SYSTEMS ENGINEERING
Research Center

Technical Leadership Development Program – Year 1

Technical Report SERC-2010-TR-013-1

December 13, 2010

Principal Investigator: Dr. Valentin Gavito, Stevens Institute of Technology

Team Members: Stevens Institute of Technology:

Dr. Dinesh Verma,

Dr. Tony Barrese,

Dr. Peter Dominick,

Dr. Michael Pennotti,

Mr. Ralph Giffin,

Ms. Nicole Hutchison

Contract Number: H98230-08-D-0171 Task Order: 0002, DO 002, RT 004

Report No. SERC-2010-TR-013-1

The Systems Engineering Research Center (SERC) is a federally funded University Affiliated Research Center managed by Stevens Institute of Technology.

This material is based upon work supported, in whole or in part, by the U.S. Department of Defense through the Office of the Assistant Secretary of Defense for Research and Engineering (ASD(R&E)) under Contract H98230-08-D-0171 (Task Order DO 0002, DO 002, RT 004).

ABSTRACT

In 2009, the Defense Acquisition University (DAU) contracted with the Systems Engineering Research Center (SERC) to develop an extension of the DAU Systems, Programming, Research, Development, and Engineering (SPRDE) program that specifically focuses on technical leadership. This Technical Leadership Program (TLP) specifically will provide leadership insights into systems engineering (SE) activities and issues at the system, business, and enterprise levels.

Curriculum development began with the identification of a set of core systems engineering (SE) technical leadership competencies. This competency model was reviewed and refined by two rounds of subject matter expert (SME) review, with different experts from government, industry, and academia participating in each review. This competency list provided a baseline for program architecture development.

The competencies were compared to the current DAU SPRDE courseware to determine overlaps and gaps. Using this as a baseline, the TLP development team allocated competencies to each of the lenses—systems, business and team (B&T), enterprise and strategy (E&S)—with particular emphasis on competencies not currently covered by SPRDE.

Using this architecture, lens learning objectives, outcomes, and focus areas were identified. The focus areas were populated with a draft list of topics. Courseware from the SERC collaborators was compared to the topical outline for each lens to identify areas where materials exist which can be tailored to support the DAU TLP model and gaps where courseware needs to be developed.

Using this approach, the TLP development team will create and deliver a pilot for the systems and B&T lenses in 2011. The E&S lens pilot will be delivered in 2012.

This page intentionally left blank

TABLE OF CONTENTS

FIGURES AND TABLES

1 EXECUTIVE SUMMARY

In 2009, the Defense Acquisition University (DAU) contracted with the Systems engineering Research Center (SERC) to develop a curriculum for technical leadership. The purpose of this work was to thoroughly research the state-of-the-art and best practices associated with technical leadership education and to incorporate these best practices, along with the experience of the SERC collaborators, into a technical leadership program (TLP) which would specifically focus on technical leadership in systems engineering (SE). This report presents the research, findings, and development that have occurred during the base year under contract with DAU.

The DoD has tremendous challenges in sustaining and growing its science, technology, engineering, and mathematics (STEM) workforces in support of acquisition excellence. In 2006 the DoD released its Civilian Human Capital Strategic Plan[1] with the goal of developing, "a civilian workforce that possesses the leadership, competencies, and commitment necessary for successful mission accomplishment." Thus, under this backdrop, research is being conducted to develop the competencies necessary for the technical leadership workforce.

