as part of the Systems Engineering Process.”
- **E** ISA 101 Obj 18.02: “For an existing IT/SIS, recognize critical success factors for software transition.”
- **P** PQM 301 Lesson 2: Transition defined (p. 14).
- **S** STM 101 Obj 3: “Describe the factors that facilitate successful technology transition.”
- **S** STM 304 Obj: “Outline the important distinction between push and pull technologies in technology transition.”
- **E** ISA 201 Obj 18.02: “For an existing IT/SIS, recognize critical success factors for software transition.”
- **S** STM 203 Obj 3: “Upon completion of this lesson, the student will be able to evaluate progress, identify and plan for changing requirements and execute the technical and business elements to successfully complete transition of an advanced development technology project to an acquisition Program of Record.”
- **S** STM 203 Obj 4: “Students will be able to analyse key issues related to transitioning technology to acquisition programs, evaluate alternative methods to address these issues and recommend steps that will lead to success.”

1.6 Lifecycle

- **✓** Understands the lifecycle
  - Manages products and systems at the appropriate stage in the lifecycle, under the coaching and direction of senior level leaders;
  - Understands the lifecycle and learns to identify whether work is complete or not;
  - Begins to develop collaborative relationships with peer junior level leaders “upstream” and “downstream;”
  - Learns to understand the relationships and impacts of decisions from definition
- **✓** Manages a technical system of system at the appropriate stage in the lifecycle, and coaches mid-level leaders to manage products and systems at the appropriate stage in the lifecycle;
- **✓** Ensures entrance criteria are met for the next phase in the lifecycle;
- **✓** Sets the criteria by which the technical product may be evaluated (and therefore pass from one stage to the next), striking an appropriate balance among product quality, product risk, and product cost and schedule;
- **✓** Understands the lifecycle process, and is
to retirement to disposal under the coaching from mid level leaders;
  o Learns to understand the interdependencies of different stages of the product lifecycle on the quality of the final product under the coaching of mid level leaders;
  o Prepared to effectively accept incoming work, and provide high quality technical plans and activities to the next stage in the lifecycle, under the coaching, guidance and direction of senior level leaders;
  o Learns to understand the relationships and impacts of decisions from definition to retirement to disposal under the coaching from senior level leaders;
  o Learns to understand the condition of all technical products moving from one stage to another, including full knowledge of any unfinished technical work;
  o Begins to develop collaborative relationships with peer mid level leaders “upstream” and “downstream;”
  o Learns to view the temporal dimension of a problem under consideration;
  o Understands the interdependencies of different stages of the product lifecycle on the quality of the final product under the coaching of senior leaders;
  o Learns to effectively negotiate product movement through the lifecycle, resulting in a win for both the acquiring and transitioning organizations, under the coaching of senior level leaders;
  o Learns to avoid the temptation to take advantage of the other party, whether by passing a poorly performing product down the line, or by attributing product shortfalls to the organization making the handoff, even when the product is technically sound, under the coaching of schedule;
  o Coaches mid-level leaders in their understanding of the lifecycle process, and ensures that they are prepared to effectively accept incoming work, and provide high quality technical plans and activities to the next stage in the lifecycle;
  o Understands and coaches mid-level leaders to understand the relationships and impacts of decisions from definition to retirement to disposal;
  o Understands the condition of all technical products moving from one stage to another, including full knowledge of any unfinished technical work;
  o Maintains strong collaborative relationships with peer senior level leaders “upstream” and “downstream;”
  o Provides input to enhance lifecycle policy and procedures to executive-level leaders;
  o Views the temporal dimension of a problem under consideration;
  o Coaches mid-level to understand the interdependencies of different stages of the product lifecycle on the quality of the final product;
  o Effectively negotiates product movement through the lifecycle, resulting in a win for both the acquiring and transitioning organizations;
  o Avoids the temptation to take advantage of the other party, whether by passing a poorly performing product down the line, or by attributing product shortfalls to the
### 1.6 Lifecycle in Relevant Scope Courses

<table>
<thead>
<tr>
<th>E ISA 101 Obj 3: “Given a scenario, evaluate an acquisition lifecycle plan for a software-reliant system.”</th>
<th>E ISA 201 Obj 3: “Given a scenario, evaluate an acquisition lifecycle plan for a software-reliant system.”</th>
<th>E ISA 320 Obj 13: “Utilizing problem solving, critical thinking and negotiation principles discussed in class, propose a team solution to a life-cycle management dilemma in a given IT acquisition.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>E ISA 101 Obj 18.01: “Identify the important software life cycle planning documents and their major components.”</td>
<td>E ISA 201 Obj 18.01: “Identify the important software life cycle planning documents and their major components.”</td>
<td>---</td>
</tr>
<tr>
<td>P PQM 301 Obj 2.01: “Describe the inputs and outputs of the Systems Engineering Process [lifecycle – see Lesson 2] for each Milestone decision and Acquisition Lifecycle phase.”</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

### 1.7 Risk Assessment

- **Understands** risk assessment;
- **Identifies** risks, under the coaching from mid-level leaders;
  - Communicates identified risks to mid-level leaders;
- **Quantifies** technical risks and develops appropriate risk mitigation strategies under the coaching of senior level leaders;
  - Assesses the cost to reduce or mitigate risks;
  - Communicates quantified risk results and costs to reduce risk to senior level leaders;
- Coaches mid-level leaders to quantify technical risks and to develop appropriate risk mitigation strategies;
- Accepts or recommends acceptance of any residual risk;
- Understands organizational risk tolerance and appropriately mitigates to acceptable levels;
- Mentors mid-level leaders, both probing them on their own assessments of risk, and providing them with “top cover” allowing them to be comfortable with their own risk taking;
- Effectively articulates and communicates

---

senior level leaders.

organization making the handoff, even when the product is technically sound.
1.7 Risk Assessment in Relevant Scope Courses

E ENG 101 Obj 17: “Describe the function of the Risk Management process as part of the Systems Engineering Process.”

E ENG 201 Obj 8: “Given DoD technical risk management problem solving scenarios, provide rationale for the selection and defense of a best solution using the guidance provided in the DoD 5000 series documents, DAG, and DoD Risk Management Guide.”

E ENG 301 Obj 11.03: “Identify sources of program technical risks.” PE

E ENG 301 Obj 18.09: “Summarize common sources of risk associated with development of software intensive systems.” MC, AC, MA

E ENG 301 Obj 22.06: “Evaluate [i.e. identify] a rapid acquisition course of action for sources of technical risk.” CS, PE

E ENG 301 Obj 25.04: “Identify sources of technical risk associated with the

E ENG 201 Obj 3: “Apply the processes for SE Design, Configuration Management, Performance Specifications development, and Statement of Work development in a given DoD acquisition scenario to reduce technical risk.”

E ENG 301 Obj 5 / Module 5: “Given a capability development scenario, the student will analyze a capability need and develop a systems engineering risk assessment to support early acquisition life cycle development planning.” CS, PE

E ENG 301 Module 7: “Describe CPI, TSN, and cybersecurity risk assessment concepts.” [p. 325]

E ENG 301 Module 8: “Given a system development scenario and system architectural description, the student will develop appropriate system security risk mitigations (system security features), in accordance with the Defense Acquisition Guidebook and concepts discussed in
preferred alternative.”

**PE ISA 101 Obj 9:** “Given a Department of Defense (DoD) Information Technology (IT) acquisition scenario, the learner will develop risk mitigation approaches in support of the government’s evaluation and management of the given IT acquisition.”

**P PQM 301 Lesson 13 Obj 3:** “Identify and discuss methods, tools and techniques used to manage and mitigate ESOH [Environment, Safety, Occupational Health] risks.”

**E ISA 201 Obj 9:** “Given a Department of Defense (DoD) Information Technology (IT) acquisition scenario, the learner will develop risk mitigation approaches in support of the government’s evaluation and management of the given IT acquisition.”

**E ISA 320 Obj 12:** “Given a scenario, determine if the proposed method to manage software development risk will achieve a favourable acquisition outcome.”

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>o Learns to focus on and understand the connections and interfaces among the subsystems in the system, under the coaching from mid level leaders;</td>
<td>o Learns to seek out holistic explanations, descriptions, and relationships when examining technical problems;</td>
<td>o Seeks out holistic explanations, descriptions, and relationships when examining technical problems;</td>
</tr>
<tr>
<td>o Learns to consider the product or component, its place in the system, and the interfaces between components, under the coaching and direction from mid level leaders;</td>
<td>o Learns to focus on and understand the connections and interfaces among the subsystems in the system, under the coaching from senior level leaders;</td>
<td>o Focuses on connections and interfaces among the subsystems in the system;</td>
</tr>
<tr>
<td>o o Learns to consider the system, its place in the system of systems, and the connection and interfaces between components, under the coaching and direction from senior level leaders;</td>
<td>o Envisions and articulates system relationships among existing systems, and extrapolates individual system characteristics into attributes of a system of systems;</td>
<td>o Envisions and articulates system relationships among existing systems, and extrapolates individual system characteristics into attributes of a system of systems;</td>
</tr>
<tr>
<td>o o o o o o Learns to focus on and understand the connections and interfaces among the subsystems in the system, under the coaching from senior level leaders;</td>
<td>o Informs mid-level leaders, executive-level leaders, peers, and stakeholders, where the structural connections in a system can be found, and coaches them on how to do the same;</td>
<td>o Informs mid-level leaders, executive-level leaders, peers, and stakeholders, where the structural connections in a system can be found, and coaches them on how to do the same;</td>
</tr>
<tr>
<td>o o o o o o Provides guidance to mid-level leaders as they design and develop technical products to consider the system, its place in the system of systems, and the</td>
<td>o Provides guidance to mid-level leaders as they design and develop technical products to consider the system, its place in the system of systems, and the</td>
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</tr>
</tbody>
</table>
connections and interfaces between components;
- Provides advice and guidance to executive-level leaders as they develop effective organizational strategies and support of organizational missions based on systems thinking.

<table>
<thead>
<tr>
<th>1.8 Systems Thinking in Relevant Scope Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E</strong> ENG 301 Objectives 3.03: “Relate the principles of systems thinking to systems engineering leadership.” MC, AC, MA (to simulation, action-based learning)</td>
</tr>
<tr>
<td>⇒ SYS 350A Pilot Jan 2015: “Applied Systems Thinking” (Core Plus)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1.9 System Complexity</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Understands the complexity of a product, component, assembly, or system under the coaching of mid-level leaders;</td>
</tr>
<tr>
<td>- Understands system complexity, and the resulting impact on system design and architecture decisions, under the coaching of senior level leaders;</td>
</tr>
<tr>
<td>- Coaches junior level leaders to understand product and system complexity</td>
</tr>
<tr>
<td>- Ensures (through coaching and mentoring) that junior level leaders are trained to recognize product designs that have the potential for emergent behavior, and take steps to mitigate that potential through thoughtful design strategies;</td>
</tr>
<tr>
<td>- Coaches mid-level leaders to understand system complexity, and the resulting impact on system design and architecture decisions;</td>
</tr>
<tr>
<td>- Recognizes the impact that system interdependence, data flows among systems, and the virtually infinite number of potential system states have on the design, development, test, and operation of complex systems;</td>
</tr>
<tr>
<td>- Ensures (through coaching and mentoring) that mid-level leaders take system complexity into account, are trained to recognize system designs that have the potential for emergent behavior, and take</td>
</tr>
</tbody>
</table>
steps to mitigate that potential through thoughtful design strategies;
- Ensures that superiors, both technical and non-technical, are cognizant of the special risks associated with the highly distributed and digitally rich systems, particularly when they are embedded in a complex socio-technical environment, and are supportive of efforts to provide for mitigation of potential emergent behavior of a negative type;
- Leads by example in learning the rapidly changing science of complexity.

1.9 System Complexity in Relevant Scope Courses

<table>
<thead>
<tr>
<th>Course</th>
<th>Module</th>
<th>Slide</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 301</td>
<td>Module 3</td>
<td>5</td>
<td>Complexity defined.</td>
</tr>
<tr>
<td>SYS 350A Pilot Jan 2015 / SYS 350A Syllabus May 2015</td>
<td>“Complexity;” “Case Study: Project/Program Complexity: Identify issues which make projects and programs complex.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYS 350A Obj Slide Deck #2</td>
<td>“Help teams solve technical problems holistically.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYS 350A Obj Slide Deck #16</td>
<td>“Distinguish between complicated and complex;” “Provide an understanding of how complex systems behave.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLR 350 Obj / SYS 350A Syllabus May 2015</td>
<td>“Diagram a complex system.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLR 350 Obj / SYS 350A Syllabus May 2015</td>
<td>“Identify issues that need to be addressed in a complex system.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TLR 350 Obj / SYS 350A Syllabus May 2015</td>
<td>“Explain challenges produced by complex systems.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYS 350A Syllabus May 2015</td>
<td>“Infer what actions can be taken to clarify system problems.” (Core Plus)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SYS 350A Syllabus May 2015</td>
<td>“Evaluate complex systems diagrams to identify the issues that need to be overcome.”</td>
<td></td>
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</tr>
<tr>
<td>TLR 350 Obj / SYS 350A Syllabus May 2015</td>
<td>“Recommend leadership approaches to address challenges of complex systems.”</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
(Core Plus)  
⇒ TLR 350 Obj: “Identify approaches that can be used by leadership to minimize complexity.” (Core Plus)  
⇒ SYS 35A Obj Slide Deck #18: “Provide a framework for assessing program complexity.” Case study with Alaska Pipeline. (Core Plus)  

<table>
<thead>
<tr>
<th>1.10 Big Picture Thinking</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Understands how the product or component fits into the system (e.g. how the valve fits in the engine), along with its budgetary, political, mission and support aspects, at the mid-level context.</td>
</tr>
<tr>
<td>o Identifies the overall context of the immediate product.</td>
</tr>
<tr>
<td>o Focuses on external connections rather than internal structure in a product</td>
</tr>
<tr>
<td>o Understands how the system fits into the system of systems (e.g. how the engine fits in the vehicle), along with its budgetary, political, mission and support aspects, at the senior level context.</td>
</tr>
<tr>
<td>o Identifies the overall context of the immediate system.</td>
</tr>
<tr>
<td>o Focuses on external connections rather than internal structure in a system, and coaches junior level leaders on how to do so in a product.</td>
</tr>
<tr>
<td>o Relays the context of why a decision was made a particular way to junior level leaders, providing mentoring and coaching of why a decision was not accepted;</td>
</tr>
<tr>
<td>o Illuminates the context for both junior level and senior level leaders.</td>
</tr>
<tr>
<td>o Understands how the technical system or system of systems, along with its budgetary, political, mission and support aspects, fits within the executive-level context</td>
</tr>
<tr>
<td>o Identifies the overall context of the immediate system of systems.</td>
</tr>
<tr>
<td>o Focuses on external connections rather than internal structure in a system of systems, and coaches mid-level leaders on how to do so in a system.</td>
</tr>
<tr>
<td>o Relays the context of why a decision was made a particular way to mid-level leaders, providing mentoring and coaching of why a decision was not accepted.</td>
</tr>
<tr>
<td>o Understands how the system fits in the context external to the agency, that is, in the Congressional context or landscape, and the national technical context or landscape.</td>
</tr>
<tr>
<td>o Illuminates the context for both executive level and mid-level leaders;</td>
</tr>
<tr>
<td>o Effectively represents the system in relevant Congressional committees,</td>
</tr>
</tbody>
</table>
providing advice and guidance to relevant national standards boards.

### 1.10 Big Picture Thinking in Relevant Scope Courses

<table>
<thead>
<tr>
<th>E ENG 301 Obj 1</th>
<th>“From an engineering leadership perspective, the student will describe elements of DoD systems engineering policy and process across the Defense acquisition lifecycle.”</th>
</tr>
</thead>
<tbody>
<tr>
<td>E ENG 301 Obj 20</td>
<td>“The student will recognize key characteristics of the DoD manufacturing environment and process improvement practices and their impact on system.”</td>
</tr>
<tr>
<td>E ENG 301 Obj 21</td>
<td>“Given a system production &amp; manufacturing scenario, the student will develop recommendations for improving manufacturing processes and overall production readiness based on manufacturing concepts discussed in class.”</td>
</tr>
</tbody>
</table>

### 1.11 Abstraction

| Recognizes patterns or abstractions across similar domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain; |
| Discerns patterns and structures in the relationships among a few similar systems; |
| Provides recommendations to mid level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level; |
| Recognizes patterns or abstractions across somewhat divergent domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain; |
| Discerns patterns and structures in the relationships among a few somewhat diverse systems; |
| Provides recommendations to senior level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level; |
| Understands how concepts and tools can be applied in situations and domains having some degree of variety; |
| Guides junior level leaders in identifying connections and new opportunities |
| Recognizes patterns or abstractions across very divergent domains, i.e. observes that a problem or solution in one domain is analogous to a different problem or solution in a different domain; |
| Discerns patterns and structures in the relationships among multiple diverse systems; |
| Provides recommendations to executive level leaders, because of the ability to abstract up ideas and solutions, to the appropriate organizational level; |
| Understands how concepts and tools can be applied in varied situations and domains; |
| Guides mid-level leaders in identifying connections and new opportunities |
1.11 Abstraction in Relevant Course Scope

⇒ SYS 350A Slide Deck 16: Abstraction defined; however, definition different from RT-149 definition. (Core Plus)

1.12 Paradoxical Mindset

- Learns to keep divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment;
- Learns to be comfortable with apparent paradox and how to examine technical problems from higher dimensions in which paradoxes may be resolved.

- Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment, while:
  - Providing reassurance and direction to junior level leaders during resolution of the resulting challenges;
  - Nurturing divergent views among junior leaders and coaching them on how to do so with their colleagues;
  - Ensuring that senior level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.
  - Is comfortable with apparent paradox and can examine technical problems from higher dimensions in which paradoxes may be resolved.

- Keeps divergent, and possibly contradictory, concepts in play simultaneously, without compromising program accomplishment, while:
  - Providing reassurance and direction to mid-level leaders during resolution of the resulting challenges;
  - Nurturing divergent views among mid-level leaders and coaching them on how to do so with their team members;
  - Ensuring that executive-level leaders and other stakeholders understand the reasons for keeping ideas in play, and are supportive of the process.
  - Is comfortable with apparent paradox and can examine technical problems from higher dimensions in which paradoxes may be resolved.

(including new product development) across domains, generated from abstract thinking, and how to apply tools in varied situations and domains;
- Guides junior leaders in the right direction with regard to scientific, mathematical and engineering insights.

- Leads multidisciplinary teams in subordinate suborganizations across multiple technical fields;
- Guides mid-level leaders in the right direction with regard to scientific, mathematical and engineering insights.
may be resolved, and coaches junior leaders on how to do so;
- Understands how to bring divergent technical approaches to resolution at the appropriate time in the system lifecycle;
- Sustains junior level leaders’ motivation, because paradoxical thinking injects an uncomfortable level of uncertainty for technical professionals who typically thrive on clarity, certainty, and solutions. In addition, one’s technical subordinates must be motivated and encouraged to engage in multiple divergent views of a problem simultaneously;
- Reassures senior and junior level leaders that the presence of multiple divergent and possible contradictory views is a good thing.

may be resolved;
- Understands how to bring divergent technical approaches to resolution at the appropriate time in the system lifecycle;
- Sustains mid-level leaders’ motivation, because paradoxical thinking injects an uncomfortable level of uncertainty for technical professionals who typically thrive on clarity, certainty, and solutions. In addition, one’s technical subordinates must be motivated and encouraged to engage in multiple divergent views of a problem simultaneously;
- Reassures executive level leaders that the presence of multiple divergent and possible contradictory views is a good thing.

<table>
<thead>
<tr>
<th>1.12 Paradoxical Mindset in Relevant Course Scope</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 301 Mod 2 Part 1 (p. 84): Paradoxical mindset mentioned; not in objectives.</td>
</tr>
<tr>
<td>Table 25 Curriculum Assessment Details for Enabling Competencies</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Junior</strong></td>
</tr>
<tr>
<td><strong>Competency Class 2: Enabling Competencies</strong></td>
</tr>
<tr>
<td>2.1. Developing People - Self</td>
</tr>
<tr>
<td>- Understands their role and contribution in a technical team, communicating effectively with team members and not working in isolation;</td>
</tr>
<tr>
<td>- Expresses appropriate appreciation and recognition of others;</td>
</tr>
<tr>
<td>✓ Receives constructive feedback and coaching and mentoring guidance in a nondefensive manner, given their typically strong technical expertise;</td>
</tr>
<tr>
<td>- Undertakes training and learning opportunities provided by mid-level leaders;</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
| 2.1 Developing People in Relevant Scope Courses | to the suborganizational vision and strategy;  
| o Helps junior level leaders define and develop their own careers;  
| o Provides training and learning opportunities for junior level leaders; and undertakes training and learning opportunities provided by mid-level leaders;  
| o Provides training and learning opportunities for mid-level leaders;  
| o Makes recommendations regarding the people development process to executive level leaders and/or appropriate lateral counterparts. |

<table>
<thead>
<tr>
<th>2.2. Leading People – Leading Self</th>
<th>2.2. Leading People – Leading the Team</th>
<th>2.2. Leading People – Leading Managers</th>
</tr>
</thead>
</table>
| o Provides guidance, direction, and motivation to senior level leaders, peers, and customers;  
| o Works well with mid-level leaders, stakeholders, and internal peers from |
| o Guides, directs, and motivates junior level leaders in a dignifying and empowering way;  
| o Provides guidance, direction, and motivation to senior level leaders, peers, |
| o Guides, directs, and motivates mid-level leaders in a dignifying and empowering way;  
| o Provides guidance, direction, and motivation to executive level leaders, |

**TLR 350 Obj:** “Explain how you manage feedback.” (Core Plus)

**SYS 350A Syllabus May 2015:** “Evaluate your technical leadership mindset to determine the feedback you would like to receive on the job.” (Core Plus)

**ACQ 453 Obj 5.04:** “Receive coaching feedback from others.” (Core Plus)

**SYS 350B Transition / KLDP Segment 3 Nov 2015:** “Leadership, coaching, and mentoring.” (Core Plus)

**ACQ 450 Obj 13:** “The learner will identify strategies for providing feedback on performance of their subordinates and peers.” (Core Plus)

**ACQ 450 Obj 13.01:** “Discuss techniques for providing performance support feedback to subordinates and peers.” (Core Plus)

**ACQ 450 Obj 13.02:** “Develop specific wording and phrasing to use in providing performance feedback.” (Core Plus)

**ACQ 453 Obj 2:** “The student will be able to develop and demonstrate powerful coaching skills.” (Core Plus)
many different cultures, backgrounds and countries;
- Possesses a strong set of values and ethics, to provide recommendations regarding risk, time, and client pressures to the mid level leaders;
- Understands and resolves conflicting views;
- Understands the importance of participating well in meetings;
- Works and communicates in a transparent manner to mid level leaders, peers, and customers;

and customers;
- Motivates and rewards junior level leaders, including celebrating junior level leaders’ accomplishments, as well as protecting them and the suborganization during failures;
- Works well with junior level leaders, senior level leaders, stakeholders, and internal peers from many different cultures, backgrounds and countries;
- Builds the team and suborganization with a diverse representation, to avoid using people with a similar demographic, personality type, educational background, program experience, or technical background;
- Learns to delegate, rather than doing the technical task themselves;
- Builds team cohesion (overcoming introversion and task orientation);
- Learns to represent the team well in peers’ meetings and senior level meetings, knowing when and what to speak and when to refrain from speaking;
- Understands when to and is able to raise a different view for discussion, rather than following a strictly conflict-avoidance strategy;
- Possesses a strong set of values and ethics, to provide recommendations regarding risk, time, and client pressures to the senior level leaders;
- Works and communicates in a transparent manner to senior level peers, and customers;
- Motivates and rewards mid-level leaders, including celebrating mid-level leaders’ accomplishments, as well as protecting them and the suborganization during failures;
- Works well with mid-level leaders, superiors, stakeholders, and internal peers from many different cultures, backgrounds and countries;
- Builds the team and suborganization with a diverse representation, to avoid using people with a similar demographic, personality type, educational background, program experience, or technical background;
- Creates environment of empowerment and expression, allowing all voices and constituencies to be heard, and listens to all voices and constituencies;
- Possesses a strong set of personal and organizational values and ethics (such as making ethical decisions in large system sign-offs under risk, time and client pressures);
- Works and communicates in a transparent manner to executive-level leaders, mid-level leaders, peers, and customers;
- Sends memorable messages informing mid-level leaders about the values, norms, and expectations of the organization’s culture;
- Sets priorities and expectations for mid-level leaders and their suborganizations,
leaders, junior level leaders, peers, and customers;
- Sets priorities and expectations for junior level leaders, measures performance and accountability;
- Creates an environment where the team of junior level leaders feel valued and appreciated, are committed to their work and want to excel;
- Provides motivation for the junior level leaders to coalesce around common goals;
- Acts through and with other people, through formal mechanisms such as goal setting and performance measurement, and informal mechanisms such as building trust and influencing others.