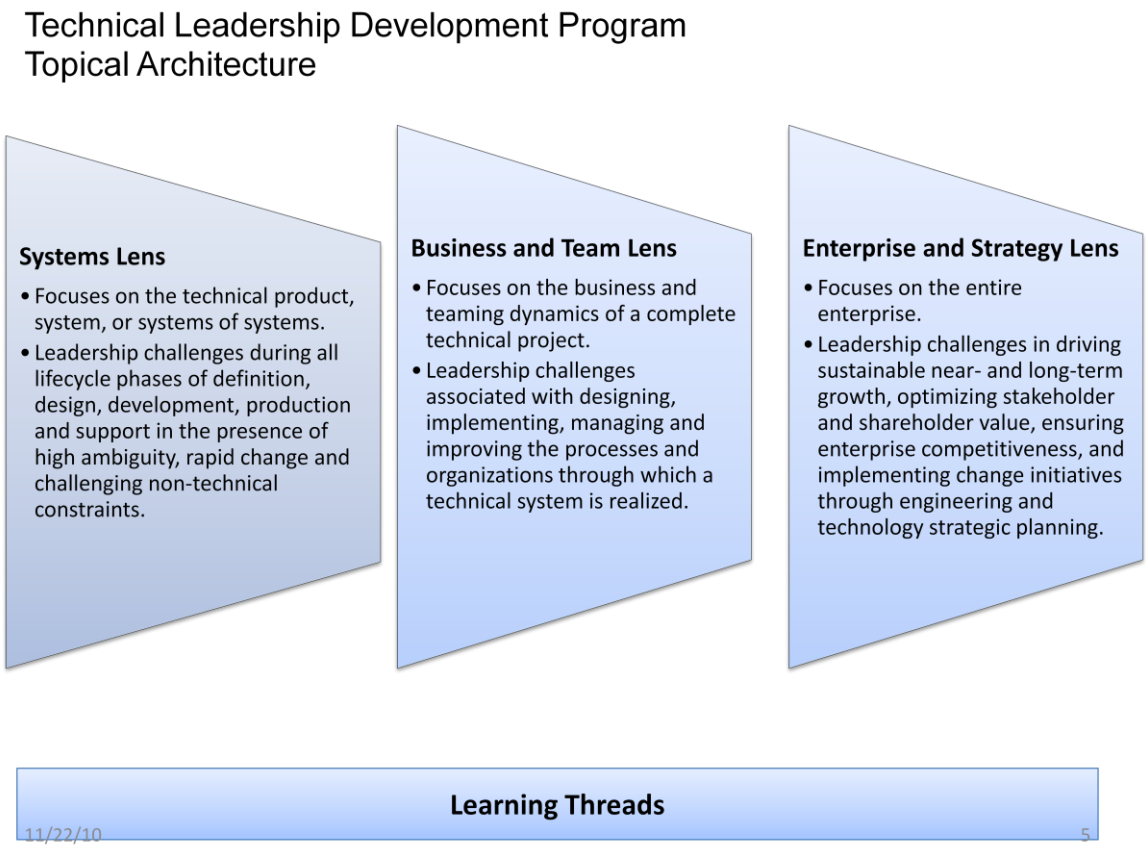
SE competency topics and elements were collected from a wide variety of sources, including NASA[2], Nokia, BAE Systems, the DoD, and the Australian government to develop our initial competency model. These models were discussed in deliverable A0009. From these competency models, possible competencies for SPRDE Level IV were identified[3].

In summer 2010, the TLP development team discussed a possible architecture with DAU representatives. This architecture is based on the principles that there are three lenses that can be used to view TLP content, as shown in Figure 1. The lenses open an increasing aperture on a specific area, in this instance systems engineering technical leadership. Each lens covers content related to systems engineering, but at a different level.

[1] This report can be accessed at http://prhome.defense.gov/docs/civilianstrat_plan7_9.pdf

[2] Compiled by Wiley Larson and titled NASA's Systems Engineering Competencies as part of the Academy of Program/Project and Engineering Leadership for NASA, 2006.

[3] We will use the term Level IV throughout this report as defined in Table 1.8. We believe that SYS 302 should be focused in developing Level III proficiencies. Whereas, SYS 351 should be mainly focused on developing professionals who oversee SE activities for a program with several systems and/or establishes SE policies at top organizational level.



The Technical Leadership Program (TLP) is a multi-disciplinary, experiential post graduate and professional development curricula that prepares senior design engineers, system engineers, and technologists for Chief Engineer, Technical Director, and Enterprise Technical Executive positions through an interactive course of independent study, simulation, and case study through the three focused lenses: Systems, Business and Team, and Enterprise and Strategy.

Using the architecture, lens learning objectives, outcomes, and focus areas were identified. The focus areas were populated with a draft list of topics. Current courseware from the SERC collaborators was compared to the topical outline for each lens to identify areas where materials exist which can be tailored to support the DAU TLP model.

The targeted learner group is high potential senior engineering designers and technologists with demonstrated superior domain engineering or technology expertise that have been identified and recommended as advanced technical leadership candidates in their organization or fields of expertise.

2 INTRODUCTION

In 2009, the Defense Acquisition University (DAU) contracted with the Systems engineering Research Center (SERC) to develop a curriculum for technical leadership. The purpose of this work was to thoroughly research the state-of-the-art and best practices associated with technical leadership education and to incorporate these best practices, along with the experience of the SERC collaborators, into a technical leadership program (TLP) which would specifically focus on technical leadership in systems engineering (SE). This report presents the research, findings, and development that have occurred during the base year under contract with DAU.