<table>
<thead>
<tr>
<th>2.2 Developing People in Relevant Scope Courses</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>E</strong> Eng 301 Obj 4: “The student will evaluate professional ethical conduct in a given systems engineering situation in accordance with professional standards of conduct discussed in class.”</td>
</tr>
<tr>
<td><strong>E</strong> ENG 301 Module 2 Part 2 Obj: “Develop ethical responses to entries in an engineer’s notebook that have potential safety consequences.”</td>
</tr>
<tr>
<td>➞ SYS 350A Pilot Jan 2015 / SYS 350A Syllabus May 2015: “Your Core Values” (Core Plus)</td>
</tr>
<tr>
<td>➞ SYS 350A Pilot Jan 2015 / SYS 350A Syllabus May 2015: “Your plans for being and developing as a leader.” (Core Plus)</td>
</tr>
<tr>
<td><strong>E</strong> ENG 301 Obj 26: “In a classroom environment, the student will lead a multi-disciplinary team in addressing an engineering challenge by providing proactive technical direction and motivation to ensure the effective application of systems engineering leadership in accordance with principles, policies, and practices discussed in class.”</td>
</tr>
<tr>
<td>➞ ENG 301 Obj 26.02: “Organize an engineering team for technical problem solving.” CS, PE</td>
</tr>
<tr>
<td>➞ SYS 350A Pilot Jan 2015 / SYS 350A Syllabus May 2015: “Your plans for being and developing as a leader.” (Core Plus)</td>
</tr>
<tr>
<td>➞ ENG 301 Obj 26.03: “Create an environment conducive to effective team performance.” CS, PE</td>
</tr>
</tbody>
</table>
### 2.3 Thinking Critically

- Applies analytical thinking across a narrow scope or range of problems and functions, and learns to do so at an intermediate scope;
- Emphasizes the recognition and prioritization of problems and analysis of courses of action;
- Possesses a balance between logical thinking and holistic thinking (e.g. IQ and emotional intelligence EI), important for technical leaders who have a natural tendency for ‘left brain’ thinking;
- Efficiently budgets time, balancing workload and schedule against completeness of work.

<table>
<thead>
<tr>
<th>Course</th>
<th>Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>SY5 30A Obj (Slide Deck #2)</td>
<td>“Establish and implement personal development plans for improving their technical leadership skills.” (Core Plus)</td>
</tr>
<tr>
<td>SY5 30A Slide Deck 12</td>
<td>“Deepen awareness of your own values and their impact on your approach to being a technical leader.” (Core Plus)</td>
</tr>
<tr>
<td>SY5 30A Obj Slide Deck 17</td>
<td>“Create personal development objectives.” (Core Plus)</td>
</tr>
<tr>
<td>ACQ 450 Obj 1</td>
<td>“The learner will formulate different conflict resolution methods for dealing with team members, peers and superiors.” (Core Plus)</td>
</tr>
<tr>
<td>ACQ 203B Obj 2</td>
<td>“Resolve an acquisition-related dilemma by prioritizing ethical values and considering how choices impact the welfare of others.”</td>
</tr>
<tr>
<td>ACQ 203B Obj 1</td>
<td>“Determine how IPT leadership concepts can be used to overcome barriers to effective teamwork, based on real world experience.”</td>
</tr>
<tr>
<td>ACQ 450 Obj 6</td>
<td>“The learner will analyse the preferences of others and determine appropriate strategies for leading a diversity of individuals.” (Core Plus)</td>
</tr>
</tbody>
</table>

- Utilizes junior level leaders’ diversity of thought, experiences, and approaches to develop alternative solutions and explanations for observed phenomena and problems, and actively considers them routinely;
- Provides junior level leaders with a moderate-scope library of ideas, frameworks, and models suitable for application in many areas;
- Applies analytical thinking across an intermediate scope or range of problems and functions, and coaches junior level leaders to do the same for their realm of responsibility;
- Supports junior level leaders with problem discovery and identification accurately;
- Utilizes mid-level leaders’ diversity of thought, experiences, and approaches to develop alternative solutions and explanations for observed phenomena and problems, and actively considers them routinely;
- Provides mid-level leaders with a wide ranging library of ideas, frameworks, and models suitable for application in many areas;
- Applies analytical thinking across a large scope or wide range of problems and functions, and coaches mid-level leaders to do the same for their realm of responsibility;
- Supports mid-level leaders with problem discovery and identification accurately;
The table represents the key points from the text on thinking critically in relevant scope courses. The table is structured as follows:

<table>
<thead>
<tr>
<th>Course</th>
<th>Objective/Module</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENG 301 Obj 3.02</td>
<td>“Relate the principles of critical thinking to systems engineering leadership.” MC, AC, MA [to simulation, action-based learning]</td>
<td></td>
</tr>
<tr>
<td>ISA 320 Obj 2</td>
<td>“Utilizing critical thinking and problem solving methodologies, propose a solution to the problem in a given case study.”</td>
<td></td>
</tr>
<tr>
<td>PQM 301 Lesson 1</td>
<td>Critical thinking defined p. 10.</td>
<td></td>
</tr>
<tr>
<td>ACQ 450 Obj 9</td>
<td>“The learner will analyse steps of the crucial thinking process.” Obj 9.2: “Apply critical thinking skills during the case discussion.” (Core Plus)</td>
<td></td>
</tr>
</tbody>
</table>

The text continues with the following points:

- Challenges junior level leaders to make inferences or draw conclusions that are justified by evidence;
- Learns to utilize the team to solve problems;
- Efficiently provides oversight of junior leaders work while giving them sufficient free rein to make decisions on their own;
- Encourages diverse technical solutions to avoid the “my way is best” engineering bias.

- Challenges mid-level leaders to make inferences or draw conclusions that are justified by evidence;
- Expands his or her thinking by actively requesting new ideas and feedback from others, and constantly requests and collects new information;
- Uses critical thinking to generate alternative courses of action and a recommendation for superiors to problems, decisions and requests identified by them.
2.4 Building Trust

| o Explains own decisions clearly, including their motives and character as well as the logic of the decision, to mid-level leaders; |
| o Uses own ability to achieve mid-level leader’s goals and objectives; |
| o Contributes to and participates in decision-making; |
| o Understands the personal experiences and connections that the mid-level leader makes; |

| o Explains decisions clearly, including their motives and character as well as the logic of the decision, to junior level leaders, senior-level leaders, and peers; |
| o Delegates responsibility and relies on the ability of the junior level leaders to achieve their goals and objectives; |
| o Shares control and increases the participation of the junior level leaders in decision making; |

| o Explains decisions clearly, including their motives and character as well as the logic of the decision, to mid-level leaders, executive-level leaders, and peers; |
| o Delegates responsibility and relies on the ability of the mid-level leaders to achieve their goals and objectives; |
| o Shares control and increases the participation of the mid-level leaders in decision making; |
- Keeps promises to mid-level leaders, and peers;
- Operates ethically and with high levels of integrity;
- Uses own resources responsibly;
- Has the courage to do the right thing, even when there may be negative repercussions;
- Takes action in spite of risk or discomfort;
- Listens carefully to mid-level leaders and peers, and communicates clearly, openly, and transparently to mid-level leaders, and peers.

- Shares personal experiences and makes connections with junior level leaders’ experiences;
- Keeps promises to junior level leaders, senior level leaders, and peers;
- Leads ethically and models high levels of integrity;
- Uses resources at the mid-level responsibly;
- Has the courage to do the right thing, even when there may be negative repercussions;
- Takes action in spite of risk or discomfort;
- Nurtures an environment that results in the mid-level team credibility and trust;
- Listens carefully to senior level leaders, junior level leaders, and peers, and communicates clearly, openly, and transparently to senior level leaders, junior level leaders, and peers.
- Contributes to program-level reputation, avoiding the tendency to focus on own team.

**2.4 Building Trust in Relevant Scope Courses**

- TLR 350 Module 5 (p. 4): Trust mentioned in context of being linked to values (Core Plus)
- TLR 350 Module 5 (p. 5): Moral courage and resiliency mentioned (Core Plus)

**ACQ 452 Obj 3:** “Analyze and share your personal stakeholder relationship experience(s) for building trust.” (Core Plus)

**2.5 Communicating Effectively**

- Speaks articulately to mid-level leaders and peers;
- Listens effectively and interprets
- Speaks articulately, delivering a well-crafted message oriented toward a specific audience (including mid and

- Speaks articulately, delivering a well-crafted message oriented toward a specific audience (including senior and executive
information and translates it into work tasks
  o Writes nontechnical documents concisely, clearly, and with crispness, rather than just using technical language
  o Understands non-technical requirements and ideas communicated by mid-level leaders;
  o Communicates persuasively to mid-level leaders and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their mid-level leaders and peers;
  o Communicates openly and transparently;

senior level leaders), and adapts messages to different audiences having a variety of viewpoints (includes a flexible communication style using story telling and analogies);
  o Actively listens (understands what is meant, in addition to what is said), clarifies what has been heard, and conveys genuine interest, to senior level leaders, junior level leaders, peers, and all stakeholders, not just those having the louder voice;
  o Social perceptiveness: being aware of others' reactions; effectively interprets intent, influence, and nonverbal communication of mid-level and senior level leaders;
  o Writes clearly and effectively, to senior level leaders, junior level leaders and peers;
  o Translates non-technical requirements and ideas to technical staffs;
  o Uses a variety of communications media to communicate technical information clearly and understandably to both technical and non-technical audiences;
  o Communicates through framing and interpreting experience to junior level leaders and peers;
  o Communicates persuasively to junior level leaders, senior level leaders, and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas level leaders), and adapts messages to different audiences having a variety of viewpoints;
  o Actively listens (understands what is meant, in addition to what is said), clarifies what has been heard, and conveys genuine interest, to executive-level leaders, mid-level leaders, peers, and all stakeholders, not just those having the louder voice;
  o Writes clearly and effectively, to executive-level leaders, mid-level leaders and peers;
  o Translates non-technical requirements and ideas to technical staffs;
  o Uses a variety of communications media to communicate technical information clearly and understandable to both technical and non-technical audiences;
  o Communicates through framing and interpreting experience to mid-level leaders;
  o Communicates persuasively to mid-level leaders, executive-level leaders, and peers about the quality of their ideas and requests and generates support for those ideas and requests; effectively sells ideas to their mid-level leaders, executive-level leaders, and peers;
  o Coaches mid-level leaders on how to do the above communication actions effectively;
  o Fosters a culture of open and transparent communication in their suborganization by example;
  o Requires mid-level leaders to evaluate
### 2.5 Communicating Effectively in Relevant Scope Courses

- **SYS 350A Slide Deck #6:** “In this module, we concentrate on the first two challenges – communication and cooperation – and their systems-based responses... Develop a diagram that would be used to explain the problem to the stakeholders in a way that could enlist them in collaborating to achieve a solution.... A variety of visual techniques exist.” (Core Plus)

- **ENG 301 Capstone Module:** a 20-page powerpoint, illustrating that the visual and verbal go together [pp. 755-774]

- **ACQ 450 Obj 8:** “The learner will determine effective ways for communicating with peers, bosses, and subordinates.” (Core Plus)

- **ACQ 450 Obj 6.01:** “Interpret behaviour preferences in others by using a case and video clips.” (Core Plus)

### 2.6 Establishing and Maintaining Stakeholder Relationships

- Builds internal relationships;
- Supports maintaining effective stakeholder relationships;
- Identifies stakeholders, and distinguishes among different stakeholder roles;
- Identifies stakeholder issues which are appropriate to be escalated to mid-level leaders;
- Learns how to maintain effective stakeholder relationships, conflict management, and negotiation;
- Joins professional societies (e.g. INCOSE).

- Maintains existing stakeholder relationships, by identifying and understanding their requirements, expectations, and needs; meeting or handling their expectations; and ensuring the right processes (including communication processes) are in place to sustain stakeholder relationships;
- Anticipates and reacts to changing clients and changing client needs;
- Identifies prospective new clients;
- Identifies stakeholder issues which are appropriate to be escalated to executive level leaders;

- Builds new stakeholder relationships, by identifying and understanding their requirements, expectations, and needs; meeting or handling their expectations; and ensuring the right processes (including communication processes) are in place to sustain stakeholder relationships;
- Identifies stakeholder issues which are appropriate to be escalated to executive level leaders;
- Balances competing stakeholder values, goals and interests, making subjective decisions and resolving conflicts...
appropriate to be escalated to senior level leaders;
- Learns to balance competing stakeholder values, goals and interests, making subjective judgments and decisions about rights and accountability;
- Learns to manage expectations of technical and nontechnical stakeholders;
- Learns to manage conflict constructively, both conflict between the stakeholder and the suborganization, and conflict between multiple stakeholders, and negotiates effectively with stakeholders;
- Learns to build new stakeholder relationships with senior level leaders;
- Coaches junior level leaders on maintaining effective existing stakeholder relationships, conflict management, and negotiation;
- Contributes to developing a unified approach to stakeholder care throughout the organization that helps meet stakeholder expectations;
- Participates in professional societies (e.g. INCOSE).
- Manages conflict constructively, both conflict between the stakeholder and the suborganization, and conflict between multiple stakeholders, and negotiates effectively with stakeholders;
- Identifies and involves mid-level leaders in building new stakeholder relationships;
- Coaches mid-level leaders on maintaining effective existing stakeholder relationships, conflict management, and negotiation;
- Develops a unified approach to stakeholder care throughout the organization that helps meet stakeholder expectations.

### 2.6 Establishing and Maintaining Stakeholder Relationships

**ACQ 101 Obj 3:** “Identify the major institutions and key drivers of the defense acquisition process.” [incl. Exec Branch, Congress, industry, DoD key players, DoD senior-level advisory orgs.]

**ACQ 452 Obj 1:** “Assess the key components for building a solid

**ACQ 452 Obj 2:** “Given a scenario, develop a stakeholder strategy.” (Core Plus)

**ACQ 452 Obj 4:** “Define/develop methods, metrics, and/or techniques for evaluating and improving stakeholder relationships.” (Core Plus)
2.7 Influencing Others

- Uses rational persuasion, including explanations, logical arguments, and factual evidence, to advocate a position, decision, request, proposal, or task, with mid-level leaders, peers and stakeholders;
- Utilizes inspirational appeals through an emotional or value-based request, to advocate a position, decision, request, proposal or task, with mid-level leaders, peers and stakeholders;
- When consulted by mid-level leaders (or taking own initiative), provides suggestions on a particular issue;

2.7 Influencing Others in Relevant Scope Courses

⇒ SYS 350B Transition / KLDP Segment 3 Nov
<table>
<thead>
<tr>
<th>2015: “Influencing without authority.” (Core Plus)</th>
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### 2.8 Developing Strategy and Vision

- Defines vision and strategy for own self;
- Supports the mid-level leader’s vision;
- Understands how junior level leader’s actions/outputs/products align to the organizational strategy;
- Actively contributes to knowledge sharing, using any technical tools provided;
- Uses controls and feedback mechanisms provided by mid level or senior level leaders to assess their (junior level leaders’) performance of strategy and associated execution.

- Develops and articulates the vision for their team, generates support for that vision from junior level leaders, senior level leaders, and peers, and aligns the vision to the suborganization, organization, and enterprise vision;
- Enables junior leaders to create their own vision, which supports the mission and values of the mid-level suborganization;
- Contributes to creating, understanding, and executing a strategy at the senior level that encompasses stakeholder expectations, industry trends, and emerging technologies;
- Connects strategy with day-to-day junior level leader’s objectives; ensures that their junior level leaders can see how their junior level leaders’ actions/outputs/products align to the strategy;
- Utilizes suborganizational structures that support strategy and promotes knowledge sharing, clear accountability, and coordination;
- Uses controls and feedback mechanisms provided by senior level leaders to assess their (mid-level leaders’) performance of strategy and associated execution.

- Develops and articulates the vision for their suborganization, generates support for that vision from mid-level leaders, executive level leaders and peers, and aligns the vision to the organization and enterprise vision;
- Enables mid-level leaders to create vision for their own teams, which supports the mission and values of the senior level suborganization;
- Creates, understands, and executes a strategy that encompasses stakeholder expectations, industry trends, and emerging technologies;
- Connects strategy with day-to-day mid-level leader’s objectives; ensures that their mid-level leaders can see how their mid-level leaders’ teams’ actions/outputs/products align to the organizational strategy;
- Develops suborganizational structures that support strategy and promotes knowledge sharing, clear accountability, and coordination;
- Develops strategy execution processes and employs incentives to support those processes and decisions;
- Modifies or creates effective controls and feedback mechanisms to allow mid-level leaders to assess performance of strategy.
### 2.8 Developing Strategy and Vision in Relevant Scope Courses

| S | STM 304 Obj: “Describe the steps to develop a well-conceived plan.” |
| S | STM 304 Obj: “Compare the major theories of strategic planning.” |
| S | STM 304 Obj: “Discuss how the DoD components conduct strategic planning and what constraints the DoD faces.” |


### 2.9 Fostering Agility

- Reorganizes, regroups, and renews own personal energy at the junior leader level in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;
- Adapt quickly and effectively to shifting demands and changing priorities from mid-level leaders or stakeholders, and other unexpected and unplanned events;
- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Uses practices introduced by mid-level leaders to do effective adaptive planning;
- Modifies their own role to incorporate agility;
- Adheres to standard operating procedures and uses knowledge management tools to

- Reorganizes, regroups, and renews own personal energy at the mid level leader in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;
- Adapt quickly and effectively to shifting demands and changing priorities from senior level leaders or stakeholders, and other unexpected and unplanned events;
- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Fosters and encourages resiliency and responsiveness in junior level leaders;
- Uses practices introduced by senior level leaders to do adaptive planning, and introduces practices to help junior level leaders do effective adaptive planning;

- Reorganizes, regroups, and renews own personal energy at the senior leader level in changing and uncertain conditions and contexts, effectively handles frustration and stress, maintains a positive attitude, and contributes to increasing resiliency in the organization;
- Adapt quickly and effectively to shifting demands and changing priorities from executive level leaders or stakeholders, and other unexpected and unplanned events;
- Is flexible in terms of organizing, structuring, coordinating, and performing the work;
- Fosters and encourages resiliency and responsiveness in mid-level leaders;
- Introduces practices to help mid-level leaders do effective adaptive planning;
- Modifies their own role and mid-level
increase their own learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.

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<td></td>
<td>o Modifies their own role and junior level leader’s roles to incorporate agility;</td>
<td>o Establishes standard operating procedures and implementing knowledge management tools to increase their own learning, mid-level leaders’ learning, and organizational learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.</td>
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<td></td>
<td>o Adheres to standard operating procedures and uses knowledge management tools to increase their own learning, junior level leaders’ learning, and suborganizational learning, and subsequently modifies their thinking, decision-making, and courses of action according to that learning.</td>
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### 2.9 Fostering Agility in Relevant Scope Courses

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<tr>
<td><strong>E</strong> ENG 301 Mod 2 Part 1: Flexible mentioned; not in objectives.</td>
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<tr>
<td><strong>P</strong> PQM 301 Lesson 11 p. 11: Agile is mentioned as essential feature of supply chain management; agile not defined.</td>
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<td></td>
<td>⇒ SYS 350A Slide Deck #10 provides an understanding of agile [technical, not personal] development. (Core Plus)</td>
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<td></td>
<td>⇒ SYS 350A Slide Deck #10: “Models can enhance [technical] agility.” (Core Plus)</td>
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<td></td>
<td>⇒ SYS 350A Syllabus May 2015: “Change: Determine how your attitudes toward change impact your ability to succeed as a technical leader.” (Core Plus)</td>
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<td></td>
<td>⇒ SYS 350A Syllabus May 2015: “Evaluate your technical leadership mindset to determine how you can drive change in your organization.” (Core Plus)</td>
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<td></td>
<td>⇒ SYS 350A Syllabus May 2015: “Understand how your attitudes toward change impact your approach to technical leadership” (tolerance for ambiguity, locus of control, goal orientation). (Core Plus)</td>
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<td></td>
<td>E ENG 301 Obj 22: “Given an urgent need, the student will develop a systems engineering approach to support the rapid acquisition of the needed capability in accordance with the DoDI 5000.02, the Defense Acquisition Guidebook (DAG), and principles and practices discussed in class.”</td>
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### 2.10 Promoting Innovation

- Contributes to the culture of technological innovation and interacts effectively with other junior level leaders regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to mid level leaders;
- Implements and/or follows processes that support innovation;
- Contributes to advancement in their own technical domain through innovation.

- Nurtures and champions a culture of technological innovation and promotes effective junior level leader team interaction regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to senior level leaders, and coaches junior level leaders to do the same;
- Supports and guides junior level leaders as they implement and/or follow processes that support innovation;
- Protects junior level leaders when their innovations fail;
- Contributes to advancement in their own technical domain through innovation.

- Nurtures and champions a culture of technological innovation and promotes effective mid-level leader team interaction regarding innovation;
- Generates new ideas, methods, products and processes, identifies any other innovation opportunities, makes the business case for them to executive level leaders, and coaches mid-level leaders to do the same;
- Supports and guides mid-level leaders as they implement processes that support innovation;
- Protects mid-level leaders when their innovations fail;
- Creates and implements innovation strategies, and provides input to organization-level innovation strategy;
- Contributes to advancement in their own technical domain through innovation (including patentable inventions).

### 2.10 Promoting Innovation in Relevant Scope Courses

| S STM 304 Obj: “Demonstrate how we can promote innovation.” |
| SYM 350A Slide Deck #8: “Learn about leadership facilitation tools for fostering collaborative problem solving & innovation.” (Core Plus) |

| S STM 304 Obj: “Demonstrate how we can promote innovation.” |
| SYM 350A Obj (Slide Deck #2): “Lead the management and evolution of complex technical systems, deciding what and when enhancements and innovations are appropriate.” |
| SYM 350A Obj Slide Deck #8: “Be able to recognize barriers to creativity & innovation.” |
### 2.11 Building Government Acumen

- o Is aware of accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA);
- o Is aware of the impact that business procedures have on the successful accomplishment of technical work;
- o Is aware that the law, congressional directives, OMB and DoD policy directives and guidance, the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) impact technical success;
- o Organizes and plans for success at the junior level in an uncertain and changing financial and regulatory environment.

- o Learns accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA);
- o Understands program budgets and operates within them effectively;
- o Learns to understand the impact that business procedures have on the successful accomplishment of technical work;
- o Organizes and plans for success at the mid-level in an uncertain and changing financial and regulatory environment.

- o Understands accounting best practices as articulated by standards setting bodies including Defense Contract Audit Agency (DCAA);
- o Sets program budgets and defends them effectively;
- o Understands the impact that business procedures have on the successful accomplishment of technical work;
- o Works within the structures of the law, congressional directives, OMB and DoD policy directives and guidance, the Federal Acquisition Regulation (FAR) and the Defense Federal Acquisition Regulation Supplement (DFARS) to chart a program course that leads to technical success, while respecting and dealing with the many obstacles involved;
- o Organizes and plans for success at the senior level in an uncertain and changing financial and regulatory environment.

### 2.11 Building Government Acumen in Relevant Scope Courses

| E | Eng 301 Obj 19: “Given a program scenario and cost reduction opportunities, the student will develop engineering inputs for a should-cost management plan in accordance with DoDI 5000 and the Defense Acquisition Guidebook (DAG).” |

### 2.12 Possessing a Macro Perspective

- o Is aware of the role of each organization
- o Understands the role of each
- o Understands, appreciates, and
and suborganization in the DoD enterprise;
- Understands how the junior level leader fits into the larger context at the mid-level leader’s suborganization;
- Understands how the junior level leader is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer junior level leaders within the suborganization;
- Aligns the junior level leader’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the suborganization, organization and enterprise.

<table>
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<tr>
<th>2.12 Possessing a Macro Perspective Building</th>
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<tbody>
<tr>
<td>E ENG 301 Obj 24: “Given contractor business information, e.g. Annual Reports and Form 10-K’s, students will (1) discuss</td>
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organization and suborganization in the DoD enterprise;
- Understands how the mid-level leader’s suborganization, along with its budgetary, political, mission and support aspects, fits within the larger context at the suborganization, organization and enterprise levels;
- Understands how the mid-level leader’s suborganization is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer mid-level leaders within the suborganization;
- Champions the role of their suborganization as a trusted business partner across the suborganization and organization levels;
- Capitalizes on the value and worth of one suborganization’s intellectual property, personnel, development efforts and products;
- Aligns the mid-level leader’s suborganization’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the suborganization, organization and enterprise.

appropriately utilizes the role of each organization and suborganization in the DoD enterprise;
- Understands how the senior-level leader’s suborganization, along with its budgetary, political, mission and support aspects, fits within the larger context at the organization and enterprise levels;
- Understands how the senior-level leader’s suborganization is impacted by the political, economic, and social aspects or context or landscape;
- Builds a supportive, collaborative and respectful relationship with peer senior-level leaders within the suborganization, organization and enterprise;
- Champions the role of their suborganization as a trusted business partner across the suborganization, organization and enterprise levels;
- Capitalizes on the value and worth of one suborganization’s intellectual property, personnel, development efforts and products;
- Aligns the senior-level leader’s suborganization’s mission, objectives and vision so as to contribute to the achievement of the overall mission of the organization and enterprise.
the contractor’s development and implementation of mission, goals, and business strategies, and (2) evaluate the impact of various government acquisition strategies on the contractor’s ability to achieve its business goals.