2.1 BACKGROUND

The Department of Defense (DoD), along with most government agencies, is under tremendous pressure to increase the success rate of its acquisitions programs by[4]:

- Better equipping/supporting/enabling the workforce to perform successfully and meet all demands,
- Mitigate loss of skilled/experienced workforce,
- Successfully compete for, hire and retain talent,
- Transfer knowledge / expertise to new generation,
- Integrate acquisition workforce planning with DoD Total Force Human Capital Planning, and
- Strategically plan and resource human capital initiatives.

The DoD has tremendous challenges in sustaining and growing its science, technology, engineering, and mathematics (STEM) workforces in support of acquisition excellence. In 2006 the DoD released its Civilian Human Capital Strategic Plan[5] with the goal of developing, "a civilian workforce that possesses the leadership, competencies, and commitment necessary for successful mission accomplishment." Thus, under this backdrop, research is being conducted to develop the competencies necessary for the technical leadership workforce.

Developing a concise and universally-accepted definition of leadership for people involved in technical engineering management is difficult. For example, Rost (1991)

[4] Taken from a briefing by Gordon Kranz, DUSD(A&T)/SSE Director, Technical Management Functional Leader, "Human Capital Strategy and Planning for SPRDE-SE & PSE, DT&E, and PQM," https://acc.dau.mil/GetAttachment.aspx?id=280166, August 28, 2009

[5] This report can be accessed at http://prhome.defense.gov/docs/civilianstrat_plan7_9.pdf

analyzed 221 definitions of leadership in an effort to develop a meaningful definition. Most definitions share several common features—leadership is an interpersonal influence process that is goal-directed and purposeful. Leadership is defined as "the process of influencing an organized group toward accomplishing its goals" (Farr, et al, 1997). For this project, technical leadership is defined as motivating and guiding a group of technical professionals to define and deliver constructive change producing new technical performance or systems. To develop a senior technical leader requires many years of experience leading to the completion of many complex projects encompassing multiple jobs involving many programs. Within the DoD, long program life cycles, competition for scarce human capital, acquisition reform, and the scale of projects within the defense community has led to a dearth of senior technical leaders with sound SE[6] and technical project leadership skills. As a result, it has become more important than ever to develop more capable senior technical leaders with not only sound engineering skills but also the ability to think and act holistically. Technical leaders must be systems thinkers, understand systems-of-systems (SoS) and enterprise issues in addition to traditional tenets of leadership and management. Research is needed to synthesize and validate curriculum content and structure for a program to develop future DoD senior technical leaders.

In support of educating the DoD acquisition workforce, the DAU provides practitioner training, career management, and services to support the majority of the acquisition, technology, and logistics (AT&L) community. Currently the Systems Planning, Research Development, and Engineering (SPRDE) career field is the largest[7]. Within the SPRDE career field, the DAU currently offers Level I, II, and III certifications in Program Systems Engineering (PSE), Science and Technology Management (S&TM), and Systems Engineering (SE) career paths. For this effort, the focus is on the SPRDE-PSE and SPRDE-SE career fields specifically.

This research topic will support and extend the SPRDE-PSE and SPRDE-SE certificates offered by the DAU at Level III. This research is needed to develop, synthesize and validate curriculum content, course materials, and structure for a program to develop future DoD senior and executive SE and technical leaders.

---

[6] Numerous definitions of SE exist. The DoD has adopted the following formal definition, derived from EIA/IS 632, *Processes for Engineering a System*. "Systems engineering is an interdisciplinary approach encompassing the entire technical effort to evolve and verify an integrated and total life cycle balanced set of system, people, and process solutions that satisfy customer needs. SE is the integrating mechanism across the technical efforts related to the development, manufacturing, verification, deployment, operations, support, disposal of, and user training for systems and their life cycle processes. SE develops technical information to support the program management decision-making process."

[7] Technical Management (TM) workforce is 41% or 36,704 employees in 2009 of the total acquisition population and includes systems engineering, developmental test and evaluation, and production, quality and manufacturing. All of the TM workforce would be interested in Level IV training.

Currently as part of Level III SPRDE-SE/PSE, the course SYS 302 is required. This course is titled *Technical Leadership in Systems Engineering* has the following catalogue description:

> Designed for senior DoD acquisition personnel, SYS 302 is focused on the application of technical leadership skills within a typical DoD systems engineering environment. SYS 302 participants are expected to have sufficient background knowledge of the DoD's systems engineering management processes, knowledge of the application of systems engineering to each acquisition phase, and the capability to apply these concepts to complex technical management problems involving critical thinking. As part of the SYS 302 course, participants will lead and participate in an engineering team that analyzes and resolves a variety of technical engineering critical issues. Class exercises are supplemented by lessons on current policy, architectures, and design considerations.

The competencies and associated content developed as part of the RT-4 initiative will be a follow on to SYS 302. Tentatively, this course has been given the number and name SYS 351, "Executive Leadership for Program Systems Engineers". However, because this may change, the RT-4 effort will be referred to as Technical Leadership Program (TLP) for the purposes of this report.

The curriculum to support SYS 351 as a follow-on course for SYS 302, obviously must include the traditional tenets of leadership and management, systems thinking, understanding SOS issues, and thinking and acting holistically. Our research was based upon a literature review, comparisons of existing competency models, and focused group exercises to develop the competency model.

2.2 Definitions

The following definitions are relevant to the research:

Competency Framework—A set of observable and measurable knowledge, skills, abilities, behaviors and other characteristics that an individual needs to perform work roles or occupational function successfully[8].

DAU Proficiencies—Stated as a thorough competence that is developed over time through training and learning, proficiency levels can be defined in four levels as follows:

[8] This is the definition used by the Office of Personnel Management or OPM for other definitions and discussions of competencies see Dubois, 1998; Treasury Board of Canada Secretariat, 1999; and Draganidis and Mentzas, 2006.

- Level I: The ability of a systems engineer to adapt and effectively ***participate*** in a SE activity that involves the application of one or more competencies (and sub-competencies, if required) as a part of the project.
- Level II: The ability of a systems engineer to adapt and effectively perform in SE projects that involves the ***application*** of one or more competencies (and sub-competencies, if required) as a part of the project.
- Level III: The ability of a systems engineer to adapt and effectively ***manage*** complex SE projects that involves the application of one or more competencies (and sub-competencies, if required) as a part of the project.
- Level IV: The ability of a systems engineer to adapt and effectively ***guide*** or direct/supervise complex SE projects that involves the application of one or more competencies (and sub-competencies, if required) as a part of the project.

These levels should not be confused with the DAU certification levels. DAU Level III training must have components of Level III and IV proficiencies.

Learning objectives—A set of skills that a student should learn and comprehend as a result of instruction. After the instruction, the SE should be able to perform tasks that they could not perform before instruction / course. Each learning objectives should be accompanied by measurable outcomes

Learning threads—Thematic aspects of the program that will be highlighted and reinforced through the learning content, experienced faculty facilitation and required student deliverables within each of the three lenses:

- ***Leadership*** – Influencing, defining direction, driving change, self-awareness, developing others;
- ***Ethics*** – Values-based challenges, working across cultures, Professional codes of conduct, Health and Safety, Legal compliance, Social responsibility, Sustainability, Environmental impact;
- ***Communications*** – Presentation skills, Writing skills –Technical reports, Summaries, Memo's, Briefings; Stakeholder needs awareness;
- ***Technical Integrity*** – Ability to ensure alignment of the mission objective(s), concept of operations, architecture, design, and test and integration; Assurance of value added; and
- ***Mentoring*** – Opportunities for on the job application and external feedback, Course outcomes that lend themselves to developmental goal setting.

Objectives—Broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve (from ABET, 2007).

Outcomes—Narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and

behaviors that students acquire in their matriculation through the program (from ABET, 2007).

Technical leadership—Motivating and guiding a group of professionals to define and deliver constructive change producing new technical performance or systems.

3 COMPETENCY MODEL DEVELOPMENT

3.1 INITIAL COMPETENCY DEVELOPMENT

SE competency topics and elements were collected from a wide variety of sources, including NASA[9], Nokia, BAE Systems, the DoD, and the Australian government to develop our initial competency model. These models were discussed in deliverable A0009. From these competency models, possible competencies for SPRDE Level IV were identified[10].

3.2.1 Identification and Aggregation of Competencies

Appendix A contains a listing of the initial competency topics developed for senior systems engineering technical leaders. Because this competency model had many stakeholders, multiple iterations were required to develop a rational and defensible competency model. An analysis of NASA/Nokia/BAE competencies was conducted to identify those competencies that were common across at least two of the three data sets to prioritize the competency topics and elements. After analyzing the data, it was readily apparent that the NASA set of competencies (or competency model) was the most robust and mature and thus this was used as a baseline.

A chief engineers (CEs) forum was held to elicit subject matter expert (SME) responses used to refine, prioritize, address gaps in, and develop the next iteration of the competency model. After this analysis, the competency elements were grouped into ten competency topics. This list was then presented at a technical leader forum held in conjunction with the Conference on Systems Engineering Research (CSER) in March 2010. This second round of SME focused on further refining the competency list and categories. The final competency model developed can be found in Appendix B. This competency model provides the baseline for developing the TLP architecture.