A ACQ 120 Obj 2: “Describe key State Department and Commerce Department players in Security Cooperation and international acquisition and their roles.”

A ACQ 120 Obj 4: “Describe international considerations in defense capabilities and in initiating defense acquisition programs.”

A ACQ 130 Obj 2: “Recognize the basic underlying security principles and authorities that govern foreign disclosure, technology control and security requirements for international acquisition programs.”

A ACQ 315 Obj 1: “Students will be able to explain how the scope and diversity of the current industry landscape influences companies’ methods of competing for defense contracts.” (Core Plus)

A ACQ 315 Obj 4: “Students will be able to explain cost accounting basics defense companies use to manage direct costs, indirect costs, and rates for proposals and program execution.” (Core Plus)

A ACQ 340 Obj 2: “The student will be able to organize and blend stakeholder needs and requirements from both domestic and international programs and use the
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<td>result to formulate a viable international strategy.” (Core Plus)</td>
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<tr>
<td>A ACQ 340 Obj 3: “The student will be able to integrate political-military principles into domestic and international customer/partner relationships.” (Core Plus)</td>
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<tr>
<td>A ACQ 370 Obj 1: “Given appropriate reference material, discuss the constitutional, statutory, regulatory, and decisional authorities applicable to both commercial and governmental acquisitions.” (Core Plus)</td>
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</table>
10 APPLYING THE FRAMEWORK: EXISTING CAREER MODELS

In Section 10, we now apply the framework to existing career models, before developing a proposed concept of operations for a career model in Section 11. A career model is defined as how a person traverses the Framework. For example, a person entering the workforce at the junior level uses the leadership development techniques and measures competency achieved to advance to the mid-level career stage. Similarly, a person in the workforce at the mid-level uses the leadership development techniques and measures competency to advance to the senior level career stage. Viewed from an alternate perspective, a career model is defined as how the various Framework elements are combined into a system. This alternate perspective also highlights the connections between the elements in the Framework.

Section 10 is structured as follows. We start by summarizing the career models identified in the technical leadership literature, featuring primarily academic studies but also incorporating relevant consulting studies. Next, we review career models designed and used by technical companies (NASA, Construx, BP, Shell, Caterpillar) from publicly available sources. Finally, we review career models at technical companies through information obtained from in-depth interviews with technical and human resource leaders at the specific company (Raytheon, Sandia, and Accenture). Career models in the engineering domain have typically been identified as Engineering Leadership Development Programs.

When discussing the career models and associated best practices at particular companies that were interviewed, we use the Framework to structure the discussion, using the following visual guide. As the first Framework element consists of the career stages, we open the best practices section of the company by first identifying the career paths available to people in the organization, and any programs associated with career paths. As the second Framework element consists of the key competency indicators, we next discuss whether competencies are an implicit or explicit part of the organization’s leadership development, and any programs associated with competencies. With the third Framework element being the techniques, we then outline company-specific tools or programs in the leadership development techniques. We also add the fourth Framework element, competency attainment. Finally, we add an additional layer, overall programs, at the bottom of the visual, because there are some company-specific programs which consist of multiple Framework elements. In this career models section, these descriptions comprise industry best practices. Figure 22 below provides a visual summary of the legend.
In our discussion of best practices, companies would frequently select a particular department or particular division as being a best practice within their whole company. Therefore, in the discussion of each company below, we begin by outlining one or two key parameters, such as subject domain and scope.

### 10.1 Knowledge Worker and Specialist Career Model

**Key Parameters**

**Subject Domain:** Knowledge workers, including technical specialists

**Source Type:** Article

---

Figure 22 Company Career Model Legend
Hirsh (2006) discusses how to effectively manage the career development of knowledge workers and specialists. Knowledge workers are those who possess particular professional or functional expertise, while specialists are those who do professional or technical work. For Hirsh, the Knowledge Worker and Specialist Career Model consists primarily of career stage and competencies. Competency attainment is mentioned only implicitly, and leadership development approaches are not addressed.

### 10.1.1 Career Stages

Hirsh (2006) suggests that Dalton’s (1989) four-stage model is beneficial because it connects different HR components, including job roles to job evaluation systems. Dalton’s four stages are as follows:

1. Apprenticeship – Employees are closely supervised
2. Independence – Employees work in a self-sufficient manner
3. Mentoring – Employees develop technical skills in others
4. Strategic – Employees influence organizational strategy

For Hirsh (2006), it is levels of work that identify hierarchically (i.e. up and down) how work and responsibility change throughout the career. In addition, Hirsh recognizes a third aspect of career stages, which is role type. Hirsh differentiates between two primary role types at the senior level:

- Specialists – a person having high knowledge responsibility to deliver technical work products, with no people responsibility, and
- Managerial positions – a person having people responsibility (as well as budget responsibility), and does no conduct technical work.

These two roles are compared with Dalton’s career stages in Table 26 the following table.

<table>
<thead>
<tr>
<th>Dalton’s Career Stages</th>
<th>Specialist Role</th>
<th>Management Role</th>
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<tbody>
<tr>
<td>Strategic</td>
<td>Senior specialist / strategic advisor</td>
<td>Senior manager</td>
</tr>
<tr>
<td>Mentoring</td>
<td>Senior specialist</td>
<td>Middle manager</td>
</tr>
<tr>
<td>Independence</td>
<td>Full professional</td>
<td>Junior manager</td>
</tr>
<tr>
<td>Apprenticeship</td>
<td>Junior professional</td>
<td>Junior professional</td>
</tr>
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</table>

Source: Hirsh (2006)

She compares the dual career track with the single career track, and observes that a single career track may lead to a glass ceiling for technical specialists (see Figure 23).
In addition to the dual career track shown in Figure 23, Hirsch observes that Rolls-Royce defines three senior role types for engineers within the organization – specialists, technical managers, and project managers (see Figure 24). The technical manager career track consists of half technical work, and half managerial work. Hirsch also observes that BP has a flexible leadership career path, as shown in Figure 25.
10.1.2 Competencies

Hirsh specifically discusses designing the *senior* roles and responsibilities for knowledge workers, and provides some example responsibilities as follows:

- Delivers complex, precise technical work that has a significant impact on the organization’s success.
- Develops new methods for technical work, incorporating industry best practices, and sets standards.
- Coaches and mentors colleagues having less experience, growing organizational capability.
- Provides strategic advice on technical decisions, internally and externally.

Figure 26 presents a common framework that can be used to define a certain role.
Competency frameworks and technical skills frameworks are discussed to illustrate the HR processes in handling the careers of knowledge workers. Hirsh suggests that competency frameworks should be used to determine generic and leadership competencies, while technical skills frameworks should be used to set objective performance criteria.

### 10.1.3 Competency Attainment

Hirsh implicitly recognizes competency attainment as being an important part of the career model, when she lists the requirements of being a senior engineering specialist (Engineering Associate Fellow) at Rolls-Royce:

- Candidates are internally recognized for their technical expertise.
- In their home country, candidates are recognized and active externally in their technical field.
- Candidates actively promote their technology.
- They act in according to company values.
- Candidates are Fellows (or equivalent) in the professional institution or society of their technical expertise.
- They demonstrate commitment to developing themselves and others.

### 10.2 Integrated Talent Management Based on Career Models

Key Parameters
White (2012) discusses the talent development framework and methods that have been successfully implemented in companies such as Microsoft. Through investigation on employee engagement and advancements in cognitive science, White proposed two primary ideas that any career models must:

1. The system must engage employees by providing answers to questions that they care the most, i.e.: what does success look like, and how do I get ahead in my career?
2. The system must be built such that employees can easily understand and identify what capabilities are needed and in what quantity, and how the capabilities relate to their current positions.

The Integrated Talent Management (ITM) is defined in White’s paper as the framework that “all aspects the ‘people system’ work together to align, sustain, and reinforce business strategy.” White considers the ITM as the go-to guidebook whenever a company needs to decide on any human recourse actions, i.e. hiring, promoting, and developing etc. It emphasizes the overall integration of each component using career models to drive change.

### 10.2.1 Career Models

White identifies two key elements in a career model: the development state and the future state. In the development state, there are three aspects:

1. Functional career paths – specify what a prototypical career path should look like in sequential career stages.
2. Competencies/expected results – define the success elements and projected results for a given function. Competencies should be natively developed, meaning that they should align with the function.
3. Key experiences – Prototypical job assignments that target the development of functional competencies.

These three aspects are connected as illustrated in Figure 27.
In the future state of the career model, the focus is on connecting the behaviors and values that enable career development to functional success. In this connection process, there are four primary steps:

1. Strategic Intent – Organizations should investigate on their needs by asking the question “What we want?”
2. Values, Processes, & Business Practices – Organizations should determine “What it will take” in order to achieve “What we want”.
3. Performance Standards and Expectations – Organizations should envision the expected results by asking “What it looks like”
4. Talent Processes – After achieving the results, organizations should then develop methods to sustain the business change.

Figure 28 illustrates this approach.
Another component to White’s career model is an employee engagement framework, that adds meaning and purpose for employees and business leaders to follow the model. White presents survey results that employees value seven critical attributes that attract and/or retain them, as shown in Figure 29.
10.3 SOFTWARE ENGINEERING CAREER MODEL

Key Parameters

Subject Domain: Software Engineering
Source Type: Article

In their study testing software competency gaps in software engineers, Colomo-Palacios, Casado-Lumbreras, Soto-Acosta, Garcia-Penalvo, & Tovar-Caro (2013) implicitly discuss career models when they identify software engineering competencies and software engineering career ladder.

10.3.1 CAREER STAGES

Colomo-Palacios et al. present a career progression ladder by identifying similarities between definitions for various professional profiles both from industry practices and technical literature. The ladder consists of seven consecutive positions – support programmer (referred to as F in the career ladder), software engineer (E), senior software engineer (D), project manager (C), program manager (B), and division manager (A). In addition, participants have to start at level G in order to advance to become a support programmer.
10.3.2 Competencies

The study identifies the importance of technical and generic competencies for not only the success of IT projects, but also for a wider scope of an organization, including all knowledge workers. While Colomo-Palacios et al. reference several other studies on the definition of the two competencies, the following definitions of generic competences and technical competences can help clarify the two concepts:

Technical Competencies – defined as the competencies that are essential to “carry out a very specific task in a particular job position, which include knowledge, skills, and abilities.”

Generic Competencies – defined as those that are not linked to a specific activity or function, and those that “make possible the competent performance of the tasks related to the work position”, which include characteristics or abilities of general behavior.

The study integrates the competency concept with the career ladder by specifying the technical and generic competence level per role (A-G). Table 27 presents the standard level of generic and technical competencies per role. It shows that generic competency levels tend to increase from lower levels to level A, which has a score of 4 across all generic competencies, except one; where technical competencies typically rise from lower levels to level D, then decreases.
<table>
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<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
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</table>

Source: Colomo-Palacios, et al., (2013)


## 10.3.3 Competency Attainment

Colomo-Palacios et al.’s competency attainment corresponds to the Framework’s leadership development techniques. In order to present their career model accurately, we use their terminology in this section.

The goal of this experiment is to investigate the competence gaps of individuals. While the sample is too small (22 subjects across 4 levels) to validate the experiment, it presents a potential validation tool for our framework. Therefore, we provide a brief summary as follows. The main contribution of this study is the experiment conducted to investigate the differences between the proposed levels and the levels derived from 360-degree evaluation analysis. Three parties (Supervisor, Peers, and Subordinates) are surveyed and their feedbacks are averaged to derive a single indicator of the level. Table 28 presents the differences of technical competencies between suggested levels and evaluation results.

<table>
<thead>
<tr>
<th>Table 28 Colomo-Palacios et al. Sample Experiment Results</th>
<th></th>
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<tbody>
<tr>
<td>Differences between evaluations and competence levels.</td>
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<td>Total (technical competences)</td>
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Source: Colomo-Palacios, *et al.*, (2013)

### 10.4 Generic Career Model

Key Parameters

<table>
<thead>
<tr>
<th>Subject Domain</th>
<th>Generic, and Technical Management</th>
</tr>
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<tbody>
<tr>
<td>Source Type</td>
<td>Article</td>
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Cao & Thomas (2013) present a high-level career model consisting of several of the Framework elements: career roadmaps (implicitly consisting of career stages), competencies, training and development, and establishing accountability. While a valuable overview and system, it does not provide as much detail on the components as some of the others.

### 10.4.1 Career Roadmaps, Competencies, Development Techniques, and Accountability

The first step is to create a career roadmap. Career roadmaps are helpful for employees to identify the sequential positions, roles, and stages of a prototypical career. They facilitate career growth and advancement of employees within an organization because they provide general guidelines for moving within and across jobs. Career roadmaps are typically designed to display in a diagram for ease of understanding.

The second step is to build position profiles. Responsibilities, skills, and requirements of each position can be defined in a position profiles in order to create distinctions among different job positions. To create a position profile, Cao and Thomas suggest that organizations should seek opinions from subject-matter experts, discuss with functional leaders, and conduct industry benchmarking externally. Using position profiles, employees can determine what are the recommended or required qualifications in order to perform adequately.

The third step is to identify core competencies and expected behaviors. While the position profiles provide a foundation of required qualifications, a career model should identify competencies that specify differentiating behavior exhibited by exceptional employees. Cao and Thomas believe that competencies may drive job performance, promote business strategy across the organization, and change initiatives to the organization through performance and behavioral standards. It is also noted by Cao and Thomas that competencies are usually the same in one career stage to the next, the differences between career stages are the scope and impact of the competencies.

In Figure 30, a vertically-integrated competencies diagram is presented in the article of Cao and Thomas to illustrate the degrees of work (six main themes) and titles/roles that technical manager should possess at three different job levels.
Incorporate training and development is their fourth step. In order for employees to develop the required position profile and the identified competencies, Cao and Thomas discuss the importance of incorporating training and development into a career model. They identify five developmental opportunities that allow employees to not only develop competencies needed for the next career stage, but also determine their career moves. The development techniques identified are “leadership training courses, stretch assignments, cross-functional teams, profit and loss responsibility, and international exposure.”

The fifth and final step is to establish accountability. Organizations should create mechanisms to measure the effectiveness of each component of the career model. These mechanisms should assign roles and responsibilities to individuals to support the career model.

Moreover, Cao also lists the key elements that lead to a successful implementation:

• **Communication** – Organizations should ensure that their employees have high awareness of the vision and philosophy of the organization’s career development.

• **Support** – tools and guidelines should be implemented to enable both the employees and employers to commit to their role and understand the importance of the career development process. Table 29 specifies the support needed for employees, managers, and external support.
• **Collaboration and Communities** – Building connections among employees to enable them to discuss career options and help each other with the learning and growing process.

• **Success Stories** – Sharing success stories may inspire employees to pursue a more creative and customized career path.

• **Strategic Analytics** – To further improve a career model, Cao and Thomas suggest that organizations should identify the gap between the answers to the following two questions in order to grasp a clearer picture of how to strategize to initiate and drive change. The two questions are:
  o What capabilities are needed to drive a desired change?
  o What capabilities the workforce actually possesses?

### 10.5 The Army Career Model

**Key Parameters**

- **Subject Domain:** Systems Engineering
- **Source Type:** Article

Gavito and Pennotti (2014) design a leadership development model for Systems Engineers within the Army. The goal of the Army Career Model is to significantly enhance the capabilities
and skills of qualified Systems Engineers to help fill Key Leadership Positions and Army Engineering Acquisition Career Field Critical Acquisition Positions (CAPs).

They identify five elements in their career model: education, experience, tenure, currency, and cross-functional competencies (see Figure 31).

![Figure 31 The Top-level Architecture of the Army Career Model; Source: Gavito and Pennotti (2014)](image)

### 10.5.1 EDUCATION

Gavito and Pennotti define education as a college degree which is advanced or relevant to a person’s functional area. The Acquisition, Technology and Logistics (AT&L) Workforce members are able to attend career development and the Acquisition Tuition Assistance Program through the Acquisition Education, Training, and Experience (AETE) program offered by the U.S. Army Acquisition Support Center (USAASC) to pursue additional educational opportunities.

### 10.5.2 EXPERIENCE

The study notes that in order to qualify to fill KLP positions, a person is to have 6-8 years of experience in acquisition, and be Level III certified. The Army's Senior Enterprise Talent Management (SETM) program is available for GS 14 - GS 15 to provide them with senior-level developmental experience and education.

### 10.5.3 TENURE

Gavito and Pennotti define tenure following the Office of Under Secretary of Defense for Acquisition, Technology, and Logistics (OUSD(ATL)) memo that a Key Leadership Position assignment is to have a written tenure agreement, comprised of significant milestones and events of the program.
10.5.4 CURRENCY

They also define currency following the OUSD(ATL) as training consisting 80 hours of continuous learning points (CLPs) in two years.

10.5.5 CROSS-FUNCTIONAL COMPETENCIES

Cross-functional competencies are an important part of the career model. The study notes that the cross-functional competencies are typically attained in an ad hoc manner, instead of through a systematic and conscious approach.

10.5.6 INTEGRATED CAREER MANAGEMENT

Gavito and Pennotti identify the importance of Army Career Tracker, a comprehensive career development system that integrates education, training, and work assignment history. The study suggests that the Army Career Tracker can assist in tackling the existing issue that many career development programs within the Army are developed independently and managed by different organizations.

10.5.7 MENTORING

Gavito and Pennotti note that mentoring can be a powerful tool for supporting and guiding the development of Engineering Acquisition Field Engineers. They discuss an existing mentoring program in the Army, the Army Mentorship Program.

10.6 ATLAS CAREER MODEL

Key Parameters

Subject Domain: Systems Engineering
Source Type: Article

The Atlas career model was developed by Pyster, et al. (2013, 2014, 2015, 2016), at the Systems Engineering Research Center over a number of years. The primary elements in the Atlas career model are discussed below.
10.6.1 Career Stages, Competencies, Leadership Development Techniques, and Competency Attainment

Pyster et al identify three career stages (junior, mid-level, and senior), based on three criteria: the number of formal leadership positions, the scope of their work, and the number of system lifecycle phases the person in which the person has gained experience. The junior level is characterized as by at most one leadership position, working at the component level in at least two system lifecycle phases, while the senior level is characterized by more than two leadership positions, working up to the system or system of systems level, with accumulated experience in at least four system lifecycle phases.

Systems engineering roles are an important component of Pyster et al.’s career model, and they identify sixteen, ranging from requirements owner and system designer to technical manager and organizational / functional manager.

Pyster et al’s notion of proficiency corresponds to competencies, “the proficiency of an individual is the quality or state of knowledge, skills, abilities, behaviors, and cognition.” They identify six high-level groups of competencies (math / science / general engineering, system’s domain and operational context, systems engineering discipline, systems engineering mindset, interpersonal skills, and technical leadership. For Pyster, et al., technical leadership is defined as the “skills and behaviors associated with the ability to guide a diverse team of experts toward a specific technical goal,” and consists of the following detailed categories: building & orchestrating a diverse team, balanced decision making & rational risk taking, managing stakeholders and their needs, conflict resolution & barrier breaking, and business & project management skills.”

In Pyster et al’s career model, leadership development techniques are referred to as forces, and include experience, mentoring, and education and training.

Finally, the researchers recognize that measuring competency attainment is a part of the model. They obtained self-assessment ratings from one (least proficient) to ten (most proficient) from a subset of their interviewees.

10.6.2 Career Model

Pyster et al.’s career model consists of a number of components, which they bring together in the following visualization: a timeline, educational milestones, career milestones, organizations, positions, roles, lifecycle phases, proficiency profiles (see Figure 32).
Pyster, et al., define a career path as, “the precise combination (in terms of characteristics, timing, and order) of experiences, mentoring, and education and training that they undergo during their entire career.” The researchers describe one career path of a real chief systems engineer from among all of the system engineering leaders that they interviewed. The descriptive data that they provide on this leader includes the number and types of educational degrees, the number and types of roles and positions, the number of types of systems engineering lifecycle phases experienced, and three levels of proficiency (or competency) realized at three points on the timeline.

In subsequent work, Pyster et al (2016) refine their initial career model to specifically focus on five aspects of career paths: experience, education, key positions or milestones, self-assessment proficiency (or competency) ratings, and a timeline. They have developed a method to catalog, analyze and compare career paths, which they term Vector. Future work is determining how to achieve better self-assessment proficiency ratings.
10.7 BP (British Petroleum)

Key Parameters:

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By 2000, BP had 35 different leadership development programs, in part due to a series of mergers and acquisitions, resulting in decentralized learning and development. These 35 different programs varied widely in their effectiveness. Therefore, BP formed a Learning and Development Committee in 2000, consisting of eight senior BP executives, to change this situation. The Committee further charged a three-person team a mandate to improve this decentralized, uneven learning by producing a new First Level Leader program which would be centralized across BP (Brown et al., 2005; Priestland & Hanig, 2005).

In 2000, the Learning and Development Committee held a number of workshops to gather input from the first level leaders themselves. In June 2001, the Committee met with fifteen human resources and learning professionals, representing the geographic diversity of the global company, to design the program curriculum. The First Level Leader courses were piloted at six different locations globally, and released into production starting in January, 2002. Subsequently, a Senior Level Leader Program and a Professional Recognition Program were also designed and developed. Finally, a Future Leaders Program was added to BP’s learning and development portfolio.

Note that because BP’s business includes exploration and production, refining, distribution and marketing, petrochemicals, power generation, and trading, it is argued that BP is a technical firm operating in a technical industry, and therefore the participants in its leadership development programs consist primarily of technical leaders.
10.7.1 BP’S CAREER STAGES

BP specifically designed its leadership development program by career stage. As noted above, BP’s first priority in 2000 was to develop a program for its First Level Leaders, which corresponds to the Framework’s mid-level career stage, while its Senior Level corresponds to the Frameworks’ senior level career stage. Specific details regarding the definition of the levels were not available in the literature identified.

10.7.2 BP’S COMPETENCIES

BP did not base its leadership development program on competencies. Instead, competencies, or behaviors, were identified after the First Level Leader Program was established in order to evaluate the effectiveness of the First Level Leader Program. BP identified seven categories of competencies, that they term behaviors, by interviewing three hundred BP employees globally. From these interviews, they identified the following seven categories of behaviors:
organizational awareness, interpersonal skills, communication skills, confidence and self-awareness, management skills, leadership skills, and team performance.

Below is the overview diagram of seven critical behaviors identified by importance at the different leadership levels.

![Figure 34 BP's Behavioral Competencies by Career Stage; Source: Brown (2005)](image)

**10.7.3 BP's Leadership Development Techniques**

BP has specific programs oriented to four of the Framework's leadership development techniques: training, job rotations, mentoring and coaching.

**10.7.3.1 Training**

The First Level Leader training program consists of three training components (supervisory essentials, context and connections, the leadership event) and one coaching component (peer partnerships).

The Supervisory Essentials course emphasizes the fundamentals of management. First level leaders receive training in project management, technology, and health, environment, safety and social responsibility issues. Course delivery includes a mix of local, in-person training and e-learning modules. Specific topics include financial decision making, safety leadership, local
Health, Safety, Security, and Environment (HSSE) and legislation, employment legislation, and ethics.

The Context & Connections course focuses on BP’s strategy and the implications of that strategy for the entire organization. As BP’s strategies and priorities change, the course is updated to reflect the changes. Specific topics include organization structure, performance goals, BP’s global and regional strategy, and the BP brand and what BP stands for.

The Leadership Event is a combination of in-person training from senior executives and action learning. The in-person training from senior executives addresses building communication, management, and leadership competencies; developing confidence and self-awareness; and handling management dilemmas. The action learning includes role playing exercises designed to build awareness of diversity and inclusion, making less ambiguous statements, and analyzing the teams’ communication style. Additional specific topics in the Leadership event include the role of leadership in BP, the role of the first level leaders, leading self and others, and leading teams.

BP does not use internal or external training professionals to teach the courses, but rather uses 250 of its own internal senior managers.

BP has also designed a Senior Level Leaders (SLL) program, which is applicable for senior level leaders. The Senior Level Leaders program consists of executive training content developed with Harvard, Stanford, and Cambridge Universities, as well as external coaches. Specific topics in this program include leadership styles, innovation, the international business framework, social and environmental responsibilities, individual behaviour, and personal impact.

Finally, BP has developed a Professional Recognition Program. The Professional Recognition Program supports a technical career track, including engineering. The focus of this track to develop, recognize, and promote subject matter experts. People in the technical career track are responsible to provide specialist advice, shape company policy, set an example to others in the same field, and to lead best practices throughout the company (pp. 145-6).

**10.7.3.2 JOB ROTATIONS**

BP has also developed a Future Leaders Program. This program is oriented towards those in the direct reports stage, which corresponds to the Frameworks’ junior career stage.

In this program, the leadership development technique most heavily relied on is job rotations. The Future Leaders program consists of two 18-24 month job rotations. In the first rotation, the program participant receives an overview of BP and an understanding of important decision making processes. In the second rotation, the program participant is placed on an international assignment. In addition to learning everything that comes by moving to an international role, the focus is also to build technical expertise and commercial acumen.
One best practice aspect that BP chooses to highlight in the Future Leaders Program is the community of people that is formed from such a technique. Specifically, program participants meet in-person at special events and conferences, as well as connecting virtually.

Part I of the rotational assignment is to gain an overview of BP and understanding the key decision making process. Structured leadership training is provided during the course of the rotational assignments and participants will be given an opportunity to work with senior managers and their assigned mentors to develop their personal career path.

Part II of the rotational assignment involves international assignments that allow participants to develop their commercial acumen and technical expertise within the energy industry. Personal development training is provided and participants can also expand their professional network.

**10.7.3.3 MENTORING**

Mentoring is reported to be integrated into at least three of BP's leadership development programs: the Future Leaders Program, the First Level Leaders Program, and the Senior Level Leaders Program. In the Future Leaders Program, the aspect of mentoring that BP emphasizes is the ability of the mentor to help the participant formulate a personal development plan. No details were reported of the Mutual Mentoring Program in the First and Senior Level Leaders Program.

**10.7.3.4 COACHING**

The First Level Leaders Program consists of a coaching component called Peer Partnerships. In the Peer Partnerships program, a new first level leader is assigned to a more experienced colleague. This coaching relationship may continue beyond the end of the First Level Leaders Program.

**10.8 CATERPILLAR**

Key Parameters:

- **Subject Domain:** Construction equipment manufacturing
- **Scope:** Corporate, globally
- **Program Name:** Leadership & Technical Development Program, Information Technology Developmental Program
- **Source Type:** Articles

In 2001, Caterpillar established Caterpillar University to advance continual learning. One of the initiatives that Caterpillar University began to increase leadership talent was to develop a new competency model. (Anderson & Arvin, 2003, p. 182) Caterpillar University also initiated a move away from classroom-delivered training to e-learning. Caterpillar University also created
a number of schools so that each could focus on a specific area. These schools include the School of Operator Training, the School of Safety, and the School of Service. Together, these three schools provide Caterpillar University’s course offering as follows: Environmental, Health and Safety Training (92 courses), Mine Safety & Health Administration (MSHA) Training (27 courses), Strategies for Safety Management (12 courses), Corporate Account Customer Operator Training (17 courses), and Public Customer Service Training (~ 90 courses). For Caterpillar, a course includes computer-based training modules as short as ten minutes (six minute video with a four minute test) to six hours, with most courses being an hour or less. Caterpillar University also established a Knowledge Network, which consists of over one thousand communities that share best practices, processes, concepts, specifications.(Anderson & Arvin, 2003, p. 182)

Caterpillar has ten professional development programs (Leadership & Technical Development Program, Engineering Rotational Development Program, Finance Services Development Programs, Analytics Professionals, Communications Professionals, HR Professionals, Returning Professional Development Program, Technical Marketing, Information Technology Developmental Program, UK Graduate Opportunities). We focus on the Leadership & Technical Development Program because of its relevance, and the Information Technology Developmental Program to expand the breadth beyond engineering leadership development programs.

Note that because Caterpillar’s business focuses on heavy construction equipment manufacturing, it is argued that Caterpillar is a technical firm operating in a technical industry, and therefore the participants in its leadership development programs consist primarily of technical leaders.

10.8.1 CATERPILLAR’S CAREER STAGES

The learning and development literature on Caterpillar does not report a link from its competencies or learning and development to the company’s career stages, although assuredly one does exist.

10.8.2 CATERPILLAR’S COMPETENCIES

Caterpillar’s competency model consists of the following competencies: interpersonal skills, problem-solving skills, communication skills, leadership skills, organization and planning skills, technical skills, responsibility, assertiveness, flexibility and judgment.(Bohlander & Snell, 2010, p. 242)
10.8.3 CATERPILLAR’S LEADERSHIP DEVELOPMENT TECHNIQUES

Caterpillar has specific programs oriented to two of the Framework’s leadership development techniques: training and job rotations.

10.8.3.1 TRAINING

Caterpillar’s Leadership & Technical Development Program consists of five different career tracks, comprised of training components:

The First Level Leader training program consists of three training components (supervisory essentials, context and connections, the leadership event) and one coaching component (peer partnerships).

10.8.3.2 JOB ROTATIONS

As the Leadership & Technical Development Program is heavily oriented to job rotation for each of the five different career tracks, we summarize them below.

The Operations Leadership Track consists of three job rotations over three years, focusing on operations management. The three rotations are in manufacturing engineering, operations supervision, and a cross-functional area. The specific job rotation assignment is based on a combination of the person’s development goals and business need. Program participants who complete the Operations Leadership Track remain in the Operations Management area for
another two to three year assignment in product engineering, process engineering, supplier quality, research and development or supervision.

The Supply Chain Management Track also consists of three job rotations spanning three years, oriented to supply chain management. The first two rotations are in material planning, demand and orders planning, and inventory management, while the third rotation is in a cross-functional area.

The Environment, Industrial Health and Safety Track is structured slightly differently from the above two tracks. Specifically, this track consists of two job rotations in one year. The first rotation occurs in the corporate-level Environment, Industrial Health, and Safety Track. The second rotation occurs in the EHS facility, and may include a focus on environmental affairs, industrial hygiene, and safety, ergonomics, or hazardous materials. When these two rotations are complete, the program participant is placed in another two to three year assignment in the EHS facility.

The Procurement Track consists of three rotations spanning three years, from among the following five positions: process control engineer, buyer / purchasing analyst, operations supervision, supply chain / logistics, manufacturing quality.

The Information Technology Developmental Program is also heavily oriented to job rotation, this time among four different career tracks.

The Business Solutions Track consists of rotations among product development, e-commerce, portal, integration, SAP/ERP and big data. The Infrastructure Track consists of rotations among storage/server, database, cross-functional tools, and productivity solutions. The Process Management Track consists of rotations among IT service management, program management, usability, and Six Sigma. The Information Security Track consists of rotations among risk mitigation, brand protection and intrusion protection.

10.8.3.3 MENTORING

New employees are matched with a formal mentor that provides guidance and development throughout an employees’ career progression.

10.9 CONSTRUX

Key Parameters

Subject Domain: Software Engineering
Scope: Corporate-level
Program Name: Professional Development Ladders
Stuart (2011) describes the professional development ladders built by Construx Software. The study identifies “the insufficient knowledge transfer of industry best practices and undefined career paths for software engineers” as the primary challenges facing the organization. The goal of this professional development ladder is to enable knowledge transfer to its technical employees and build a foundation of knowledge and skills across the organization.

### 10.9.1 Construx’s Competencies

Construx’s career ladder identifies ten Competency Knowledge Areas (CKAs) required for software engineers, based on IEEE’s Software Engineering Body of Knowledge:

- **Configuration Management** – Controlling changes to IT project artifacts, and control of IT system versioning and release to the customer.
- **Construction** – Writing software code to implement a particular design.
- **Design** – Defining the architecture and state of the IT system.
- **Engineering Management** – Administering the software function in terms of project, personnel, and business factors.
- **Tools and Methods** - Using software engineering technologies and techniques to create software.
- **Process** – Work related to improving software development quality and productivity, and decreasing time to produce the product.
- **Maintenance** – Work related to installing, deploying, and operating software on an ongoing basis.
- **Quality** – Work conducted on software to ensure that software meets technical requirements (i.e. verification and validation).
- **Requirements** – Identifying, modeling and documenting the user’s needs, and translating into associated functions to be implemented.
- **Testing** – Running the software under a variety of scenarios and conditions to empirically determine any problems and evaluate functionality and features.

There are four different capability levels distinguished for each Competency Knowledge Area. The first capability level is introductory, in which a person conducts the basic work tasks, typically under supervision. The second capability level is competency, in which a person conducts independent work, is a role model for introductory-level people, and sometimes coaches others. The third capability level is leadership, in which a person conducts outstanding work, regularly coaches others, and provides project-level leadership. The fourth capability level is mastery, in which a person provides industry-level leadership, and has either taught classes or written published articles or books on the topic.
10.9.2 Construx’s Career Model

The main focus of Stuart’s work is to build a professional development ladder that is suitable for software engineers. A progression in ladder levels requires employees to gain additional breadth (more knowledge areas) and depth (deeper understanding) within various CKAs. There are 8 ladder levels and the scope of responsibilities, experiences, and coverage of CKAs increases as ladder levels rise.

For example, college graduates that start at level 9 as they being to learn about the principles of being software engineers and they work under close supervision. At level 10, they should possess some background in software engineering and has 1-2 year of relevant work experience. At level 11, they should possess a strong background in software engineering and have the ability to work independently.

At each level, the professional development ladder specifies the exact requirement of how engineer can progress to a certain ladder level given the CKAs. For example, Figure 36 and Figure 37 show the requirements for a software engineer to reach level 10 and level 12 respectively. The highlighted boxes are the required capability level.

![Construx Capability Level Requirements for Level 10](image)

Figure 36 Construx Capability Level Requirements for Level 10; Source: Stuart (2011)
10.9.3 Construx’s Leadership Development Techniques

Each KSA is accompanied by detailed description of activities necessary to obtain each level of capability (introductory, competence, leadership, mastery levels discussed in the competencies section) within each CKA, producing a total of 30 different capability areas. Activities may include readings, classroom education, attending seminars, and obtaining professional experiences.

For example, Stuart provides an example of activities required to reach each capabilities for one of the CKAs, engineering management.

In order to reach the “Introductory” capability level in engineering management, employees must complete the following activities:

- **Readings** – Three software-related texts are required.
- **Work Experience** – Employees should be able to “plan and track personal activities, and review a project plan”.

To reach the “Competency” capability level in engineering management, employees must complete the following activities:

- **Readings**
- **Work Experience** – Employees must “participant in the creation of a project estimate, act as reviewed on at least one project pan, and assist with project management on at least one project”.
- **Seminars** – Employees must “attend a software project management boot camp and also a seminar on software estimation in depth”.

Figure 37 Construx Capability Level Requirement for Level 12; Source: Stuart (2011)
In addition, Stuart also discusses other development approaches that reinforce the professional development ladder. He emphasizes on the importance of structural and cultural reinforcements to ensure everyone is fully engaged in the system in order to achieve desired benefits. The following reinforcements are discussed:

10.9.3.1 MENTORING

Mentoring process within Construx is tailored in order for its employees to develop an appropriate and practical professional development plan. Support and guidance are provided as employees attempt to move up the professional development ladder. All employees from level 8 – 11 must have mentors that allow for discussion and development of their professional development plan. Employees at level 12 or above are not required to have a mentor as they have reached a significant milestone that they possess the ability to work independently. However, mentors can be assigned to them if “they specifically request a mentor or wish to work towards an additional grade level promotion”.

10.9.3.2 TRAINING PROGRAM

The organization “targets 10-12 days of focused training per year”, and also provides on-the-job training during any software development work. Training approaches for employees at lower ladder levels are primarily to attend classes and conferences, while employees at level 12 or above have to engage in professional activities such as preparing for conference presentations and organizing interest groups.

Other Leadership Development Techniques are also discussed:

Professional Development Plans (PDPs) – PDPs provide a comprehensive tool to “plan, track, and document career progression along the ladder”. The primary goal of PDPs is to outline the work an engineer needs to accomplish within 1-5 year in order to achieve a grade level promotion.

Professional Development Plaques – The organization recognizes a range of milestones, such as any “promotions, first class taught, first paper published, or first leadership role on projects”. They can show appreciation and reflect the importance of the contribution of employees.

Performance Review Program – Standard performance reviews can provide valuable feedback for employees.

Software Engineering Discussion Groups – They allow employees to engage in discussions that enrich their software engineering knowledge.

10.10 SHELL

Key Parameters:

Subject Domain: Information Technology in the energy sector
Shell’s career model incorporates the management, learning, and development of IT competencies.

10.10.1 CAREER STAGES

Shell’s career model consists of four career stages: the early career, consisting of technical and project roles; the mid-level career, consisting of supervisory and advisory roles; the senior-level career, consisting of management roles; and the executive-level career. In addition to the career stages, all IT jobs within Shell are categorized into eight skill pools and each pool has different roles defined in a career path. The eight skill pools are as follows: IT Service Delivery & Support, IT Solutions Consulting & Development, Business Analysis, IT Project & Programme Management, IT Service Management & Integration, IT Strategy, Planning & Portfolio Management, and IT Governance. Figure 38 provides a visual summary of how Shell views its leaders progressing from one level to the next through different roles and skill pools (Anonymous, 2008).

![Figure 38 Shell Sample IT Job Progression Map; Source: Shell (2008)]
Shell’s Leadership Development Techniques

Shell uses four techniques to develop its leaders. The company is a strong advocate of training, offering Shell Open University courses and e-learning tools, and supporting external training and professional certifications offering training. Second, the company promotes professional experience, including professional certifications and projects as well as experience. Third, Shell supports self-development through reference materials, including books and publications, as well as websites and professional communities and networks. Finally, Shell also recognizes development techniques including mentoring and coaching, and learning through discussion with third parties and stakeholders.

As an example, Shell identifies and details the following coaching and on-the-job experience in order to develop IT project management competency:

- Identify a certified project manager, and receive mentoring from them.
- Understand project management tools, methodologies, and standards.
- Receive training from project management courses.
- Gain experience by taking part in a technology implementation project.
- Obtain the Project Management Professional certification.
- Lead an IT project characterized by moderate scale and complexity.
- Engage in various project management office roles to provide depth.
- Accept responsibility for an IT project management role characterized by a large scope and complexity, increasing breadth of business knowledge, and experience working with stakeholders, possibly in a multi-cultural environment.
- Obtain internal project management accreditation.
- Continue participation in project management community to identify and share best practices.
- Mentor and coach junior and mid-level project management staff.

As a different example, Shell identifies and details the following professional experience to develop IT project management competency:

- Start with various roles in IT service operations, technology evaluation, and implementation to gain technical depth, and understanding delivering IT services to the business.
- Undertake junior roles in IT project management, utilizing project management tools and methods, for projects having low to moderate complexity.
- Advance to roles in the project management office, recommending and applying project management tools and methods to support IT projects.
- Take on a role in business IT to acquire business knowledge and develop relationships with stakeholders.
• Become a lead or senior project manager of IT projects characterized by high complexity, global scope, and a multicultural and/or multi-vendor environment, directly reporting to the project steering committee and stakeholders.

### 10.10.3 Competency Attainment

For Shell, the competency attainment process is where competency attainment and the other elements come together to form the career model. In the first step, competencies are assessed through a self-assessment and supervisor’s evaluation. In the second step, the employees and supervisors discuss this together, to agree on competency gaps. In the third step, the employee formulates an individual development plan. In the fourth step, the employee actions the development plan, while in the fifth step, they receive coaching and mentoring. This sixth, and final step before beginning the process again, is for the employee to go through the annual performance appraisal.

![Diagram](image)

*Figure 39 Shell Competence Development Cycle; Source: Shell (2008)*

### 10.11 Raytheon’s Technical / Leadership Development Program

Key Parameters:

- **Subject Domain:** Aerospace Engineering
- **Scope:** Corporate-level (Raytheon) and department-level (Raytheon Missile Systems Quality)
- **Program Name:** Technical / Leadership Development Program
- **Source Type:** Interviews
Leadership development is closely integrated with an HR function that Raytheon calls “talent development.” The Talent Development organization is responsible for recruiting, training, and career management of all employees, not just technical personnel.

Talent development is corporate focus at Raytheon. We were given anecdotal examples of candidates for top leadership positions in the company that were rejected out of hand personally by the CEO because they had not completed development activities or did not have a personal development plan on hand. An integrated company wide system collects and records information about employee development and automatically makes that information available to hiring managers at every level and for all employee categories. The Raytheon Missile Systems technical leadership development program(s) exist within the context of this corporate level infrastructure, and are strongly supported by it.

Raytheon has a concept called “assignability” which evaluates whether an employee, having completed the required training and experience requirements for a given job assignment, is actually considered available for assignment. Much of the leadership development apparatus is designed to provide hiring managers with hard data (on performance and other factors) that can be used to make assignments, which are – in accordance with corporate culture – made collectively by groups of managers across functional and program organizations and staff elements during what they call a “talent review” meeting. We interviewed senior managers (executive level) and SMEs in several organizations highly aligned with the RT-149 scope: Test & Evaluation, Engineering, Quality management, IT, and Project Management (Raytheon Missile Systems does not have a separate S&T function – it is small, and integrated into the engineering organization).

Within Raytheon, the Missile Systems Quality department contains several best practices in terms of leadership development, and therefore was selected as a best practice department within the company. Many of the named programs discussed below are pertinent to Missile Systems Quality, such as EOQ rotations. While EOQ rotations are discussed below, it is important to note that Raytheon has additional rotation programs within the entire company.

Raytheon’s overall technical / leadership development program may be visualized as shown in Figure 40.
Raytheon’s career path can be described as using a linear, bifurcated career model. One specific example of such a model in Raytheon is the Quality department’s career track in the Missile Systems division at Raytheon (see Figure 41). In this career model, new technically trained college graduates are hired into the technical track, and progress up the technical track, through the junior and mid-level stages. When they reach the senior level is the point where the bifurcation occurs: the career track branches into two ladders, one being a technical track, and the other being a management track.

Raytheon has a specific program, the E44 Pipeline Program, related to this Framework element. Raytheon created the E44 Pipeline Program to support a career track for the technical expert to complement the management career track. In this expert technical career track, there are two positions available: Engineering Fellow (E44) and the Principal Engineering Fellow (E88). The requirements for Engineering Fellow include demonstrated technical achievements, inventions (such as patents), publications, and program technical expertise, and the requirements for the
Principal Engineering Fellow include these and national recognition in the person’s field of expertise. The Engineering Fellow corresponds to the Framework’s senior technical leader, while the Principal Engineering Fellow corresponds to the Framework’s executive technical leader.

![Figure 41 Raytheon’s Linear Bifurcated Career Path Structure](image-url)
Raytheon structures its competencies into two overall groups: technical competencies and leadership competencies. The technical competencies are specific to divisions and to departments in divisions. For example, the Quality department in the Missile Systems division has identified a set of technical competencies, called Quality Engineering Competencies in ten categories: continuous improvement, process control, product and process design, quantitative methods and tools, quality system, customer-focused organizations, quality management tools, strategic management development and deployment, supplier management, and training and development. Raytheon’s leadership competencies are corporate-wide, and consist of the following twelve areas: strategic and visionary thinking, customer focus, ethical leadership, achieves alignment, performance/results, business acumen, innovation/creativity, diversity/inclusive, people development, influential communication, courage, and self-management. For Raytheon, the competencies form a critical part of their leadership development program.

The Program Management Excellence organization evaluates all Program Management candidates on a spider chart against a couple of dozen competencies divided into “domain” (meaning Program Management skills) “technical” (meaning science and engineering skills) and “leadership” (similar to our enabling competencies). The results of this process are used in the Program Management organization to determine “assignability” to Program Management candidates at six levels, ranging from level 1 (the SM-3® and Tomahawk® programs) to level 6 (small, short term projects of limited duration and staffing). Program Managers cannot be assigned to lead a program for which they have not satisfactorily met the assignability criteria for the appropriate level. The program levels are based on consistent across Raytheon, so Raytheon Missiles is the only business unit with level 1 programs.

Raytheon has a specific program, Integrated Talent Strategies, which related to this Framework element. Integrated Talent Strategies is a corporate level developmental strategy in which current and future competency needs are identified, and these current and future competency needs become the basis to drive competency hiring and development. The Integrated Talent Strategies Program is a five year plan that identifies retired talent and news skills, that is, buy talent, which resulted in a hiring list for about 800 people.

Raytheon Missile Systems Quality department has specific programs oriented to three of the leadership development techniques: training, job rotations, and mentoring.

10.11.3.1 Training
The Raytheon Missile Systems Quality department has four programs related to training: lunch time learning, QM Community of Practice, Quality Professional Symposium, and internal and external certifications.

Lunch Time Learning is an informal training technique in which team members can learn, discuss challenges, and learn from peers over lunch.

The Quality Management Community of Practice is an informal training technique consisting of a monthly meeting which allows participants to gather relevant and timely information, discuss any challenges and opportunities, and implement specific actions to improve the team.

The Quality Professional Symposium is an annual event providing targeted learning as well as the opportunity for the individual to build their network.

Raytheon Missile Systems Quality department advocates both internal and external certifications. Certifications are classified as training because the learning that takes place is analogous to the learning that takes place from instructor-led training courses. The actual certificate itself corresponds to a measurement of the self-led training, Framework element 4, competency attainment.

The internal Mission Assurance Certification Program is open to all Raytheon employees, not just those in Mission Assurance. The goal of this program is to provide knowledge and expertise depth in the Mission Assurance field. The internal Mission Assurance Certification program consists of an online course, as well as required experiences, to get certification. There are five levels of certification in this program. The Quality Engineering Center Director handles the qualifying at the lowest two levels (Levels 4 and 5), while at the top level (Level 1), certification is handled by a Mission Assurance Council.

The external certification is the Certified Manager of Quality / Organizational Excellence by the American Society of Quality. The primary topics in this external certification are consistent with competencies, and include the following topics: leadership, strategic plan development and deployment, management elements and methods, quality management tools, customer-focused organizations, supply chain management, and training and development.

At the corporate Raytheon level, certification must occur in a person’s field of expertise. For a person whose expertise is in quality, program management is not a valid certification.

10.11.3.2 JOB ROTATIONS

The Raytheon Missile Systems Quality department has two programs related to job rotations: EOQ rotations and MA rotations.

Participants in EOQ (Engineering, Operations, and Quality) rotations consist of early stage, highly performing engineers. The rotations occur through Missile Systems Division Directorate
in Engineering, Manufacturing and Test Engineering in Operations, and Quality in Quality & Missions Assurance. The purpose of the cross functional rotation program is to build competency breadth and expanded business acumen through experiential learning.

An MA rotation is a rotation in Mission Assurance.

10.11.3.3 MENTORING

Raytheon specifically distinguishes mentoring from both coaching and managing as follows. For Raytheon, mentoring occurs outside of the direct reporting relationship (i.e. manager-employee relationship); the mentee is the one who takes the initiative; and the focus is on the mentee’s career or professional development. As a part of the Mentor Program, Raytheon provides a guide to the mentor to assist in building productive mentor-mentee relationships. The guide is based on an external source (i.e. CEB Analysis). The guide consists of expectations regarding performance expectations, time commitment, mentor “citizenship”, development partner, role model, and broker for resources. The guide also includes a list of nine questions for the mentor to ask the mentee to assist them in structuring the relationship. Finally, the guide provides suggestions for building and sustaining momentum, including tips for building the meeting plan, suggestions for potential agenda topics, and suggestions for potential activities.

At Raytheon, it is the employee (or mentee) who is tasked to go get a director mentor. They are also told to mentor a peer or subordinate.

10.11.4 RAYTHEON’S ADDITIONAL TECHNICAL / LEADERSHIP DEVELOPMENT PROGRAMS

Raytheon has two programs which combine multiple Framework elements: the Top Talent Program, and the Career Progression Guide.

10.11.4.1 TOP TALENT PROGRAM

The Top Talent Program consists of collaboration meetings, technical and leadership development activities, mentoring, experiential activities, and industry conferences for top performing early and mid-career employees in Quality & Missions Assurance. The Top Talent Program consists of people who have achieved an E (Exceeds) or F (Far Exceeds) rating. People in this program receive extra assignments, report to the leadership team, and participate in networking events. This program spans several Framework components: technical and leadership development and mentoring, with experiential activities perhaps mapping to job assignments.