It should be noted that, in addition to the competency-based discussions, there were also some other SME recommendations as to the ideal characteristics of technical leaders, such as passion, problem-solving ability, and charisma. These characteristics were captured and are being considered for incorporation in the TLP.

---

[9] Compiled by Wiley Larson and titled NASA's Systems Engineering Competencies as part of the Academy of Program/Project and Engineering Leadership for NASA, 2006.

[10] We will use the term Level IV throughout this report as defined in Table 1.8. We believe that SYS 302 should be focused in developing Level III proficiencies. Whereas, SYS 351 should be mainly focused on developing professionals who oversee SE activities for a program with several systems and/or establishes SE policies at top organizational level.

3.2 Research and Recommendation on Closing Gaps

Initial discussions of the TLP included considerations for how it would be used to improve upon the current DAU SPRDE program (Levels I-III). To help identify where TLP might improve upon SPRDE, a first step was to determine the alignment between the competencies to be covered by the TLP program (Appendix B) and the learning outcomes covered by current SPRDE courses. The competency list was compared to the outcomes lists, and overlaps were identified (see Appendix C). This provides a baseline understanding of the competency levels for the incoming students for TLP.

Competencies that are not covered by the current SPRDE courses are considered targets that should be addressed by TLP. It should be noted that competencies with some coverage in current SPRDE courseware would still be covered within the TLP. However, they will be covered either from a different perspective (e.g. with a leadership slant) or to a deeper level.

The competency framework and mapping to current SPRDE courses provided the baseline for development of the curriculum architecture.

4 Initial Curriculum Development Activities

4.1 Architecture

In summer 2010, the TLP development team discussed a possible architecture with DAU representatives. This architecture is based on the principles that there are three lenses that can be used to view TLP content, as shown in Figure 1. The lenses open an increasing aperture on a specific area, in this instance systems engineering technical leadership. Each lens covers content related to systems engineering, but at a different level.