10.11.4.2 CAREER PROGRESSION GUIDE

Raytheon Missile Systems Quality Career Progression Guide is a corporate development tool that provides an individual with the opportunity to conduct a competency gap self-assessment, and then develop action plans to address those gaps, resulting in furthering their career development. It corresponds to the Framework’s career stages and leadership development techniques elements. We provide a detailed discussion below.
Raytheon Missile Systems Quality has developed a Career Progression Guide, which outlines the quality function roles and responsibilities, leadership roles, career progression and career progression resources. The guide is a career development and management tool enabling those employees in the Quality department of the Missile Systems division at Raytheon to develop, implement, and sustain their career development. As Raytheon has designed and developed a competency-based career model, the Career Progression Guide builds on this established base by identifying the high-level responsibilities and competencies associated with the career stages or labor grades for Quality and Mission Assurance roles. The Career Progression Guide also provides self-assessment tools and a list of resources by which a person can conduct a competency gap analysis to identify opportunities for future development.

Raytheon follows a competency-based career development model. The technical competencies vary by function and discipline. Within the different disciplines identified within Quality Engineering, there are four groups of common skills identified: capture management, processes and tools, domain knowledge, and customer interface. These skills are explicitly or implicitly incorporated in the Quality Engineering Roles and Responsibilities.

Section 1 of the Career Progression Guide outlines the Quality Engineering Roles and Responsibilities, from junior to mid-level, i.e. E01 to E05/E06. For each of the five roles, six or seven facets are identified that characterize the role: knowledge level, problem solving, discretion, impact, behavior, liaison, and experience and education.

It is observed that as one moves up the roles, the scope or breadth increases. For example, in the first labor grade level (E01), problem solving is characterized as understands and develops solutions to problems of appropriate complexity, while in the second labor grade (E02), the problems are characterized as having moderate scope and complexity, and in the third labor grade, the scope advances to a wide range of problems.

Section 2 of the Career Progression Guide discusses the Leadership Roles and Responsibilities. Raytheon has identified twelve leadership competency areas, each having their own specific key actions. For each of the three leadership roles identified, six or sevens facets are identified that characterize the role: impact, liaison, experience and education, guidance, policy involvement, supervisory relations, and operations involvement.

Section 3 sets forth the career progression. It contains the Quality Employee Career Development workbook, which consists of three steps: 1) setting career goals, 2) conducting the career self-assessment, and 3) determining actions and timelines. The career self-assessment also includes the 360 Leadership Assessment process. The 360 Leadership Assessment process is a structured approach to gather feedback from leaders, direct reports, peers, and colleagues on a person’s leadership effectiveness, using Raytheon’s 12 leadership competencies.

Section 4 identifies career progression resources, including tips, and a number of internal and external websites.
In addition, Raytheon uses an experiential grid or matrix that tracks employee assignments and competency attainment. One of its objectives is to give millennial engineers control of their own career development. The experiential grid is also a way to track incremental progress toward “assignability” at the next level. Employees are rated as “far exceeds” “exceeds” “meets” or “fails to meet” competencies at each level, and must achieve the “exceeds” or better level on all competencies before being eligible for assignment at the next level.

### 10.11.5 Raytheon’s Career Model

Raytheon Missiles experience with starting entry level engineers on a path toward “chief engineer” qualification was not initially very successful: they spent a lot of time on technical breadth, with success in broadening participants engineering skill set, but were not successful in placing individuals in higher level jobs. As a result, they changed the process to concentrate on the four things they believe are important: 1) the “art” of chief engineering; 2) a narrow but deep technical base; 3) soft skills; and 4) the Chief engineer as Technical Executive. The key takeaway here is that the “technical breadth” we all believe are important for technical leaders does NOT mean knowing the details about many technical fields, but being able to ask the right probing questions, balancing the leader’s sense for appropriate technical focus with the SME’s acknowledged depth of expertise. The fourth element, which is called out separately, is close to our “big picture thinking” competency, but really goes to the technical leader’s understanding that they are more than the technical expert, dispensing wisdom from on high, but a key executive participant in program success – i.e., the Chief Engineer has “skin in the game” for program success. The goal of the chief engineer development program is to “accelerate the development of scar tissue.”

### 10.12 NASA’s System Engineering Leadership Development Program (SELDP)

Key Parameters:

- **Subject Domain:** Aerospace Engineering
- **Scope:** Corporate-level (NASA) and one illustration at the departmental level (NASA Marshall Space Flight Center Mission Operations Laboratory)
- **Program Name:** Systems Engineering Leadership Development Program
- **Source Type:** Articles and Interview

NASA’s Systems Engineering Leadership Development Program has a history, and covers many of the Framework elements and leadership development techniques (see Figure 42).
In 2005, NASA created the Integrated Learning and Development Program (ILDP). It defined its overall goal and objective as follows: “Implement an integrated technical workforce development model to consolidate training where possible, provide discipline-specific training tracks when necessary, and permit efficient transfer between development tracks to maximize development of the individual and benefit to the agency (Menrad & Larson, 2008).”

10.12.1 NASA’s Career Stages

The career stages were not specified in the published articles that described NASA’s technical workforce development models. While the career stages undoubtedly exist, they were not explicitly included as a part of NASA’s workforce development models.

Separately, from an interview, one career model was identified in one department at NASA: the NASA Marshall Space Flight Center (MSFC) Mission Operations Laboratory (MOL) spiral career model. This model may be represented graphically as shown in Figure 43.
The important feature about this spiral career model is the spiral: it uniquely builds leadership capability through a “repêchage” process in which technical employees progress through the three career stages first as technical leaders without formal supervisory authority, and then loop back to the mid-level as Branch Managers before coming back to the senior level again with formal supervisory authority.

10.12.2 NASA’s Competency Models

In 2005, the NASA ILDP conducted a search and found a validated program/project management competency set, but did not find a validated systems engineering competency set. Consequently, NASA created its first systems engineering competency model in 2005, compiled via aligning of the systems engineering competencies/processes/functions/tasks from its Centers (MSFC, GSFC, JSC, KSC, ARC), NASA (ILDP SE DACUM; OCE Systems Engineering NPR
(Draft); APPL PMDP Competency Model; NESC), and other external systems engineering sources (DoD, INCOSE). This resulted in the Integrated Learning and Development Program (ILDP) Design-A-CURriculum (DACUM) Systems Engineering Competency Set, comprised of ten systems engineering competency areas (concepts and architecture; system design; production, product transition, operations; technical management; project management and control; NASA internal and external environments; human capital management; security, safety and mission assurance; professional and leadership development; and knowledge management).

Subsequently, the ILDP conducted another analysis, this time focused on distinguishing systems engineering competencies, project management competencies, and competencies shared between the two areas. The results of this analysis are summarized in Figure 44.

![Figure 44 Systems Engineering and Project Management Competencies; Source: Menrad and Larson (2008)](image)

The next step the NASA ILDP team took in building its integrated workforce development model was to specify four tiers, or performance levels, using existing work already conducted by NASA’s Academy of Program/Project & Engineering Leadership (APPEL): know, apply, manage, and guide. Knowing is equivalent to understanding; applying is equivalent to doing; managing is equivalent to getting the work done through people, and guiding is equivalent to getting the work done through projects. Although it might be possible to map the four performance levels to the Framework’s career stages, NASA did not report linking the four tiers or performance levels to career stages.

The final step was to link the competencies to the curriculum, and this is discussed in the Integrated Workforce Development Model Section.
In 2008, NASA APPEL conducted a separate study to identify the behaviors of highly performing systems engineers. This resulted in the NASA Systems Engineering Behavioral Competency Model, comprised of five systems engineering competency areas (leadership; attitudes and attributes; communication; problem solving and systems thinking; technical acumen). The distinguishing feature of this model is that by structuring the focus on behaviors, the resulting systems engineering competency model is more oriented towards common technical leadership competencies than the IDLP systems engineering model, which is more oriented towards engineering leadership competencies.

10.12.3 NASA’S SYSTEMS ENGINEERING LEADERSHIP DEVELOPMENT TECHNIQUES

NASA has specific programs oriented to three of the leadership development techniques: training, job rotations, mentoring and coaching.

10.12.3.1 TRAINING

In 2005, the NASA Integrated Learning and Development program structured its curriculum into three categories of courses. The first category, the Global Community Development category, identifies courses which are common to the entire technical workforce, through identification of universal development goals for all technical employees. The second category, the Cross-Community Development category, identifies courses which are common to a subset of the technical workforce, through identification of development goals shared by two or more communities. The third category, the Focused Community Development category, identifies courses which are particular and tailored to a single community, through identification of that community’s development goals.

Subsequent to the NASA ILDP, starting in 2008, NASA APPEL created the Systems Engineering Leadership Development Program (SELDP). This one-year program consists of competencies, developmental mobility assignments, gap analyses and assessments, leadership development workshops and training, and coaching. We discuss each of these elements in the appropriate Framework section, here and below (C. R. Williams & Reyes, 2012).

The leadership development workshops and training consist of training and experiential exercises in a training (not on-the-job) setting to build communication, systems thinking, and executive presence competencies. Additionally, the leadership development workshops and training included a benchmark of systems engineering best practices in government and industry.

10.12.3.2 DEVELOPMENTAL MOBILITY ASSIGNMENTS

The job rotations that are a part of the NASA SELDP are developmental mobility assignments. The specific purpose of these job rotations is to rotate the person from their home center to a
different location, as well as to a different task, in order to increase their breadth and their competency to lead complex, NASA-wide programs.

A unique feature of the SELDP is that participants are not responsible for picking their assignment. Rather, the decision is made by a board consisting of highly performing systems engineers. The rationale for this design decision is that APPEL has observed that when participants select their job rotation, they typically make their decision based on personal preferences, or select a new location having the same role and responsibility, or select the same role and responsibility at one level higher than their current level. The NASA SELDP designers’ preference is to place participants in a role which required them to develop competencies highlighted from their gap analyses. “SELDP advocates ensured that participants were placed in stretch assignments – in areas where they had little or no previous experience and would expand their understanding of SE and NASA’s engineering culture (C. R. Williams & Reyes, 2012).”

10.12.3.3 MENTORING

The SELDP implements mentoring through advocates, assignment supervisors, and home supervisors. The advocate is a senior or chief systems engineer who is selected by a center’s engineering director to be a mentor for participants. The entire NASA-wide advocate team is responsible for conducting the gap analyses for each participant, for identifying the best job rotation for them, and for helping to produce the developmental plans for participants to meet those competency gaps. Advocates meet with participants during the program to ensure progress on the developmental plans. APPEL also views the assignment supervisors and home supervisors as providing a mentoring role, again defined in terms of meeting participants’ developmental assessment needs and developing the participants.

10.12.3.4 COACHING

The NASA SELDP makes extensive use of coaching. The program director selected three master certified coaches, having previous NASA experience. Five different types of coaching were used. In one-to-one coaching, program participants receive twelve hours of individual coaching. In group coaching, coaches facilitate group sessions, in which program participants together could learn when one member at a time received coaching. In class coaching, coaches provide observations to participants during program events and workshops. In peer coaching, participants give each other coaching. Finally, in transition coaching, participants receive twelve hours of coaching upon transitioning back to their home centers.

10.12.4 NASA’S ADDITIONAL SYSTEMS ENGINEERING LEADERSHIP DEVELOPMENT PROGRAMS
10.12.4.1 **INTEGRATED WORKFORCE DEVELOPMENT MODEL: THE REQUIRED OCCUPATION COMPETENCIES AND KNOWLEDGE PROGRAM**

Subsequent to the creation of the competency models in 2005, the NASA ILDP team then formulated a curriculum for systems engineering and project/program based on the performance objectives of each of the four tiers (know, apply, manage, guide). The curriculum consisted of common coursework (between systems engineering and project/program management) as well as subject-specific courses. The integration aspect of this model is contained in the common coursework. Consequently, NASA ILDP identified this product, the Required Occupational Competencies and Knowledge (the ROCK) program, as an integrated technical workforce development model, that provided structure and governance to systems engineers and project/program managers’ professional development requirements. In particular, the ROCK program specifies different courses for each of the four tiers for systems engineers and project/program managers to enable them to plan their professional development.

![Image of the Integrated Learning and Development Program (ILDP) Required Occupation Competencies and Knowledge Program (the ROCK); Source: Menrad and Larson (2008)](image)

10.12.5 **GAP ANALYSES AND ASSESSMENTS**

Only the high performers have the opportunity to participate in the NASA SELDP. Part of the selection process includes an assessment of people’s technical competencies and on their leadership competencies (including creativity, flexibility, critical thinking, and handling complexity). For those that pass the selection process and are granted entrance to the SELDP, these assessments are provided to them. In addition, program participants go through a 360 degree Systems Engineering Assessment based on the Behavioral Systems Engineering
competency model. The results of these assessments are used to produce a development strategy for each participant. Finally, at the end of the program, another 360 degree Systems Engineering Assessment is performed, both to identify progress and as well as to revise the person’s development strategy.

10.12.6 Comments

The NASA SELDP approach emphasizes an other-driven, and/or superior-driven focus, in contrast with the Raytheon approach, with emphasizes an individual-driven focus. In other words, Raytheon’s approach is to have the individual drive their development plan and choose their job rotations. In contrast, NASA SELDP’s approach places more of the responsibility on superiors. For example, it is superiors which identify job rotations: “Unlike most mobility assignments, participants did not select their own assignment. Instead, a board of highly skilled systems engineers, known as advocates, made the assignment selections ... [Participants] lack the experience to make the best and most objective decision about what is needed to reach the next level in their careers.”

10.13 Accenture

Key Parameters:

Subject Domain: Technology, digital, consulting, strategy and operations services
Scope: Corporate
Program Name: Leadership Development
Source Type: Interviews
10.13.1 Accenture’s Career Stages

Accenture has six career stages that correspond to the Framework’s career stages as follows: the analyst and consultant levels correspond to the Framework’s junior career stage, the manager and senior manager correspond to the Framework’s mid-level stage, the managing director corresponds to the Framework’s senior level career stage, and the senior managing director level and corporate-level suite (e.g. CFO, CIO) correspond to the Framework’s executive level.

10.13.2 Accenture’s Competency Model

Accenture has five career tracks: clients and markets; client, delivery and operations; innovation and thought leadership; sales, and corporate functions (human resources, marketing and communications, finance, IT). Each track consists of a number of talent segments, such as technology consulting, management consulting, and human resources. The talent segments are
further subdivided into skills and specialties. Finally, the skills are further subdivided into defined traits. The skills are distinguished from the traits in that skills identify what is to be done, while the traits identify how it is to be done.

![Career Track](image)

Figure 47 Accenture’s Competency Pyramid

Finally, the complete hierarchy, from career track to defined traits, is applied to the career stages. The resulting competency matrix identifies different competencies that are required for people at the various career stages. This matrix forms the basis for employee development and assessment.

The competency matrix is embedded in Accenture’s performance measurement and management process. In particular, the leadership dimensions of the competency matrix are included in employees’ performance ratings, and are incorporated into promotion decisions.

The three areas of leadership are value creator, people developer, and business operator.

10.13.3 **Accenture’s Leadership Development Techniques**

Accenture’s leadership development techniques consist of training, experience, job rotations, mentoring, and coaching.

10.13.3.1 **Training**

Accenture’s training is implemented through its Consulting University Program, which offers training courses at each career level. The training approach used by Accenture is *durable learning*, which is characterized by an absence of lectures. Learning occurs through business simulated training and case studies in project teams. The team is expected to work together to solve problems, just as what is to occur in the workplace. The role of the faculty is that of real-time coach, in contrast with a lecturer approach. The faculty coach on expected traits. For example, at the analyst level, in Value to Clients, one expected trait that faculty coach on during
the business simulated training is, “knows when to engage in conversation and when to listen.” At the managing director level, the equivalent trait is, “influences members of the C-suite through story-telling and metaphors,” and “anticipates issues through open and honest dialogue.” The faculty members coach the participants on these expected traits in the competency matrix. This training takes place on campus in the Consulting University Program. For Accenture, durable learning is experiential learning rather than “death by 1,000 slides.”

Accenture also has local training in addition to the in-residence, global training. One of the local training is Connected Classroom. As Accenture has over one hundred locations globally, Connected Classroom is a mechanism to allow learning and training to take place on-site without the need to travel to a single location. Another local training is the Think Tank Series. The Think Tank Series teaches new IT trends and topics in an afternoon, workshop format. Two to three locations are connected with large screens. Each pod in the classroom has a speaker and a microphone, and the camera automatically follows who is speaking. A different local training is Teaching Forward. In Teaching Forward, people who have taken a class, find a new topic in a related area, and teach it forward. There is also Peer Learning.

Another training technique used by Accenture is the professional community. There are over one hundred professional communities, which consist of a digital platform where like-minded people gather. Some of the participants are champions who share information and insights, and answer questions. These professional communities break down the organization structure and allow learning to take place across the boxes in the organization structure.

At the senior level, there is a Leadership Development Program. Participants are required to be nominated to this program. It lasts for one year. The assignments given are to solve real problems for Accenture, either client-facing or internal, such as increasing diversity, or increasing the number of women in management. Participants meet with their team about two times per month, and work through sprints. Participants are responsible to present their work to senior level leaders. Participants also have access to senior leaders for coaching. People participating in this program continue their current role and responsibilities, and the Leadership Development Program is on top of this. There is also a week-long campus event. During the year, participants receive coaching on various competencies, including how they need to behave and present themselves.

There is another program, Leading Extraordinary Teams, which is designed to be available to more employees throughout Accenture. This program is targeted at junior managers. It is aimed at fifty percent of the team leader population, and the goal is to all team leaders, and the goal is for them to be better leaders.

10.13.3.2 Experience

Because many people work on client-centered projects at Accenture, and the client-project combination changes regularly, people are informally provided with a lot of rotation as a part of their regular work experience.
When people achieve the senior level, the next role that they receive is more defined, distinct, and separate.

10.13.3 Rotations

At the senior level, people are provided with expatriate assignments as formal job rotations.

10.13.4 Mentoring

Accenture has a mentoring program called Career Counselor Program, which is designed for all managers and above. The match between mentor and mentee is made on job function. For example, if a mentee is in financial services, then the mentor will be in financial services, because the mentor understands the clients, the function, and the mentee will follow in the mentor’s footsteps. The matching is done on location, career level, and job function. They also create feedback loops, so that if the match between mentor and mentee is not good, there can be a reconsideration.

10.13.5 Coaching

There is a Coaching Center of Expertise, which consists of professional coaches to coach Managing Directors. This is conducted in partnership with Gallup Strength Finder. When a person completes the Gallup Strength Finder, it provides a customized report on their strengths. Accenture is currently training more people around strengths-based coaching, and plans to do one-to-one coaching with other employees.

10.13.4 Measuring Competency Attainment

There are three mechanisms that Accenture uses to track how competencies are attained. First, the success of the new Managing Director promotions over the number of years is tracked. Second, leadership surveys, such as 360 surveys, are used. Third, it is noted that leaders promoted through the ranks are more effective than external hires.

10.14 Sandia National Laboratories

Key Parameters:

Subject Domain: National security, nuclear science
Scope: Corporate
Program Name: National Security Leadership Development Program, Lockheed Martin’s Full Spectrum Leadership Program
Source Type: Interviews
At the outset, it is important to note that Sandia National Laboratories (Sandia) is managed by the Sandia Corp., a subsidiary of Lockheed Martin. Consequently, Sandia participates in the corporate Lockheed Martin development programs, especially the Center for Leadership Development program, but not the divisional ones.

Sandia has two career tracks: a formal management track, which consists of technical leaders having people responsibility, and a technical leadership track, which consists of technical leaders having knowledge responsibility. The technical leadership track is at the division level, and is not formal. The technical track’s career stages consist of member, senior member, principal member, distinguished member, senior scientist, and fellow. Fellow is the highest career stage in Sandia; there is no correspondence to the VP level in the management track. There are a very small number of fellows, only four laboratory fellows in all of Sandia.
10.14.2 SANDIA’S COMPETENCIES

Sandia’s competencies are included Lockheed’s Full Spectrum Leadership Program. There are five primary imperatives, each includes a subset of competencies: shape the future; energize the team; model personal excellence, integrity and accountability; build effective relationships; and deliver results.

10.14.3 SANDIA’S LEADERSHIP DEVELOPMENT TECHNIQUES

10.14.3.1 TRAINING

There is a “Lead From Where You Are” training class that is designed for individual contributors. This training class is by management nomination. Classes consist of 25-30 people, who meet two days a month for three months. Guest speakers are brought in from different parts of Sandia. Currently, the participants are from business, finance, human resources, facilities, security, and IT, and the plans are to expand it to Engineering in the future.

Technical leaders who have no management training can take rudimentary fundamental management courses such as a one-week course at UCLA, the Levinson Institute, crucial conversations, how to give feedback, difficult conversations, and making decisions. In addition, there are several leader programs, such as Harvard Kennedy School’s Research Fellowship in National Security and MIT’s Seminar XXI. It was noted that Seminar XXI does not have the same dynamics as Sandia’s National Security Leadership Development Program (NSLDP), because (1) Seminar XXI, sponsored by MIT, includes leaders from the broader national security community, while the NSLDP is an internal development program; (2) the focus of Seminar XXI is on national security issues, while the focus of NSLDP is on leadership development; and, finally, Seminar XXI is primarily a series of seminars, while NSLDP includes tours, coaching, and the assignment of a “wicked” problem to solve.

A growing focus in leadership training is Emotional Intelligence. For Sandia, understanding emotional self-awareness is a big indicator of people’s ability to lead. One such class is the Social Styles class, which informs a person about styles (e.g. amiables), and how to interact with their style. The point is to adapt to people’s styles, rather than expecting a person to adapt to you. The class also incorporates how everyone else sees you.

Other leadership training classes are available to all members of the workforce. Topics include communication, effective presentations, dealing with difficult conversations, decision making, coaching for performance, influence, trust, and employee engagement.

Prior to applying for a management position, interested individual contributors attend a “Preparing for Management” course, which helps them better understand what management at Sandia is like, addresses basic leadership skills, and provides basic interviewing tips and techniques.
For the new recently promoted leader, there is a series of courses designed to help these newly appointed managers (level 1), team leads, and team supervisors better understand and execute their roles. These courses address everything from hiring and onboarding, to developing and engaging employees. They also provide an overview of key practices and policies related to finance, HR, procurement, and other key areas.

10.14.3.2 MENTORING

Sandia has an Executive Roundtable Mentoring (ERM) program. A total of 50 first level high-potential leaders are selected by their division leadership. The ERM is composed of three parts. First, six 3-hour sessions focus on specific leadership topics considered by executive leadership to be critical to leadership success. These sessions are offered over six to nine months. During these sessions, executives share their leadership stories and discuss these leadership-centric skills in a conversation style format. Second, leaders are matched with second level mentors. The mentor’s role is to help their mentees explore how to take the concepts learned in ERM sessions and apply them back in the workplace. Third, participants are expected to teach back their learning to others in the organization. One of the significant benefits of this program is that it provides visibility between first level leaders and executive level leaders.

There is no formal mentoring program for junior level leaders, but there is an informal one. Currently, at Sandia, there is increased focus on mentoring, with the goal of everyone, from individual contributor at the junior level all the way up, to get a mentor.

10.14.4 SANDIA’S COMPETENCY ATTAINMENT

Sandia uses the competencies in the Full Spectrum Leadership in a person’s performance objectives, and they are evaluated on how well they perform in terms of the competencies at the end of the year.

In the Talent Management Process, all senior managers and above are assessed as to what their potential is. In the lower levels, it is currently optional.

At Sandia, 80-85% of positions are filled by high potentials. This is used as an indicator to see how well the development process is working.

10.14.5 SANDIA’S ADDITIONAL TECHNICAL LEADERSHIP DEVELOPMENT PROGRAMS

Sandia’s National Security Leadership Development Program is Sandia’s flagship leadership program. This nine-month program is designed to prepare high potentials for the executive level, and the target audience is senior managers and directors. It consists of three to four day off-sites, with three or four VPs being present the entire time. In addition, participants are divided into groups, where they work on a problem that colleagues find challenging and useful. It was highlighted that some of the important benefits of this program are to learn about multiple areas of the Labs and to expand everyone’s network at Sandia.
10.14.6 ADDITIONAL COMMENTS

One interviewee also mentioned their strategy for how to walk the line between understanding all the technical details versus taking on faith what the people say. Their strategy was twofold: to ensure that appropriate critical review of the work was sought out, and to identify the leader’s level of confidence, their knowledge of risk, and the knowledge of where they are not confident.

Another interviewee identified, “Sesame Street Engineering: which of these [engineering] designs is not like the other.”

One interviewee responded that one has to work just as hard at being a leader as at being a technical expert.

10.15 NAVY STRATEGIC SYSTEMS PROGRAMS

Key Parameters:

Subject Domain: National security
Scope: Strategic Systems Programs
Program Name: Senior Leadership Institute, Mid-Level Leadership Institute
Source Type: Interviews

The Navy is comprised of several different entities. One entity known for its best practices in technical leadership is the Navy Strategic Systems Program (SSP), which we focus on in the discussion below. Prior to that detailed discussion, we discuss a common theme that emerged from interviews in the Navy.