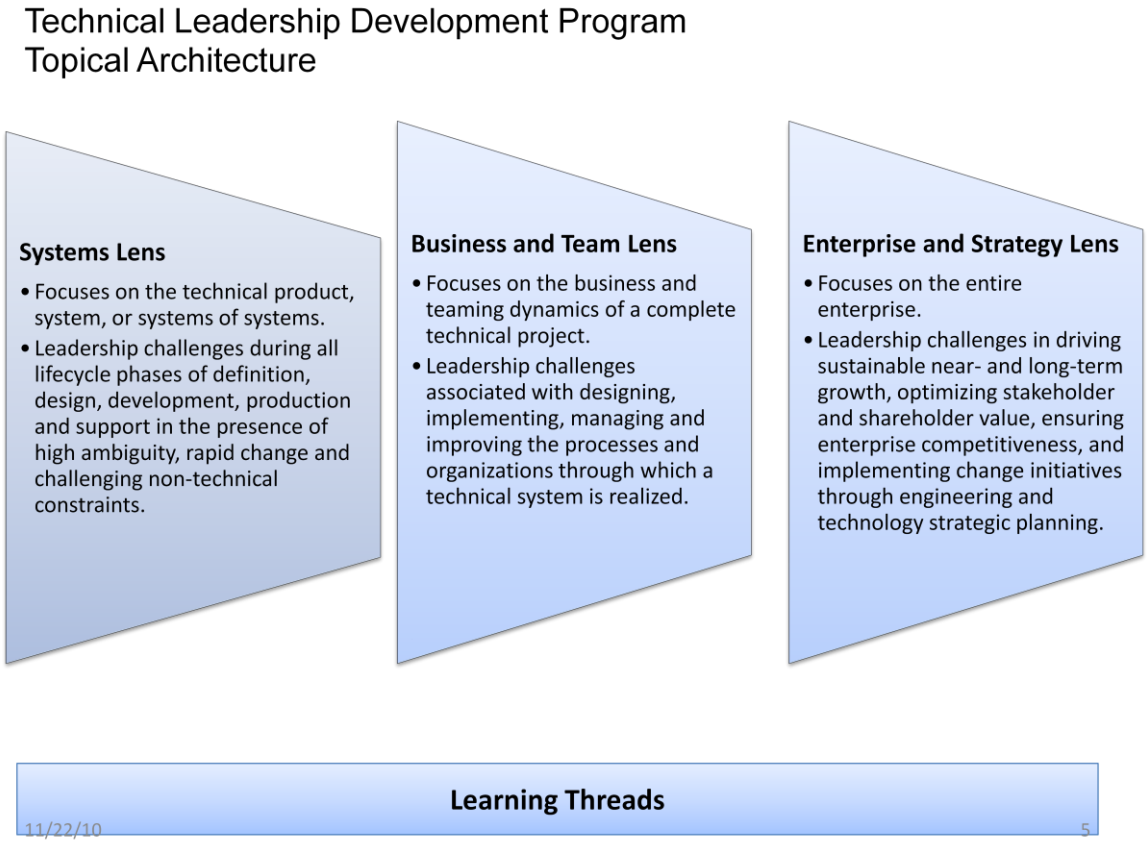


Figure 1. TLP Topical Architecture

For each lens, the TLP development team created a list of applicable competencies. This was done by mapping the competency list (Appendix A) to the objectives and outcomes of each lens. The partitioning of competencies to the different lenses can be seen in Appendix D. Each lens will include a project which will be used to engage the students and evaluate their level of learning.

In addition to the lenses, the TLP also addresses the more esoteric skills associated with technical leadership. These skills are integrated throughout the lenses and are called **learning threads**. Learning threads represent thematic aspects of the program that will be highlighted and reinforced through the learning content, experienced faculty facilitation, and required student deliverables within each of the three Program Lenses. There may be differences in the extent to which each thread is relevant to the content and requirements for a given lens.

- ***Leadership*** – Influencing, defining direction, driving change, self-awareness, developing others.
- ***Ethics*** – Values-based challenges, working across cultures, Professional codes of conduct, Health and Safety, Legal compliance, Social responsibility, Sustainability, Environmental impact.
- ***Communications*** – Presentation skills, Writing skills –Technical reports, Summaries, Memo's, Briefings; Stakeholder needs awareness.
- ***Technical Integrity*** – Ability to ensure alignment of the mission objective(s), concept of operations, architecture, design, and test and integration; Assurance of value added.
- ***Mentoring*** – Opportunities for on the job application and external feedback, Course outcomes that lend themselves to developmental goal setting.

4.2 Delivery Modes

In addition to the content of the lenses, the TLP development team is also considering the possible ways in which this content can be provided to students. These methods, or delivery modes, each have strengths and weaknesses and each is suited to different content types. The delivery modes currently under discussion are:

- Lecture-based
- Self-study and
- Experience-based
- Simulation

4.2.1 Lecture-Based Content Delivery

Lectures are, perhaps, one of the most common means of delivering knowledge in an academic setting. Lectures in the TLP program would be focused on imparting the basic tenets and principles of a particular topic. They may be delivered by the course instructor or by guest lecturers. Lectures, though an important part of the course structure, will be a small fraction of the total contact time spent with students.

4.2.2 Self-Study Content Delivery

For some topics, particularly those that are covered within SPRDE levels I-III, students will receive read-ahead materials that they will be expected to review on their own. This self-study will likely be evaluated by written or oral responses. Self-study assignments will prepare students for the contact portion of the course. However, it is possible that some self-study assignments will be incorporated into the overarching course projects.

4.2.3 Experience-Based Content Delivery

A core tenet of the TLP is that it will be based on real-world SE experience, particularly experience within the defense and aerospace realms. The concept is that students will be exposed to historical or current scenarios and will be asked to work through some of the major issues associated with them. Experience-based delivery is a critical component of the TLP and there are 4 basic types that will be used:

- **Anecdote**—a brief account of a real-world scenario, the actions taken during that scenario, and the lessons learned associated with it. Anecdotes will likely be delivered by guest lecturers and will include time for student interaction through open question-and-answer segments.
- **Vignette**—A vignette will provide students with a situation. Students will then be asked a series of questions designed to help them think through the technical leadership aspects of the situation. Vignettes may be based on real events or may be simulated, but all will have real-world constraints. Guest facilitators may deliver vignettes.
- **Issue**—An issue will provide students with a problem scenario and a series of decisions points that will require students to determine methods of correcting the problem(s). These decisions will be carried through the issue, so that students may understand how their decisions affect the outcomes of scenarios. Faculty instructors will facilitate issue delivery.
- **Case Study**—A case study will be the most formal form of experience-based delivery, with the most data available to students. Case study backgrounds will be delivered as read-ahead materials that students will review. Students will then provide written reports or oral presentations on the lessons learned on the case studies, where different decisions could be made, etc. The faculty instructor will facilitate case studies.

An overview of the delivery modes, and how they may be implemented within the TLP, can be found in Figure 2.

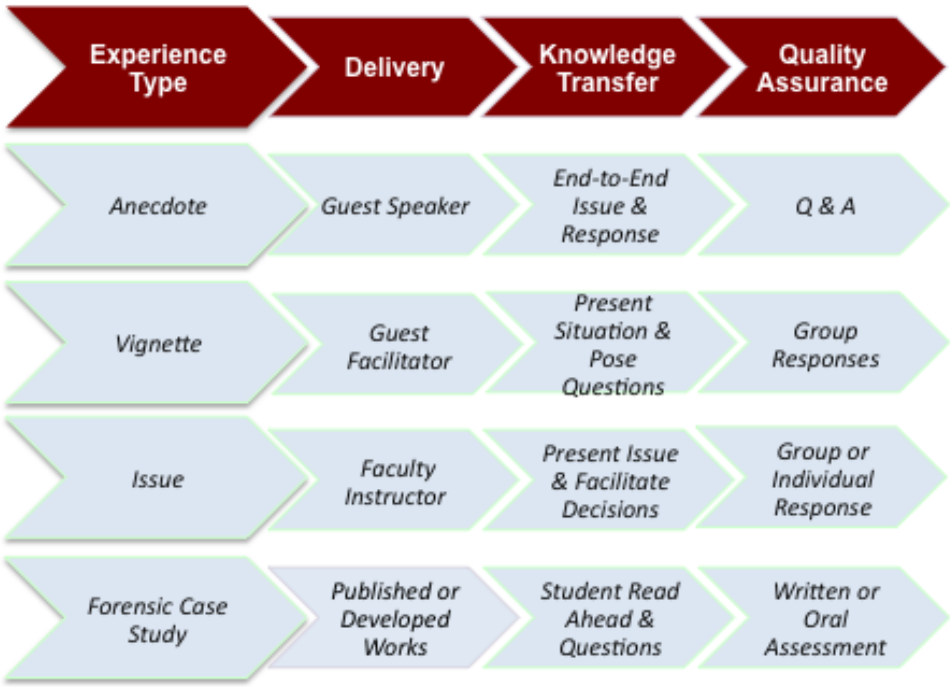


Figure 2. Overview of the Delivery Modes for TLP

4.2.4 Simulation-Based Delivery

The TLP development team is considering the use of more formal simulations as part of the program. This may be tied with the SERC Experience Accelerator project, which provides a virtual environment for simulations and learning.

4.2.5 Delivery Mode Recommendations

The overarching strategy for delivery modes requires a combination of all of these methods. The course content will focus on experiential learning, with lectures to bookend each student interaction. Case studies will map to the specific aspects of each lens.

The current architecture calls for there to be three to four student interactions during the TLP. Of these, there will be no more than four weeks of contact time total, with no more than two weeks of consecutive time. At least three of these interactions will be 5-day sessions based on one of the lenses (systems, B&T, and E&S). The overarching concept for these delivery modes can be found in Figure 3, below.