One common theme in the Navy is the high degree of tailoring or customization, irrespective of the technical leadership development framework element. One interviewee described it as, “We do it our way.” With respect to competencies, the Navy developed their own Systems Engineering Competency Career Model, consisting of 27 technical competencies and 14 professional competencies (Whitcomb, Khan, & White, 2014). With respect to rotational assignments, in NAVSEA’s structured rotation program, there is no one size fits all rotation. NAVSEA’s job rotation best practice is to create positions with intent and to staff those positions with intent. Both sides (the person who is creating the job rotation assignment and the person who will fill that position) are taken into consideration and balanced. Similarly, in the Office of Naval Research (ONR) Science & Technology job rotation program, one type of rotational assignment is an ad hoc or emergent position (an emerging need is identified, a position is detailed out at a level above where the potential candidate is currently operating at, and the potential candidate is matched to the position). With respect to training, ONR’s Academy of Learning is tailored to the ONR organization. It consists of lectures, by
professionals and guest practitioners, and technical simulations. The Academy of Learning is unique to ONR’s purpose, mission, and people.

Figure 49 The Navy Strategic Systems Programs Technical Leadership Development Summary

10.15.1 The Navy Strategic Systems Programs’ Career Stages

As the Navy Strategic Systems Programs is a part of the Department of Defense, it structures its career stages using the following GS levels: the junior level consists of GS 7-11, the mid-level consists of GS 12-13, and the senior level consists of GS 14-15.
10.15.2 THE NAVY STRATEGIC SYSTEMS PROGRAMS' LEADERSHIP DEVELOPMENT TECHNIQUES

10.15.2.1 TRAINING

The Navy SSP describes their technical leadership development as consisting of technical knowledge development and leadership development. Technical knowledge development training consists of the Technical Disciplines Training & Qualification Program, the Strategic Weapons System (SWS) and Subsystem training, and position specific training and development. The Technical Disciplines Training & Qualification Program is for civilians in technical positions for less than three years. It provides participants with foundational training in the technical disciplines that comprise the Navy SSP, such as the safety program. Participants obtain a basic understanding of the “what” and “why,” and do reflective thinking as part of their training. This training lasts for 21 months, and runs concurrently with the participants’ jobs. Senior Navy SSP leadership, including those at the Senior Executive Service (SES) level, contribute substantially to the training. One of the Technical Disciplines Training & Qualification Program’s requirements is the practical application of a technical discipline. Two examples of such practical applications include observing a TRIDENT II missile launch, and conversing with two SESs and two branch heads to learn about their jobs.

The SWS and Subsystem training is designed for those in the junior through to senior career stage. The three primary courses that comprise it are as follows: 1) a one-week SWS orientation course, 2) subsystem courses (varying from 1-5 days) including missile, guidance, reentry, navigation, submarine, and launch courses, and 3) TRIDENT Training Facility (TTF) courses, which are designed for those on submarines who need to know specific support equipment. Finally, there are additional courses available in the SWS and Subsystem training, such as the Advanced Missile course.

The third component of the Navy SSP’s technical knowledge is position specific training and development, in which supervisor and branch leadership set certain training requirements for people. These requirements are beyond the command-wide training, and are incorporated into the Individual Development Plan.

The Navy SSP’s leadership development training occurs in the Senior Leadership Institute and the Mid-Level Leadership Institute. These Institutes were developed on the initiative of the Navy SSP Technical Director. The objectives of the Senior Leadership Institute are to foster leadership capability at both the individual and organizational level, broaden and deepen business acumen, increase knowledge of SSP strategy and key players, and enhance senior leaders’ ability to shape the desired culture. Participants in the Senior Leadership Institute are senior leaders, GS-15s, who have been chosen through a competitive nomination process. Participants are nominated by their managers, who, in turn, sponsor and coach them if the nomination is successful. A group or cohort consists of 20-24 participants. In building the cohort, the Technical Director ensures that there is cross-division and cross-branch representation. The selection criteria include the following: 1) GS-15, 2) high levels of motivation and interest to learn, 3) the candidate is a high performer, in whom the investment
in leadership will provide positive payoffs to the organization, 4) the candidate is desiring and has the potential to take a bigger role in SSP, and 5) the candidate is at the right stage in their career.

The Senior Leadership Institute consists of six sessions held every other month, off-site, for 2-3 days each. It was created based on the five Executive Core Qualifications, competencies required to lead at the executive level. Specifically, Sessions 2-6 correspond to the five ECQs: leading change, leading people, results driven, business acumen, and building coalitions. The content for the sessions is also shaped by the information derived from the individual leadership assessments and 360 degree assessments. The success of the Senior Leadership Institute is partially due to senior leadership sponsorship and support. This commitment is demonstrated through the Admiral providing talks at the sessions, and an SES sponsor for each session, who actively contributes to shaping the agenda and content. High expectations are set not only for the participants, but also the managers and SES sponsors. In particular, participants are expected to actively participate in all sessions, including pre-work and assignments; take part in a learning team between sessions; apply the learning to their current work; discuss with their manager what they learned and how they are applying it; and are held accountable for meeting these expectations. Managers are expected to participate in a one-day workshop held prior to the Senior Leadership Institute kick-off; participate in the kick-off and the final session; coach participants in applying lessons learned to their job; structure special assignments to increase the application of lessons learned through the training; and discuss with the participants what they learned and how they are applying it. The SES session sponsors are expected to understand the Senior Leadership Institute’s goals, and materials; specify content for their session; identify speakers (internal and external) for their session; identify relevant case studies; help participants connect session content with SSP plans and strategy; and strengthen session learning throughout SSP. The first Senior Leadership Institute began in December, 2013 (completing in October, 2014), and the fourth one will begin in December, 2016.

Based on the success of the Senior Leadership Institute, a request for such a program at the mid-level began, and the Mid-level Leadership Institute was launched in January, 2015. Similar to the Senior Leadership Institute, the Mid-level Leadership Institute’s goal is to foster leadership capability at both the individual and organizational levels, increase the breadth and depth of SSP program and process knowledge, develop skills to improve team effectiveness, increase bench depth by creating a pipeline of candidates to fill other positions, and enhance a person’s ability to shape the desired culture. Participants in the Mid-level Leadership Institute are mid-level leaders, GS-12 and GS-13, who are nominated by their managers. The selection criteria are the same as for the Senior Leadership Institute, except that nominees are at the mid-level.

The Mid-level Leadership Institute is shorter than its senior counterpart, with only three sessions spanning six months. Sessions are of a similar length, specifically, 2½ to 3 days. Graduates of the Senior Leadership Institute sponsor the Mid-level Leadership Institute. The course content, while aligned to the Senior Leadership Institute, is tailored for mid-level
leaders. In particular, the focus in Session 2 is working with others (including leading from the middle), and in Session 3 the focus is leading teams. The session content is also shaped by information from individual needs assessment, and 360 degree feedback. The same high expectations are set for participants and managers of the Mid-level Leadership Institute as the Senior Leadership Institute.

10.15.2.2 JOB ROTATIONS

The Broadened Horizons Program is the Navy SSP’s job rotations program. This program was re-energized resulting from the first Senior Leadership Institute cohort project. The Program is a three-tiered program, in which projects consisting of varying duration, complexity and skills sets are grouped into three tiers. Tier 1 projects consist of organizational familiarization activities for specific areas of interest, short term events that offer exposure, or general awareness meetings / events. Tier 1 projects typically span 1 to 30 days. Example activities include participating in flight readiness review, design review, or attend long range planning meeting. Tier 2 projects consist of technical familiarization and team building. These projects are characterized by active involvement in project meetings, technical observations, or solution development. Tier 2 projects are short term or part time, and not to exceed 120 days.
11 APPL YING THE FRAMEWORK: A CONCEPT OF OPERATIONS

11.1 INTRODUCTION

Our benchmarking with a variety of industry, DoD, and other Government organizations suggests that the best technical leadership development programs are those that are specifically tailored to fit the needs of the particular organization’s mission and that address the specific set of technical specialties involved in accomplishing that mission.

Consequently, we do not recommend a one-size-fits-all, linear career model as a guideline for all technical acquisition programs across the Department of Defense. Rather, we propose a broadly based Technical Leadership Development Career Model founded on four fundamental principles:

1. Conscious and systematic application of development methods to foster competencies;
2. Systematic evaluation of capability attainment through the evaluation of individual accomplishments;
3. Flexible application of the Framework and Career Model to meet the needs of individuals, commands and career fields;
4. Personal ownership of each individual’s career development.

The first fundamental principle is conscious and systematic application of development methods to foster competencies. There are six development methods outlined in the Framework, from education and training, to experience and job rotation, to coaching and mentoring. The conscious and systematic application of development methods to foster competencies includes coordination among these elements to encourage competency growth. For example, if a person is targeting improving their competency in developing people and leading people, their training courses should be focused on developing and leading people, and their current job position should require developing and leading people, and they should have a mentor who asks them what they are learning about developing and leading people in their training courses and in their normal, on-the-job experience. With this triangulation, a person is learning from others (receiving training), learning on-the-job, and then being held accountable for this learning by their mentor. If they do not have a mentor, or their mentor is unaware of their intent to grow in developing and leading people, it is possible that the person can receive the training and not apply it in their current position, because of a lack of accountability. Similarly, if the person has training and a mentor, but does not have the opportunity in their current job to apply what they are learning about developing and leading people, this competency will not grow significantly. When the three development approaches are present and working together, this will expedite growth in that competency.

There is another aspect to the conscious and systematic application of development methods, and that is to incorporate them into the existing culture and standard operating procedures.
For example, the existing culture probably includes meetings between superiors and subordinates. Conscious and systematic application includes superiors asking subordinates questions about how the subordinates are growing in competencies, asking how their training class is providing them with the knowledge about the competencies, asking how they are changing the application of that particular competency in their current position (i.e. experience), and asking how their mentor is supporting their growth in a particular competency on a regular basis, not just in the annual performance review. The existing culture may include colleagues going to lunch or chatting over the water-cooler. Conscious and systematic application includes turning those conversations to the above list of questions, rather than the weather or the current sports statistics. One way to make technical leadership development important is by making it important in conversations; if the topic never comes up in conversations, it is not really important. In short, conscious and systematic application includes coordination among the Framework elements to encourage competency growth, as well as incorporating a focus on learning in the existing culture and standard operating procedures.

The second fundamental principle is systematic evaluation of capability attainment through the evaluation of individual accomplishments. An important aspect here is the focus on outcome-based evaluation rather than activity-based or assessment-based evaluation, or focusing solely on capabilities. While evaluating capability attained is typically done through self-assessment, and sometimes through a 360°-degree assessment, advancing beyond a subjective rating to the evaluation of individual accomplishments is a stronger measurement and ought to connect more closely with performance objectives. For example, if the competency is developing people, advancing beyond asking the person how they think their skills in developing people improved, or asking superiors, subordinates, and peers how they think that person’s skills developing people improved, one could assess the number of subordinates that were promoted, or were hired away by other organizations. If the competency to be evaluated is abstraction, instead of asking how good a person’s abstraction skills are (assessment-based evaluation), or documenting the number and type of patterns and structures in the relationships among multiple diverse systems (activity-based evaluation), the goal rather is to identify what that abstraction allowed a person to achieve in terms of problem solving or generating solutions (outcome-based evaluation). In addition, outcome-based evaluation of individual accomplishments aligns more closely with annual performance objectives.

The third fundamental principle is flexible application of the Technical Leadership Development Framework and Career Model to meet the needs of individuals, commands and career fields. Given the size, structure, and diversity of organizations and agencies in the DoD, there may be differing views on what level and type of degree should be achieved in what career stage, which DAU courses (Core only, or Core Plus?) should be taken, which other technical leadership training courses should be taken, what job rotations are best for individuals at a particular career stage, when should a person receiving coaching, and who should mentor whom. In addition, individuals may differ: some may learn best in a learning-by-doing mode, others by being taught (education and/or training), while still others learn best through an individual relationship in which they are held accountable (mentoring). Finally, the differences among career fields (engineering compared to IT compared to science and technology compared to
test and evaluation) may also require different education and training (even when it comes to technical leadership), because the fields have different contexts. Because of all this diversity, it is recommended that the Framework and Career Model be applied in a flexible manner.

The fourth fundamental principle is personal ownership of each individual’s career development. This fundamental principle emphasizes that it is the person’s responsibility to actively manage their career. Even though all the Framework elements may be in place, ultimately it is the individual who is responsible for their growth and development, including the growth and development of competencies. If the person is not engaged, then education and training simply become book-learning, experience becomes something one has to do, and mentoring is an alternative which is not exercised. If the person is engaged, then education and training enable one to perform better on the job, experience becomes an opportunity to learn and grow, and mentoring becomes a tool to ask the questions that it is difficult to ask in the other Framework elements.

Building on these principles, we structure the Technical Leadership Development Career Model to consist of the following:

1. The Framework itself (career stages, competencies, development methods, metrics);
2. The complementary application of a variety of development methods; and,
3. Periodic, systematic evaluation of competency attainment.

First, the Technical Leadership Development Career Model is based on the Framework and associated competencies outlined in this study. In Section 11.2 we discuss how a person moves
among the various Framework elements over time, so that the elements are integrated into a working system. Here, we observe that while there have been a large number of competency sets advocated over time, the one proposed here has been carefully selected to satisfy the specific requirements for the development of technical leaders.

Second, the complementary application of a variety of development methods is based upon the conscious and systematic application of different development methods. There are a large number of available development tools, experiences and opportunities; and while most organizations make use of a subset of these, those with best-in-class development programs do so systematically and purposefully. In particular, the six leadership-development methods come in complementary sets, as indicated in Figure 50. For example, formal education is complementary with training and coaching. Each imparts knowledge (i.e. each is instructional in nature); however, education is probably most useful early in a career, while training can be used to complement instructional gaps in basic education and is best applied at the mid-career stage. At the senior career stage, most instructional gaps are narrowly focused and best addressed through targeted coaching of the senior leader by a subject matter expert (examples of such skills include congressional and media relations).

Third, our proposed Technical Leadership Development Career Model includes outcome-based or evidence-based assessment of competency on a continuing basis. As shown in Figure 50, the process involves assessment of competency attainment on each of the 24 competencies, divided into two radar chart representations. This assessment is to be conducted at least annually, against the appropriate career stage key competency indicators for each of the 24 technical leadership competencies. In the highest performing organizations, these evidence-based assessments are integrated into the performance assessment and promotion readiness systems. As discussed in the second fundamental principle, measurement is demonstrated by accomplishment rather than by capability (something that an individual can lay claim to).

The application of evidence-based assessment need not be tied to a developing leader’s relationship with a particular supervisor. Since the competencies to be assessed are clearly and transparently accessible, any individual developing leader can easily self-assess by conducting their own independent evaluation of their accomplishments against each of the 24 competencies, and then track their own progress toward full proficiency at each career stage, soliciting feedback from supervisors, mentors, peers and subordinates as they do so. The completed radar chart becomes an artifact for discussion between the developing leader and his or her supervisor, a conversation that can be initiated by either party, and a tool for deciding which of the six methods are appropriate for closing any competency gap that may exist. In this way, the individual is able to take control of his or her own leadership and career development, employing the fourth principle.

Within the context of these three major structural features, our analysis has shown that the particular path followed by an individual developing leader is best defined by his or her unique organization and technical career field, using the Framework as a guide, and ongoing assessment to select the appropriate development methods, employing the third principle of
flexible application. For example, the specific description of mid-career KCIs for an S&T leader at AFRL would, and should, be different than the same description applied to an IT professional at the same level in SPAWAR. Within a specific career field at a specific organization, competency objectives should be tailored to particular position descriptions and grade levels within the organization, based on the Technical Leadership Development Framework competencies. We now turn to a more specific discussion of the Technical Leadership Development Framework Career Model.

**11.2 Application of the Framework: The Technical Leadership Development Career Model**

In Sections 4 through 8 of this report, we describe the five elements of the Technical Leadership Development Framework. As presented in those sections, the Framework is static. The above introduction to the Technical Leadership Development Career Model implicitly introduces the time dimension with the notion of periodic assessment. In this section, we more explicitly describe how the inclusion of time in the Framework results in a dynamic career model. We illustrate this with a detailed example prior to discussing a more comprehensive, high-level, abstract perspective.

Figure 51 provides an overall illustration of the Technical Leadership Development Career Model, and Figure 52 provides a visual summary of the following example. A technical person graduating with a Bachelor’s degree in Electrical Engineering obtains a junior-level engineering position in the DoD. Employing principle #4, individual ownership, this person then uses the Framework in the following way. The first thing they do is review the competencies in the competency model. This may be a highly revealing exercise, because educational training received during the Bachelor’s degree might emphasize building knowledge expertise. Therefore, a junior person reviewing the competency model might observe that not only are technical competencies important, but enabling competencies are important as well. Understanding this, the person could decide that over the next year or two that they want to grow in these competencies.
Next, the person notices that there are several distinct leadership development techniques. Observing this, the person can choose to utilize them sequentially or in parallel. For example, the person can acquire one or two mentors, such as a peer or a superior. They can also start attending DAWIA Level I certification training courses, observing that it is possible for them to complete the required Core courses, and the optional Core Plus courses, in one year. Having a mentor and taking DAWIA Level I training are two leadership development techniques that can occur in parallel. At the end of their first year, it is possible for them to complete their DAWIA certification, as it requires one year of technical experience and the required core and optional Core Plus courses. In their second year, the person may request a job rotation in which they evaluate technical proposals. It is possible that these technical proposals are not restricted to their domain of technical expertise, that is, electrical engineering, but span other topics, such as mechanical or chemical engineering. Therefore, the person decides that they want to expand their technical expertise, and enroll in a part-time Master’s program, majoring in electrical engineering, and taking elective courses in mechanical and/or chemical engineering. Consequently, in this second year, the job rotation, mentoring, and education leadership development techniques all occur in parallel. At the end of the second year, the person then decides to conduct a self-assessment and a 360°-degree assessment to evaluate the level of competency they have achieved over the past two years. The person is may be promoted, but their new position is most likely still within the junior career level.
The Technical Leadership Development Career Model consists of the Technical Leadership Development Framework elements, and the linkages or movement between the elements. As we have extensively discussed the Framework elements previously, we begin by discussing the linkages or movement.

The linkages or movement among the Framework elements may be represented by arrows, as displayed in Figure 52. Activities that occur in parallel are represented by arrows having a common point of origin. For example, the arrow representing movement to DAWIA Level I and the arrow representing movement to peer-to-peer mentoring have a common point of origin, the competency model, to represent the fact that DAWIA Level I training and peer-to-peer mentoring occur in parallel. Activities that occur sequentially, that is, one after the other, are represented by one arrow starting and stopping, and another arrow starting. For example, the arrow representing the movement from the junior level career stage to the competency model is distinct from the arrow representing the movement from the competency model to the DAWIA Level I training program, indicating that these are sequential activities. If there is an arrowhead in a particular leadership development technique, with no corresponding start of another arrow, then it indicates that technique is still ongoing. For example, the arrowhead in peer-to-peer mentoring and Master’s degree but no corresponding start of another arrow indicates that peer-to-peer mentoring and the Master’s degree have not completed, but are ongoing.

Generalizing the above illustration so that it can be applicable to any individual at any career stage yields the following description. The career model is how the person moves through the
framework over time, that is, the Technical Leadership Development Career Model is how a person traverses the Technical Leadership Development Framework over time. The starting point is the person’s career stage (Framework element 1). From there, it is best to move to the competency model (Framework element 2), so that a person understands the competencies that are expected. After understanding them, the next step is to make use of multiple development methods (Framework element 3). Subsequently, it is important to assess the level to which competency has been achieved (Framework element 4). In deciding which of the development methods to use, it may prove useful to review the evaluation and validation of the leadership development techniques (Framework element 5).

The time dimension influences both the sequencing and the pacing of leadership development activities. DeRue and Myers (2014) contend that these two aspects are important in developing leadership development programs, based on recent research by Adolph, Robinson, Young, (2008) and Gill-Alvarez (2008). Sequencing refers to the temporal order of the development activities, while pacing refers to how quickly the development activities progress. Each of these is important in designing a technical leadership development program, and hence we include them in our application process.

Another important connection between two Framework elements in the Technical Leadership Development Career Model is the connection between career stage and leadership development approach. The combination between career stage and leadership development technique defines the individual components forming the technical leadership development delivery at each stage. It is important that leadership development approaches appropriate to the demands and abilities of each career level be provided at that level. For example, education at the junior career stage consists of a Bachelor’s degree component; education at the senior career stage consists of a Master’s degree component).

Incorporating competency attainment and leadership development technique validation differentiate this model from the usual corporate or government development programs. Because measuring competency attainment and validating the leadership development techniques are difficult, these elements are often not included in career models.

11.3 IMPLEMENTATION AT THE NATIONAL LEVEL

The Framework and Career Model for technical leadership development can be implemented DoD-wide through the promulgation of appropriate policies. These policies will be designed to make the following points:

The essential elements of the Framework serve as policy guidance across the five specified career fields.

The definitions of career stages (Framework Element 1), the 24 specified technical and enabling competencies (Framework Element 2), and the six development methods (Framework Element
3) represent our current understanding of the best practices for technical leadership development across industry and government, and their application is therefore highly likely to result in best in class technical leadership development within the DoD acquisition community.

It should be noted that the current set of competencies represents a broad consensus among technical leader SMEs and is also consistent with a comprehensive evaluation of scholarly literature on this subject. However, our understanding of the topic is fluid and changes continuously. It is therefore contemplated that the precise list of competencies (KSAs and KClS) will change over time as more data are collected and analyzed.

In addition, the state of knowledge regarding measuring competency attainment (Framework element 4) is limited, as this has not previously been an area for rigorous data collection and analysis. Little work has been done in this area, so this question must necessarily be the subject for additional study, including rigorous longitudinal study of subject and control populations over time, as a result of which continued evolution of Framework element (5) is likely. Note that we have proposed a technique for assessment using 360° feedback. The implicit assumption here is that feedback from supervisor, peers, subordinates and others is a viable metric for competency attainment. The technique also incorporates the idea of the “Value Proposition” for competency attainment as articulated by Gavito and Pennotti (2010) in connection with the concept of “accomplishment vs. capability.” These are powerful ideas, but we must understand that they have not yet been subjected to rigorous experimental validation.

The same caveat applies to the efficacy of the various development methods (Framework element 5). Consequently, it is also contemplated that changes over time will result from further analyses in this area.

With due regard to these caveats, the Framework as described here represents our best current understanding of the skill set required to build great technical leaders at all career stages. Consequently, executive leadership throughout the Department of Defense is strongly encouraged to ensure that developing leaders are provided every opportunity to attain the competencies embodied in the Framework.

It is understood that additional competencies may be required or desired by the various components, agencies, and subordinate organizations within DoD. What we have described here is the minimum essential set specifically for technical leadership development in the broadest sense.

*Career Model implementation is expected to be tailored.*

Our study has found that the best career development programs for technical leadership are highly specific to individual career fields and organizations.

Therefore, wherever necessary, DoD organizations are encouraged to delegate implementation of the Career Model to the most appropriate subordinate organizational level – taking into
account the details of organizational and mission requirements – and that the implementation at those echelons should include the crafting of tailored competency descriptions reflecting the requirements of the organization at those levels. The extent to which this process is centralized or distributed must follow the chain of command. Organizations at higher echelons may decide to delegate implementation down the chain of command, or retain implementation details at higher echelons.

The decisions needed within the implementing organization, which have purposely NOT been dictated in the description of the Framework and Career Model, include:

• At which GS (or comparable excepted service) grade does the transition from Junior to Mid-level to Senior career stage occur? This transition is necessarily different across the wide variety of organizational structures within the Department of Defense;
• For any given position description, how do the responsibilities of the position correlate to the 24 competencies described in the Framework?
• Within a typical career advancement pattern for a particular career field in a particular organization, it is inevitable that some KSIs will tend to be “missed” as the developing leader progresses from job assignment to job assignment, and from grade to grade. Provision must be made to develop these KClIs through rotational assignments and/or training, and this pattern will vary significantly from one career field and organization to another.

_Tight integration with other Human Resource processes_

We found that in the best-in-class organizations we studied, there is a tight integration between technical leadership development and other institutional processes of HR. Thus, implementation of the Framework and Career Model will only be successful if it is integrated into an organization’s processes for recruitment, selection, performance evaluation, and promotion. In the most effective organizations, consideration of competency attainment by developing technical leaders is a matter for formal joint discussion and decision-making involving HR professionals, the task organization (e.g., program management), and “home room” supervision (i.e., functional management).