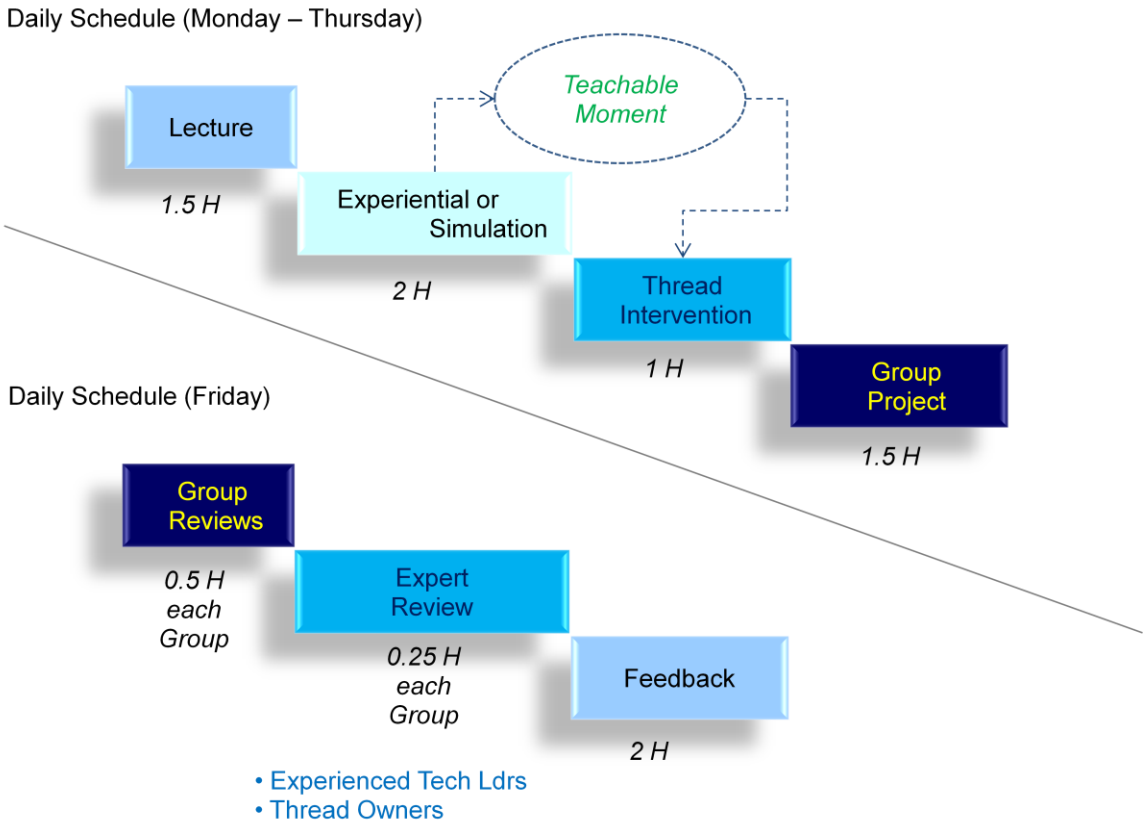


Figure 3. Layout for TLP Delivery Modes

The overarching concept is that pre-reading will lead to a lecture-based discussion. This will be followed by some sort of experiential learning (as described above) or a simulation exercise. Within each simulation there will be at least one intervention, which will specifically focus on one of the learning threads (leadership, communication, ethics, mentorship, etc.). This series of instruction will feed into a group-based, in-class project. This is the first four days of a week of instruction. The project will be presented to a group of SMEs for feedback on the final day of the week-long intervention.

5 Recommended Curriculum

5.1 Program Overview

The Technical Leadership Program (TLP) is a multi-disciplinary, experiential post graduate and professional development curricula that prepares senior design engineers, system engineers, and technologists for Chief Engineer, Technical Director, and Enterprise Technical Executive positions through an interactive course of independent study, simulation, and case study through the three focused lenses: Systems, Business and Team, and Enterprise and Strategy.

Using the architecture, lens learning objectives, outcomes, and focus areas were identified. The focus areas were populated with a draft list of topics. Current courseware from the SERC collaborators was compared to the topical outline for each lens to identify areas where materials exist which can be tailored to support the DAU TLP model.

The targeted learner group is high potential senior engineering designers and technologists with demonstrated superior domain engineering or technology expertise that have been identified and recommended as advanced technical leadership candidates in their organization or fields of expertise.

5.2 Course Description

5.2.1 Systems Lens

The Systems Lens focuses on the technical product, system, or systems of systems and helps students develop the skills to take on the leadership and influencing challenges associated with the roles of Chief Engineer or Chief Technologist during all life cycles phases of definition, design, development, production, and support in the presence of high ambiguity, rapid change and challenging non-technical constraints.

The learning experiences comprising this component of the curriculum will enhance individuals' ability to independently lead and assume accountability for systems engineering in any phase of a product or system life cycle. This includes being able to independently strategize and lead innovation efforts; secure and assess customer value propositions; manage customer expectations in a systems design space; and staff, organize, and train engineering and technology teams for any phase in a product or system life cycle.

This part of the overall leadership development program prepares participants to take on leadership challenges most typically associated with the roles of Chief Engineer or Chief Technologist.

Figure 4, below, provides an overview of the systems lens, starting with the objective for this module. From the objective, learning outcomes were developed. These outcomes map to focus areas that provide a way to group topics and content areas for the lens. An initial cut at the number of contact hours and student's independent study hours for the systems lens was also created for planning purposes.

	Systems Lens Summary			
Lens Objective	focuses on the technical product, system, or systems of systems and helps students develop the skills to take on the leadership and influencing challenges associated with the roles of Chief Engineer or Chief Technologist during all life cycles phases of definition, design, development, production, and support in the presence of high ambiguity, rapid change and challenging non-technical constraints.			
Learning Outcomes	independently strategize and lead innovation efforts	secure and assess customer value propositions	manage customer expectations in a systems design space	staff, organize, and train engineering and technology teams for any phase in a product or system life cycle
Focus Areas (derived from outcomes)	***Innovation***	***Value