_Competency Assessment._

Competency based assessment is a critically important component of the Career Model. Since “you get what you measure,” it is important that the performance evaluation of developing technical leaders _always_ include an accomplishment-based evaluation of accomplishments based on the 24 technical leadership competencies of the Framework. In the best case, this will involve 360° evaluation that is evidence-based, that is, for each level-appropriate KCI, the developing leaders should provide a statement of accomplishment that reflects that KCI, and the veracity of that claim should be evaluated by superiors, peers, and subordinates.
Apart from the four features of policy guidance above, implementation should be left to individual organizations within DoD to whom such implementation has been duly delegated by higher echelons of executive management. Hereafter, we will use the term “action level” to indicate the level of organization at which the Framework and Career Model are executed.

11.4 IMPLEMENTATION AT THE ACTION LEVEL: ROLES AND RESPONSIBILITIES

At the action level, we identify three important roles:

1. Executive Sponsor;
2. Supervisor; and,
3. Developing Technical Leader.

These are defined as follows.

11.4.1 EXECUTIVE SPONSOR

The Executive Sponsor is the Executive within whose organization the Technical Leadership Development process is implemented. Since we have said that in our examination of best practice organizations, we found that the process is highly distributed and tailored, one might suspect that the “executive sponsor” might not in fact, be an Executive. However, in our view, this would be a mistaken approach, for two reasons.

First, the Framework and Career Model encompass all grades up to but not including Executive rank, but including the most Senior non-executive leadership (nominally envisioned as GS-15 or the equivalent.) It therefore is the case that leaders at that most senior level will be participants in the process (as developing leaders) and therefore the process should be overseen by an individual senior to that grade, in other words, an Executive.

Second, since, as we have pointed out, successful application of the Career Model requires full integration of both the technical organization and the Human Resource function, and since these two functions do not normally have joint reporting responsibilities below the executive level, the tailored policy should be in force at least at the organizational level where a mission-focused executive has as a minimum a “dotted line” supervisory authority over personnel matters.

The Executive Sponsor has two key roles: first, to oversee the tailored implementation of the Framework and Career Model; second, to “walk the walk” of technical leadership by exhibiting mastery of the competencies (as appropriate), by serving as a mentor, and by requiring that direct reports to the executive do the same.

To be clear: the answer to the undefined questions asked above (regarding grade level corresponding to the career stages, tailoring of the competency descriptions, and provision for
full attainment of competencies over the course of a career) is the responsibility of the Executive Sponsor.

11.4.2 Supervisor

Needless to say, depending on the organizational echelon at which the Framework may be implemented, the manager filling the Supervisor role might be anything from a senior executive with reporting executives, down to a fist level supervisor. For the purpose of providing comprehensive guidance across a myriad of different implementation strategies and situations, we can say this: at any number of intermediate echelons, the “supervisor” may at the same time be responsible for flow-down functions as described in paragraph (1) above, as well as the supervision of subordinate technical managers at any and all career stages, and of course, might also be a “developing leader” at the same time.

We concentrate here on those responsibilities unique to the supervisor of individual developing leaders.

In the first place, the supervisor is responsible for ensuring that the developing technical leader is assessed, as comprehensively as possible, on the applicable KCIs related to the 24 competencies that form Framework Element (2). Let’s be honest: the bulk of an employee’s evaluation is always based on their accomplishment of their assigned duties. So making sure that they are progressing toward mastery of the leadership competencies requires extra effort on the supervisor’s part.

Secondly, the supervisor needs to make sure that the developing leader is exposed to sufficient opportunities to support attainment of the required competencies. This can take several forms. For example, as mentioned earlier, a “path of least resistance” career for a given developing leader might not include exposure to the job experience required to build certain technical leadership skills. In that case, the supervisor would need to identify specific training, or rotational assignments, that would best help in attaining those competencies. In making this decision, the supervisor should be guided by our findings as to which development methods are most effective for each competency at each career stage.

11.4.3 The developing technical leader.

We have defined the quality of leadership at the Junior career stage as “leadership of self,” and there is no better exemplar of this than a pro-active, engaged participation in one’s own career development. We have described elsewhere how the most promising junior technical professionals distinguish themselves by seeking out additional and varied assignments, by pursuing training and education opportunities, and by exhibiting curiosity about technical fields outside their own area of specialization.
As a result, the developing technical leader plays the most important role in the technical leadership development process. Indeed, a cursory review of the 24 Framework competencies (Framework element 3) clearly shows that almost all are directly applicable reflexively to the development of the leader’s own career: critical thinking, big picture thinking, lifecycle focus, planning, transitions, and requirements analysis are all skills that a developing leader can apply to their own career evolution.

In fact, a developing technical leader in an organization that has not implemented the DoD Framework and Career Model can nonetheless take advantage of them acting individually and unilaterally. So, if you see yourself as a developing technical leader, and are serving in an organization that has not implemented the Framework and Career Model or does not provide career development assistance, then this section is written especially for you (which is why the remainder of the section is written in the second person)! The actions to be taken by the developing leader are identical in nature whether or not there is organizational support.

First, familiarize yourself with the competencies and the specific KCIs under each competency for your current career stage (and for the earlier career stage or stages if you are not at the Junior stage). You can dive into this career model at any stage – just remember that the KCIs are cumulative, so if you are starting this process at the Mid or Senior stage, you will need to go back and address all the KCIs at the earlier stage(s).

Second, conduct a “radar chart” assessment of your attainment status against each KCI for all 24 competencies at your career stage and below. It is best if you perform this assessment through a 360˚ assessment, that is, by getting input from your supervisor, peers, and subordinates (if you have any of these). The assessment should be based on measurable accomplishments you identify that exemplify your attainment of the KCIs.

KCI attainment is binary – either yes or no – if most or all of your raters think you have proven a competency (KCI) then fine. If not, then you have more work to do on that KCI.

Third, plot the results on the spider chart. What you want to do is reach the point where the entire “web” of the spider chart fits within the target ring or beyond it or the career stage you are working on. At that point, you are ready to start working on the next ring.

Pick the “spoke” of the spider chart on which you are weakest, that is, the one for which you and your raters agree you are least well prepared. Consult the sections of this report that deal with the six development methods. Determine which are the most effective for developing the competencies on which you need to concentrate. Then, have a conversation with your supervisor. This is easy, of course, if your organization already has a program for technical leadership development, whether it’s based on this Career Model or not. If the organization does not have such a program, you may want to share this study with your supervisor. Present and discuss your spider charts. Own your shortfalls, and propose actions to strengthen those skills. Specific examples of the use of the six methods are given below:
Education is a key method at the Junior career stage. As a technical professional, you should aspire to the highest level of education you can reach in your technical specialty. With the help of your supervisor and other mentors, select the most appropriate program for your needs, and use whatever mechanisms are available to you to pursue it (SF-182 reimbursement, agency funded program, GI Bill, etc.);

Training is widely available and often locally supported even in these austere budget times. You should take heed of the first principle in this Career Model: “conscious and systematic” application of development methods. Do not select training opportunities for any reason other than that they will address gaps in your competencies;

Job experience has been found to be the single most valuable method for gaining competency as a technical leader. Be aware of available bidding opportunities. Do not hesitate to compete for assignments that help you to build competency in areas where you have shortfalls. Consult with your supervisor, other mentors, and HR professionals to ensure that your next assignment will keep you on track to grow as a technical leader. Do not be afraid to move laterally or even “backward” in order to build skills. This is only a rule of thumb, of course, there are many exceptions, and it is also true that jobs can change significantly while you are in them, leading to additional opportunities to gain competency through experience, without having to change grade, title, or position;

Each of the above methods shares a single negative characteristic: they may not be “in the cards” for various reasons outside your control. In that event, you need to resort to additional methods of development to achieve the competencies you need. Rotational assignments are an outstanding way to get experiential training that isn’t available in your permanent assignment. If the KCI you are trying to develop is amenable to it (not all of them are), you may seek out coaching.

Finally, you must both seek out mentors and become a mentor yourself! A mentor need not be someone senior to you, although it is always good to have one who is. Peer mentorship – including mutual mentorship – is an excellent approach. You should look for a mentor who occupies a position similar to one that you aspire to.

11.5 READING PROGRAM AS PART OF THE FRAMEWORK APPLICATION

It is common for organizations at all levels to provide guidance to emerging/developing leaders on selection of useful reading materials for their own personal development. Organizations are encouraged to make reading of case studies, leader biographies, professional trade press articles, scholarly papers, histories, and leadership texts an integral part of their leadership development programs. It is extremely important to note, however, that this facet of leadership development goes well beyond the establishment of a reading list, but must be embedded in a broader process that is focused on setting the context for reading. Like the application of other development methods, reading programs need to be purposeful and systematic. Junior emerging leaders should be given reading suggestions targeted to their level of experience; mid-level and senior leaders should be provided with reading opportunities with broader scope. Each reading selected should be intended to enhance one or more of the 24 competencies. The expectation, however, is that developing leaders are exposed to a variety of views through
reading – NOT that they are being given a series of “handbooks” from which they will learn the canonical answers to leadership problems. A reading program succeeds only if the proper context is established, so that the developing leader gains an appreciation for examination of a wide variety of ideas and points of view. Since this approach exposes the participant to a wide range of opinions and conclusions, many of them contradictory, and requires comparison of one with the other, the very application of this contextual framing for a reading program is ideal for building critical thinking skills, for exercising paradoxical thinking, as well as systems thinking abstraction, as well as strategy and vision!

A one-size-fits all reading program is not a good answer across the many organizations that make up the Department of Defense. Instead, individual organizations are encouraged to establish reading programs within their own confines. In order to be effective, these programs need to be focused on the context of self-development through exploration of ideas, as discussed above; the materials selected need to be thoughtfully chosen to reflect competency improvement; need to be targeted to the developing leader’s career level; and for best results the program should include an opportunity for group discussion. Although this sounds like a “book club” model, in reality it should include more than just books (all the types of material listed above), and might best be implemented in “lunch and learn” format on a regular basis.

Although we recommend that individual organizations should establish their own programs, the Defense Acquisition University does have an online book program that can be used by individual organizations as a source of suggestions. The selections reviewed on the DAU website are carefully curated and vetted, and each has been reviewed for its applicability. This is a great resource, which should be used in conjunction with the components discussed above.

### 11.6 Implementation at the Action Level: Career Model Flow

As we have pointed out, the Career Model introduced here is not intended to be a fixed, linear path defined by a series of steps to be checked off over time. It is not a monolithic process of progression from one defined assignment to the next, and from one grade to the next higher one. There are a virtually unlimited number of career paths that a successful technical leader may follow. The intent of the Model is not to endorse one such path over another, but to assure that as technical professionals in DoD progress from one career stage to the next, they build an ever stronger set of technical leadership skills that will allow them to be effective whether they serve in a personnel supervisory role, or in program management, or as technical experts.

Instead of a linear flow, then, it is useful to think in terms of a cyclical model, embodying a continuing process of assessment and an associated set of competency building activities. Once the full set of competencies at a given career stage is attained, then a new set of cycles can begin at the next career stage. An individual is of course free to move on to more advanced competencies as the basic ones are completed, and it is of course frequently true that relatively
junior leaders find themselves engaged in activities (and gain the resulting experiential competencies) far beyond the responsibilities of their permanent job assignment.

Application of the competency development cycle need not be annual, although we recommend that any formal implementation should require a formal assessment and supervisor/employee discussion at least annually. However, an individual developing leader is free to conduct informal assessment at any appropriate time, and to take development actions as guided by those assessments.

Figure 53 The Career Model Flow

Although attainment of higher levels of competency is not a guarantee of increases in rank, compensation or responsibility, DoD organizations are expected to require such attainment as a condition for increased rank, salary and responsibility.

11.6.1 HOW SHOULD THE FRAMEWORK BE IMPLEMENTED IN A PARTICULAR AGENCY/ORGANIZATION?

The competencies, related KCIs at each level, application of development methodologies, and career model elements are to be thought of as DoD-wide best practices, to be used in developing specific technical leadership development programs in different organizational components. This allows flexibility at the organizational level to define specific GS grade levels at which the transition from junior to mid to senior might occur (while being generally consistent with the definitions of these stages in the overall Framework). Likewise, the specific description of a particular competency can, and should, be tailored to specific career fields, and to specific positions within a particular organization, as well as being applicable to specific job descriptions within such an organization.
For example, for any given job description at a particular grade level, a determination will be made regarding the career stage represented by that job. Then, for each of the KClIs associated with that career stage, a tailored description of the KCI will be developed (if necessary, in many cases no tailoring will be required) that is focused on the mission and work environment for that particular job. Indeed, it is conceivable (it’s indeed very likely) that there may be KClIs that are not represented in a given job assignment. At that point it is the responsibility of the developing leader’s organization to make provision for building competency through the use of rotational assignments, targeted training, and/or coaching. Although we do not envision this career model and the Framework to be prescriptive, waiving any competency related KCl at any level is not okay: our review of the literature and our benchmarking interviews show that the lack of any one of the 24 competencies identified in the Framework is likely to result in failure to achieve success as a technical leader.

11.6.2 Conducting Assessments

Although conducting a competency assessment is a fairly straightforward process, this step is so crucial to the implementation of the career model that it seems worthwhile to provide a specific example to assist organizations, supervisors, and developing technical leaders with the implementation of this phase of the process. The first step is to create an inventory of KClIs for the appropriate career stage on each of the 24 competencies.

As noted earlier these are most powerful when tailored to a specific career field and organizational mission. In our example, however, we will use the standard formats for the KClIs (i.e., not tailored). Figure 2 is an example of a raw data input form. For purposes of example we have only included the first few KClIs for the Junior career stage: the full form would include roughly 40 entries, all the KClIs for each of the 24 competencies.

In addition to a restatement of the KCI, the form provides a blank to be filled in by the developing leader being rated, consisting of an example accomplishment that the developing leader believes provides proof of accomplishment. For instance, under KCI 1.2 of the Technical Planning competency at the Junior stage, our example shows “Delivered program plan for milestone 1.0 of Program 1234.” The last column is for the rater to assess the developing leader’s actual attainment of this KCI based on the evidence provided. Our example shows a 1 to 5 rating scale, but this could be implemented just as well as a single “go/no-go” checkbox, a verbal comment, or some other metric.

In the best case, the rating form would be filled in by multiple raters – peers, supervisor and subordinates (if any) – and the results collated across all raters.
Once the rating forms have been collected, the resulting data must be entered on the spider chart diagram. For instance, in the technical planning KSA, there are two KCIs at the junior level. Let us suppose that using the 5-point rating scale, a developing leaders received an average score of 4.5 on KCI 1.1, and an average score of 4.3 on KCI 1.2. The simplest approach is to simply add these two scores up, resulting in a net attainment score of 8.8/10 for competency (KSA) #1. This score is then plotted on the appropriate radial of the spider diagram for that competency – namely the one labeled “KSA 1 – Technical Planning.”

![Figure 54 Plotting Total Attainment Score on Single Radial of the Spider](image)

When plotted on the appropriate radial, as shown in Figure 54, this shows that the rate is 8.8/10 toward attainment of KSA 1 for the Junior level. The same steps are repeated for the remaining 21 competencies (KSAs) The points on each radial are connected and the resulting plot provides a visual overview of the developing leader’s progress toward full competency.

For clarity and convenience, we present the data as two plots: one for the 12 technical competencies, the other for the 12 enabling competencies, as shown in Figure 55.
Figure 55 demonstrates the application of the spider chart assessment tool, showing how an individual's progression from junior to mid-level attainment status is documented over time. This individual developing leader has reached senior level status on at least one competency – namely, Thinking Critically. In this example, a rating scheme of 0-100 is used, with 0-40 allocated to the junior category, 41-80 allocated to the mid-level, and 81-100 to the senior level. The relative weighting used is a matter of choice, as it is simply a matter of visualization (the critical element is the attainment of the competency at a particular level, not the numerical difference between one level and the next.)

These are shown on the two following pages as full size blank forms that can be photocopied and manually filled in.

Any number of variants on this scheme are possible, and all are acceptable in implementing the Career Model. For example, it is not necessary to assess all the competencies at once. Although a full assessment using the 360° feedback mechanism is highly recommended on an annual basis, interim assessments of one or two competencies, including self-assessments, are fine to maintain focus and perspective.

It is easy to implement the assessment process in a spreadsheet for many variations of the rating scheme. Excel allows direct plotting of the calculated assessment values on a spider chart (they are called “radar” charts in Excel.) Figure 48 illustrates the assessment process graphically.
Instructions:
Mark level of competency attainment on each radial. Dark grey area is Junior career level; medium grey area is mid-career level; light area is Senior career level.
ENABLING COMPETENCIES

Instructions:
Mark level of competency attainment on each radial. Dark grey area is Junior career level; medium grey area is mid-career level; light area is Senior career level.

Figure 57 Enabling Competency Spider Chart
11.6.3 Using the Career Model at the Action Level

As we have seen, the Career Model can be implemented at the individual level – that is an individual developing leader can take action to make progress against the 24 competencies, conduct self-assessments, and choose assignments and training opportunities that will build higher levels of competency without participating in a formally sanctioned technical leadership development program. The expectation is that an individual who self-implements the Career Model as a strategy for career advancement is likely to be successful, a) because the set of 24 is drawn from observation of the traits of successful technical leaders, b) because the application of the development methods is based on our best understanding of how these methods are most effectively used to develop competency, and c) because the Career Model in which the Framework is embedded takes advantage of best practices drawn from examination of organizations that have been identified as best in class in the development of technical leaders.

Figure 58 The Competency Attainment Assessment Process
On the other hand, it goes without saying that the most effective use of the Framework and Career Model will be at what we have defined as the Action Level, with executive sponsorship and support, a tailored set of KCIs specific to the organization’s mission and career field(s), and proactive engagement by functional and task management, as well as the HR organization.

In order to get the most out of the Framework and Career Model, these should be integrated into the basic HR procedures of organizations that depend on technical leaders. Ideally, the Framework should be part of the recruitment and hiring system. In the best in class organizations we have surveyed, this happens in two ways: first, prospective employees are assessed against the 24 competencies. In one case we examined, interviewers are provided with a script including questions based on the desired competencies; second, the existence of the Career Model, with its strong individual career development component, which involves the individual technical performer’s ownership of their own career development, is used as a recruiting tool to highly motivated, self-managing employees. One engineering talent development Director we interviewed spoke in this context as “taking the development program to where the engineers are in their career.”

Once the developing technical leader has been recruited, a key element of implementation is the assessment process, with an annual 360° review of competency attainment conducted as part of the regular annual performance review process. As we have already pointed out, the career development will never, and should not, take the place of performance assessment against achieving the deliverable goals of a particular assignment. However, career development (for technical leaders and for every other employee) should always be one element of performance review (as is in fact mandated by OPM). The annual technical leadership assessment should result in a meaningful conversation between developing leader and supervisor including discussion of next steps and the appropriate application of development methods. (Who’s your mentor? What are you doing for yourself on your own time/nickel?)

In keeping with the primary principle of “purposeful and systematic” application of the six development methods, the highest leverage use of the career model includes discussion of technical leadership competencies that cannot be adequately covered through the developing leader’s current assignment, and therefore the identification of potential rotational assignments designed to provide that opportunity.


12 Future Work

The Framework and career model introduced in this report are sound, based on recognized scholarship and the opinions of subject matter experts, and consistent with the best practices of organizations across government and industry. As such, they will provide a strong foundation for the development of technical leaders in the Department of Defense. Nonetheless, we see several areas in which the depth and quality of the Framework and career model could be strengthened. These are summarized in Figure 59, and discussed below.

Recommended Future Work
1. Additional benchmarking with best-in-class institutions;
2. Experimental assessment of development methods;
3. Experimental analysis of competency attainment metrics;
4. Longitudinal study of target and control cohorts;
5. Analysis of resume databases.

Figure 59 Recommended Future Work

As envisioned at the outset of this work, we have been able to benchmark the elements of the Framework against the best practices of a small number of best-in-class organizations, as reported in Section 10 of this report. These include four private industry companies (Accenture, Boeing, Raytheon, and Gulfstream), one Government Owned/Contractor Operated National Laboratory (Sandia), three Department of Defense entities (the DAU Huntsville office, the Missile Defense Agency and the Navy’s Strategic Systems Program), and one non-DoD government entity (NASA’s Marshall Space Flight Center). We have supplemented these benchmarking efforts with additional interviews with subject matter experts at a number of U.S. Navy activities. We have also included in this survey information from our own work with the Department of the Army, and with Lockheed Martin. The data collected through this process has been of exceptional value. There is now an opportunity to improve the depth and quality of our understanding by extending the benchmarking process to an additional set of best-in-class organizations, including, for example United Technologies, with whom we have initiated contacts but have been unable to schedule a data collection visit. While each benchmarking visit to date has largely served to confirm the conclusions from our study, it is also true that in almost every case we have learned new and valuable insights from each visit. Additional work in this area would be of great value and serve to improve the end product.

A second area of further study involves our understanding of how the various development methods affect leadership development. We have based our work on information gleaned from the scholarly literature, both academic and from the consulting press, as well as the opinions of leadership development subject matter experts. This approach has been satisfactory, but the amount of rigorous, statistically sound experimental research around this question is relatively
sparse. We believe that the Department of Defense should conduct such experiments in order to refine the application of these methods to the technical leadership development effort. Another analytic approach to valuing the leadership development technique of training is to design a training scorecard and a leadership development training return-on-investment (ROI). A training scorecard and training ROI will enable one to measure the extent to which learning has occurred, competencies have been acquired, behavior has changed, and valuation of the training investment.

In order to support the aforementioned analysis of development methods, it is important to have good metrics for competency attainment by individual developing technical leaders. As in the case of our evaluation of development methods, we have used prior research and SME interviews as the source of our understanding in this area. We have also recommended an assessment process based on our observations of best practices in industry. However, what is needed to confirm the value of these assessments is a well-constructed longitudinal study involving target and control cohorts of developing technical leaders over time.

A less rigorous and time consuming approach that appears to have a good deal of promise is the analysis of data derived from resumes of successful technical leaders, as well as a control group of randomly chosen individuals.

Each of the above approaches requires the establishment of human subject research protocols, the approval of which requires time and effort beyond the scope of the relatively short study reported here.

In addition, it would be valuable to develop two specific instantiations of the overall technical leadership Career Model, namely, an engineering career model and an IT career model. A balanced career model for technical leaders is helpful, but because the engineering specialty is sufficiently distinct from the information technology (IT) specialty, it would be even more helpful to have an engineering balanced career model specified and an IT balanced career model specified as well.

The work described in this report represents a significant departure from previous efforts in the field, which have largely been based on the personal opinions of the management teams responsible for establishing career development programs. The chosen development methods have generally been assumed to be effective, without any support from data collection; there has generally been no follow up to determine the value of development programs; and there have generally been no efforts to assess the performance of individuals who were the product of these development programs. Our contribution here has been to base our Framework and Career Model on methods and structures that are widely used by best-in-class institutions, are favored by recognized experts in leadership development, and have reasonable support in the scholarly literature.
We believe, however, that the quality of the Framework and Career Model can be strengthened by pursuing the additional work described above, and we strongly urge the Department of Defense to pursue such efforts.
13 CONCLUSIONS AND RECOMMENDATIONS

The training and development of technical professionals is important, because ultimately they are the ones who envision systems and bring them into being. In addition, as the GAO has identified strategic human capital management as a high risk in government, this is an area that deserves increased attention. Our study provides an initial framework to address this challenge. Based on previous research in both business and government, as well as government best practices and structured interviews with relevant subject matter experts, we have designed a framework that can be used to provide guidance on training and developing technical leaders, at all stages of their career lifecycle. Importantly, we recognize that measuring the performance of the leadership development approaches at the different career stages is critical to determine the effectiveness of the components in such a framework. Future work will examine the purpose-based and evidence-based metrics in more detail, focusing on key knowledge, skills and abilities. Our ultimate goal is not only to provide a comprehensive framework for technical leadership development, but also the tools to effectively monitor and evaluate the effectiveness of any program based on this framework.

Based on our comprehensive review of prior literature, examination of corporate and government leadership development programs, and interviews with subject matter experts, we have developed a Framework and career model for use in developing technical leaders in the Department of Defense.

<table>
<thead>
<tr>
<th>Significant Findings</th>
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<tbody>
<tr>
<td>1) Broad Leader competency in technical and leadership domains;</td>
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<tr>
<td>2) Specific attainment of 24 technical leadership competencies;</td>
</tr>
<tr>
<td>3) Application of six technical leadership development methods;</td>
</tr>
<tr>
<td>4) Locally tailored and implemented approach;</td>
</tr>
<tr>
<td>5) Fully integrated with HR</td>
</tr>
<tr>
<td>6) Purposeful and systematic application of methods;</td>
</tr>
<tr>
<td>7) Evidence-based assessment of accomplishments, not capabilities;</td>
</tr>
<tr>
<td>8) Positive value proposition (such as ROI).</td>
</tr>
</tbody>
</table>

Figure 60 Significant Findings

The Framework and career model are consistent with the following major findings of this work (Figure 60 lists these findings as summarized below):

1) In addition to deep technical competency in their own specialty, and more broadly across multiple disciplines related to mathematics and physics, technical leaders must also become competent across the full spectrum of leadership competencies as described in the management literature;
2) Beyond these broad areas of competency, we have identified and describe in this report a set of 24 technical leadership competencies that uniquely combine BOTH Technical AND Leadership qualities. These may be considered the defining characteristics of technical leaders;

3) We have examined as set of six development methods widely used in industry and government and have assessed their applicability to leader development across three career stages, i.e. junior, mid, and senior level. When used appropriately, these methods have been shown to be effective in leader development;

4) Best practice has shown that technical leadership development is most effective when it is specifically tailored to a particular career field and mission oriented organization;

5) In order to work effectively, leadership development must be fully integrated with an organization’s Human Resource processes. The Career Model should encompass recruitment, performance appraisal, and promotion, and in the best of the organizations we surveyed, decisions about recruitment, performance appraisal, promotion and assignment are made collaboratively with the participation of Human Resources, the project or task organization, and the technical functional organization (career field “home room” management);

6) Previous research has shown, and our current work confirms, that best-in-class technical leadership development is successful through purposeful and systematic application of the development methods;

7) Prior research and our own work also show that best-in-class leadership development programs incorporate continuing evidence-cased assessment against target competencies including 360° feedback mechanisms, the use of self-assessment using the plane of reflection, and evaluation of competency-related accomplishments rather than capabilities;

8) In the best, rarely attainable ideal cases, the success of a technical leadership development program is judged on the basis of measurable favorable outcomes for the organization, often thought of in terms of ROI, but more broadly understood as a positive value proposition for both the organization and the developing leader.

Based on the above findings, we make the following recommendations, listed in Figure 61 and summarized below:

1) The Department of Defense should implement a Technical Leadership Development policy covering the five technical acquisition career fields, based on the Framework and Career Model described in this report;

2) In keeping with industry and government best practices as shown by our research, the implementation of this policy should be distributed and tailored, and should be executed at subordinate levels of the Department of Defense as guided by the individual needs of component echelons of command;
3) In order to be most effective, the execution of the Framework and Career Model should be fully integrated and coordinated with Department Human Resource functions for recruitment, personnel evaluation, and promotion;

4) While the elements of the Framework and Career Plan are in keeping with our best understanding of the process of technical leadership development based on prior scholarship and expert opinion, implementation of these elements should be reviewed on an annual basis to incorporate lessons learned from the experience of implementation;

5) In keeping with the above recommendation, the Department of Defense should continue to conduct research into the development of technical leaders, this research should in particular address the following three areas:

- Continued in-depth benchmarking with best-in-class organizations within the Department, elsewhere in government, and with private industry;
- Rigorous, statistically sound experimental investigation of the efficacy of specific development methods;
- Longitudinal, human subject research involving target and control groups to determine suitable metrics for assessment of competency attainment.

**Key Recommendations**

1) Implement a Technical Leadership Development Policy based on the Framework and Career Plan
2) Delegate implementation of this policy to appropriate subordinate levels in DoD
3) Integrate Technical Leadership Development with existing HR functions
4) Revisit and improve the policy annually
5) Initiate continuing research to improve validation of methods and metrics

*Figure 61 Key Recommendations*
## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Echelon</td>
<td>An hierarchical organizational level within the Department of Defense</td>
</tr>
<tr>
<td>Developing leader</td>
<td>A technical professional pursuing leadership development goals</td>
</tr>
<tr>
<td>Competency</td>
<td>One of the 24 desired traits of technical leaders – synonymous with KSA</td>
</tr>
<tr>
<td>KSA</td>
<td>Knowledge, Skills and Abilities – synonymous with competency here</td>
</tr>
<tr>
<td>KCI</td>
<td>Key Competency Indicator – a sub-element of one of the KSAs</td>
</tr>
<tr>
<td>Career stage</td>
<td>One of three defined stages in a career – Junior, Mid-level, Senior</td>
</tr>
<tr>
<td>Career Model</td>
<td>The implementation of the Leadership Development Framework</td>
</tr>
<tr>
<td>Development Method</td>
<td>One of six techniques identified for competency development</td>
</tr>
<tr>
<td>Organization</td>
<td>A specified sub unit of DoD</td>
</tr>
<tr>
<td>Action Level</td>
<td>An organization within which the Career Model is implemented</td>
</tr>
<tr>
<td>Education</td>
<td>Formal academic coursework</td>
</tr>
<tr>
<td>Training</td>
<td>Any instruction not involving formal academic credit</td>
</tr>
<tr>
<td>Coaching</td>
<td>One on one instruction from an SME to a recipient</td>
</tr>
<tr>
<td>Mentoring</td>
<td>A relationship in which a junior professional receives advice from a senior</td>
</tr>
<tr>
<td>Job assignment</td>
<td>An individual’s full time, regular, work assignment</td>
</tr>
<tr>
<td>Rotation</td>
<td>A short or longer term assignment outside an individual’s normal duties</td>
</tr>
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</table>
# LIST OF ACRONYMS AND ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Full Form</th>
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</thead>
<tbody>
<tr>
<td>ACQ</td>
<td>DAU Acquisition Course</td>
</tr>
<tr>
<td>AETE</td>
<td>Acquisition Education, Training, and Experience program</td>
</tr>
<tr>
<td>AFRL</td>
<td>Air Force Research Laboratory</td>
</tr>
<tr>
<td>APPEL</td>
<td>Academy of Program/Project &amp; Engineering Leadership</td>
</tr>
<tr>
<td>ARC</td>
<td>Ames Research Center</td>
</tr>
<tr>
<td>ASTD</td>
<td>American Society of Training and Development</td>
</tr>
<tr>
<td>BKCASE</td>
<td>Body of Knowledge and Curriculum to Advance Systems Engineering Project</td>
</tr>
<tr>
<td>BP</td>
<td>British Petroleum</td>
</tr>
<tr>
<td>CAP</td>
<td>Critical Acquisition Position</td>
</tr>
<tr>
<td>CEO</td>
<td>Chief Executive Officer</td>
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<td>CFO</td>
<td>Chief Financial Officer</td>
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<tr>
<td>CIO</td>
<td>Chief Information Officer</td>
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<tr>
<td>CKA</td>
<td>Competency Knowledge Area</td>
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<tr>
<td>CLP</td>
<td>Continuous Learning Points</td>
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<tr>
<td>CMMF</td>
<td>Competency Model Maturity Framework</td>
</tr>
<tr>
<td>COR</td>
<td>Contracting Officer</td>
</tr>
<tr>
<td>CSEP</td>
<td>Certified System Engineering Professional</td>
</tr>
<tr>
<td>DACUM</td>
<td>Design-A-CUrriculum</td>
</tr>
<tr>
<td>DARPA</td>
<td>Defense Advanced Research Projects Agency</td>
</tr>
<tr>
<td>DASD(SE)</td>
<td>Deputy Assistant Secretary of Defense for Systems Engineering</td>
</tr>
<tr>
<td>DAU</td>
<td>Defense Acquisition University</td>
</tr>
<tr>
<td>DAWIA</td>
<td>Defense Acquisition Workforce Improvement Act</td>
</tr>
<tr>
<td>DCAA</td>
<td>Defense Contract Audit Agency</td>
</tr>
<tr>
<td>DFARS</td>
<td>Defense Federal Acquisition Regulation Supplement</td>
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<tr>
<td>DoD</td>
<td>U.S. Department of Defense</td>
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<tr>
<td>ECQ</td>
<td>Executive Core Qualifications</td>
</tr>
<tr>
<td>EHS</td>
<td>Environment, Health and Safety</td>
</tr>
<tr>
<td>EI</td>
<td>Emotional Intelligence</td>
</tr>
<tr>
<td>EIT</td>
<td>Engineer in Training</td>
</tr>
<tr>
<td>ELD</td>
<td>Executive Leadership Development</td>
</tr>
<tr>
<td>ELP</td>
<td>Executive Leadership Program</td>
</tr>
<tr>
<td>ENG</td>
<td>DAU Engineering Course</td>
</tr>
<tr>
<td>EOQ</td>
<td>Engineering, Operations, and Quality</td>
</tr>
<tr>
<td>EPP</td>
<td>Executive Potential Program</td>
</tr>
<tr>
<td>ERM</td>
<td>Executive Roundtable Mentoring</td>
</tr>
<tr>
<td>FAR</td>
<td>Federal Acquisition Regulation</td>
</tr>
<tr>
<td>FEI</td>
<td>Federal Executive Institute</td>
</tr>
<tr>
<td>FFRDC</td>
<td>Federally Funded Research and Development Center</td>
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<tr>
<td>FY</td>
<td>Fiscal Year</td>
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<tr>
<td>GAO</td>
<td>U.S. Government Accountability Office</td>
</tr>
<tr>
<td>GS</td>
<td>General Schedule</td>
</tr>
<tr>
<td>GSFC</td>
<td>Goddard Space Flight Center</td>
</tr>
<tr>
<td>HR</td>
<td>Human Resources</td>
</tr>
<tr>
<td>HSSE</td>
<td>Health, Safety, Security, and Environment</td>
</tr>
</tbody>
</table>
IEEE Institute of Electrical and Electronics Engineers
IG Inspector General
ILDP Integrated Learning and Development Program
INCOSE International Council on Systems Engineering
IPA Intergovernmental Personnel Act
IPT Integrated Product Team
IQ Intelligence Quotient
ISA DAU IT Course
IT Information Technology
ITM Integrated Talent Management
JFCS Joint Forces Staff College
JSC Johnson Space Center
KCI Key Competency Indicator
KLP Key Leadership Position
KPP Key Performance Parameter
KSA Knowledge, Skills, and Abilities
KSC Kennedy Space Center
MA Mission Assurance
MBA Master’s of Business Administration
MDA Missile Defense Agency
METL Master’s of Engineering in Technical Leadership
MIT Massachusetts Institute of Technology
MOL Mission Operations Laboratory
MSFC Marshall Space Flight Center
MSHA Mine Safety & Health Administration
NASA National Aeronautics and Space Administration
NSF National Science Foundation
NSLDP National Security Leadership Development Program
OMB Office of Management and Budget
OPM Office of Personnel Management
OUSD(ATL) Office of the Under Secretary of Defense for Acquisition, Technology, and Logistics
PDP Professional Development Plan
PE Professional Engineer
PEO Program Executive Office
PQM DAU Production, Quality, and Manufacturing Course
QM Quality Management
ROCK Required Occupation Competencies and Knowledge
ROI Return on Investment
RT Research Topic
SAP/ERP SAP Enterprise Resource Planning
SE Systems Engineering
SEBoK Systems Engineering Body of Knowledge
SELDP System Engineering Leadership Development Program
SERC Systems Engineering Research Center
SES Senior Executive Service
SETM U.S. Army’s Senior Enterprise Talent Management
SF-182 Standard Form 182
SLL Senior Level Leaders
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM-3®</td>
<td>Standard Missile 3</td>
</tr>
<tr>
<td>SME</td>
<td>Subject Matter Expert</td>
</tr>
<tr>
<td>SPAWAR</td>
<td>Space and Naval Warfare Systems Command</td>
</tr>
<tr>
<td>SSO</td>
<td>Source Selection Official</td>
</tr>
<tr>
<td>STEM</td>
<td>Science, Technology, Engineering and Mathematics</td>
</tr>
<tr>
<td>STM</td>
<td>DAU Science and Technology Management Course</td>
</tr>
<tr>
<td>SYS</td>
<td>DAU Engineering Course</td>
</tr>
<tr>
<td>T&amp;E</td>
<td>Test and Evaluation</td>
</tr>
<tr>
<td>TLR</td>
<td>DAU Technical Leadership Course</td>
</tr>
<tr>
<td>TST</td>
<td>DAU Test and Evaluation Course</td>
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<tr>
<td>UCLA</td>
<td>University of California at Los Angeles</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>USAASC</td>
<td>U.S. Army Acquisition Support Center</td>
</tr>
<tr>
<td>USD(AT&amp;L)</td>
<td>Under Secretary of Defense for Acquisition, Technology and Logistics</td>
</tr>
<tr>
<td>VP</td>
<td>Vice President</td>
</tr>
</tbody>
</table>
## 14 Appendix A: High Quality Metrics by Leadership Development Approach and Career Stage

### 14.1 Education Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Skills strategy (curriculum compared to skills) (Butler, 2010)</td>
<td>• Skills strategy (curriculum compared to skills) (Butler, 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Performance in real-world better than competency self-assessment (While, 1994)</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### 14.2 Training Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Intellectual stimulation (Barling, 1996)</td>
<td>• Manager/direct report relationship (Snipes, 2006)</td>
<td>• Organizational awareness (Brown, 2005)</td>
<td>• Customer satisfaction (Snipes, 2006)</td>
</tr>
<tr>
<td>• Individualized consideration (Barling, 1996)</td>
<td>• Recognition / feeling valued (Snipes, 2006)</td>
<td>• Interpersonal skills (Brown, 2005)</td>
<td>• Employee satisfaction (Snipes, 2006)</td>
</tr>
<tr>
<td>• Charisma (Barling, 1996)</td>
<td>• Opportunity for learning and growth (Snipes, 2006)</td>
<td>• Communication skills (Brown, 2005)</td>
<td>• Employee retention (Snipes, 2006)</td>
</tr>
<tr>
<td>• Organizational commitment (Barling, 1996)</td>
<td>• Team collaboration (Snipes, 2006)</td>
<td>• Confidence and self-awareness (Brown, 2005)</td>
<td>• Leader/follower relationship quality (Snipes, 2006)</td>
</tr>
<tr>
<td>• Behavioral change (Barling, 1996)</td>
<td>• Making an impact (Snipes, 2006)</td>
<td>• Management skills (Brown, 2005)</td>
<td></td>
</tr>
<tr>
<td>• Commitment (Barling, 1996)</td>
<td></td>
<td>• Leadership skills (Brown, 2005)</td>
<td></td>
</tr>
<tr>
<td>• Financial performance (Barling, 1996)</td>
<td></td>
<td>• Team Performance (Brown, 2005)</td>
<td></td>
</tr>
<tr>
<td>• ROI using KSAs (de Albuquerque, 2012)</td>
<td></td>
<td></td>
<td></td>
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### 14.3 Experience Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Strategic thinking competency (Dragoni, 2011)</td>
<td>• Supervisors evaluate work products to rate workers on competencies</td>
<td>• 6 managerial competencies evaluated by supervisor (Dragoni, 2009)</td>
<td></td>
</tr>
<tr>
<td>• Number of lifecycle phases experienced (Pyster, 2014)</td>
<td>• Supervisors evaluate work procedures to rate workers on competencies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Number of organizations (Pyster, 2014)</td>
<td>• Job performance in annual job performance reviews (Dokko, 2009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Experiences across domains (Pyster, 2014)</td>
<td></td>
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</tbody>
</table>

**Action-Learning Metrics**

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Supervisors evaluate 6 ECQs (Leonard, 2010)</td>
<td>• 360 degree assessments on 10 leadership competency classes (Leonard, 2010)</td>
<td>• Program assessed with usefulness, applicability, and learning transfer metrics; assessments on 19 leadership competencies (Leonard, 2010)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Supervisors evaluate 8 ECQs (Leonard, 2010)</td>
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</tbody>
</table>
## 14.4 Job Rotation Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Model using firm learning (Ortega, 2001)</td>
<td>• Promotions (Sargent, 1952)</td>
<td>• Promotions (Sargent, 1952)</td>
<td>• Promotion rate (Campion, 1994)</td>
</tr>
<tr>
<td></td>
<td>• Salary (Sargent, 1952)</td>
<td>• Salary (Sargent, 1952)</td>
<td>• Salary growth (Campion, 1994)</td>
</tr>
<tr>
<td></td>
<td>• Increasing breadth (Sargent, 1952)</td>
<td>• Increasing breadth (Sargent, 1952)</td>
<td>• Early promotion (Sweeney, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Productivity (Ichniowski, 1997)</td>
<td>• Promotion rate (Campion, 1994)</td>
<td>• Military commander assignment (Sweeney 2007)</td>
</tr>
<tr>
<td></td>
<td>• Labor productivity (MacDuffie, 1995)</td>
<td>• Salary growth (Campion, 1994)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Promotion rate (Campion, 1994)</td>
<td>• Early promotion (Sweeney, 2007)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Salary growth (Campion, 1994)</td>
<td></td>
<td></td>
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</tbody>
</table>

## 14.5 Mentoring Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Improved individual performance; increased skill (Dinolfo, 2010)</td>
<td>• Increased organizational commitment (Ragins, 2000)</td>
<td>• Reduced turnover intention (Viator, 1991)</td>
<td>• Reduced turnover intention (Viator, 1991)</td>
</tr>
<tr>
<td>• ROI (Dinolfo, 2010)</td>
<td>• Reduced turnover intention (Viator, 1991)</td>
<td>• Increased promotional rate (Scandura, 1992)</td>
<td>• Subjective rating of job performance (Parise, 2008)</td>
</tr>
<tr>
<td></td>
<td>• Subjective rating of job performance (Parise, 2008)</td>
<td>• Subjective rating of job performance (Parise, 2008)</td>
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<td></td>
<td></td>
<td>• Subjective rating of job performance (Parise, 2008)</td>
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</table>
## 14.6 Coaching Metrics

<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Effect against objective (Cohen, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Effect on behavior (Cohen, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Return on Investment (Cohen, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Client and manager reports (Bono, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Business outcomes (Bono, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Promotion (Bono, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Reduced complaints (Bono, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- ROI based on utility analysis (Bono, 2009)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Behavior change (Bono, 2009)</td>
<td></td>
<td></td>
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<tr>
<td>- Learning or skill development (Bono, 2009)</td>
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<table>
<thead>
<tr>
<th>Overall</th>
<th>Junior</th>
<th>Mid-Level</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Learning and skills person applied on job (Bernard, 2006)</td>
<td></td>
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<td></td>
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<tr>
<td>- Business results: changes in results and productivity (Bernard, 2006)</td>
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<tr>
<td>- Return on Investment (Bernard, 2006)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Measurement against KPIs or goals (Franze, 2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Productivity (Olivero, 1997)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>- Learning and skills person applied on job (Bernard, 2006)</td>
<td></td>
<td></td>
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<tr>
<td>- Business results: changes in results and productivity (Bernard, 2006)</td>
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<tr>
<td>- Return on Investment (Bernard, 2006)</td>
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</tr>
<tr>
<td>- Measurement against KPIs or goals (Franze, 2011)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>- Productivity (Olivero, 1997)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Overall</td>
<td>Junior</td>
<td>Mid-Level</td>
<td>Senior</td>
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<tr>
<td></td>
<td>• Mission planning (Bowles, 2007)</td>
<td>• Mission planning (Bowles, 2007)</td>
<td>• Mission planning (Bowles, 2007)</td>
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<tr>
<td></td>
<td>• Time management (Bowles, 2007)</td>
<td>• Time management (Bowles, 2007)</td>
<td>• Time management (Bowles, 2007)</td>
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<tr>
<td></td>
<td>• School recruitment plan (Bowles, 2007)</td>
<td>• School recruitment plan (Bowles, 2007)</td>
<td>• School recruitment plan (Bowles, 2007)</td>
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<td></td>
<td>• Daily progress report (Bowles, 2007)</td>
<td>• Daily progress report (Bowles, 2007)</td>
<td>• Daily progress report (Bowles, 2007)</td>
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<td></td>
<td>• Leader plan of action (Bowles, 2007)</td>
<td>• Leader plan of action (Bowles, 2007)</td>
<td>• Leader plan of action (Bowles, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Training (Bowles, 2007)</td>
<td>• Training (Bowles, 2007)</td>
<td>• Training (Bowles, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Analysis (Bowles, 2007)</td>
<td>• Analysis (Bowles, 2007)</td>
<td>• Analysis (Bowles, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Leadership (Bowles, 2007)</td>
<td>• Leadership (Bowles, 2007)</td>
<td>• Leadership (Bowles, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Job Knowledge (Bowles, 2007)</td>
<td>• Job Knowledge (Bowles, 2007)</td>
<td>• Job Knowledge (Bowles, 2007)</td>
</tr>
<tr>
<td></td>
<td>• Percentage of performance (i.e. recruiting) goals achieved (Bowles, 2007)</td>
<td>• Percentage of performance (i.e. recruiting) goals achieved (Bowles, 2007)</td>
<td>• Percentage of performance (i.e. recruiting) goals achieved (Bowles, 2007)</td>
</tr>
</tbody>
</table>
Although it is clear that some technical leaders are more competent, effective, and successful than others, it is not clear why this is so. This observation has led to two distinct questions: first, what is it about great technical leaders that makes them successful, and second, how can we tech most technical leaders to embody at least some of the attributes characteristic of their most effective peers?

Researchers at the Stevens Institute of Technology have been working on these two questions for over a decade mostly, but not entirely, under the auspices of the System Engineering Research Center. The first question has been the subject of research conducted under the Helix, Atlas, and experience accelerator efforts.

The second question has been the subject of a larger number of independent efforts, growing out of an initiative conceived at Stevens in 200x, in which the assumption was made that we know what traits we want to instill, so let’s go ahead and develop a curriculum to do so.

The first effort was the NASA Executive Leadership Development (ELD) program, a collaborative Stevens/NASA initiative that culminated in the graduation of a cohort of senior NASA trainees and resulted in the publication of a paper. Wiley Larson led the Stevens team, while Mike Ryschewitzch, the then NASA Chief Engineer, was the lead for the agency.

One of the earliest research topics under the newly established SERC was RT-4, which looked at this issue in depth. RT-4 laid out the framework for technical leadership development and proposed a curriculum for implementation at DAU.

In the interim, Stevens, under the direction of the new Technical Leadership Development director, Val Gavito, rolled out a Masters of Engineering in Technical Leadership program (METL), delivered in large measure at the Institute’s Washington DC location, that conceived of technical leadership as falling under three “lenses”: Systems, Business, and Enterprise. The METL program concluded at the Stevens campus in Hoboken in order to comply with accreditation rules.

Following the METL experiment, SERC conducted a research topic to transform the METL concept into a series of three DAU courses, SYS 350A, B, and C, each of which incorporated the concepts developed under the three METL lenses.

At the same time, Stevens implemented an Engineering leadership development program for the Lockheed-Martin Mission Systems and Training business unit. Under this program, high potential junior employees are selected to participate in an intensive and accelerated SE instructional program followed by completion of a Masters degree program of their own choosing.
As a follow-up to the RT-4, METL, and DAU efforts, the 350A course was developed into part of the DAU advanced curriculum (TLR 350) while the 350B and 350C courses (the business and enterprise lenses) became part of a Missile Defense Agency pilot leadership development program.

Meanwhile, in RT-121, the Stevens team tackled the Army’s technical leadership development needs, structuring a technical leadership development career model compatible with the Army’s acquisition professional career development process. RT-121 introduced the concept of “evidence based value proposition” in technical leadership development, namely the idea that a properly designed development program should result in meaningful, and measurable, organizational outcomes.

The NASA, METL, RT-4, DAU and MDA efforts constitute a continuum of increasingly refined training programs targeting the preparation of senior technical leaders for executive responsibility.

The Lockheed Martin ELDP represents an effort to introduce similar concepts at the most junior level. RT-121 represents an effort to incorporate those same concepts in a value added career model for technical leaders at all levels.

RT-149 makes four specific contributions to this growing body of work:

- Broad-based definition of three career stages below the executive level;
- Specifying a set of competencies tailored to those career stages under 24 headings covering both technical and leadership skills and abilities;
- Providing a comprehensive review of existing validation for the application of six leadership development methodologies; and
- Comprehensively reviewing existing metrics for attainment of specified competencies by leaders under development.

<table>
<thead>
<tr>
<th>Research Activity</th>
<th>Dates</th>
<th>Synopsis</th>
</tr>
</thead>
<tbody>
<tr>
<td>NASA ELD</td>
<td>2008/2009</td>
<td>Leadership Development for System Engineers</td>
</tr>
<tr>
<td>RT-4</td>
<td>2010/2012</td>
<td>Developed framework for DAU 350 courses</td>
</tr>
<tr>
<td>METL</td>
<td>2010/2011</td>
<td>Piloted a 3 lens Masters of Engineering program in Technical Leadership</td>
</tr>
<tr>
<td>RT-120/RT-140</td>
<td>2016/2016</td>
<td>Transition 350 courses to DAU, MDA</td>
</tr>
<tr>
<td>RT-104RT-121</td>
<td></td>
<td>Army technical acquisition career model</td>
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<tr>
<td>Helix (RT-45/106/130/135)</td>
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<td>Assessed characteristics of</td>
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<td>“great” SEs</td>
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<td>-----------------------------</td>
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<tr>
<td>RT-125</td>
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</tr>
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<td>Experience accelerator</td>
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</table>


Cao, J., & Thomas, D. (2013). When Developing a Career Path, What are the Key Elements to Include?


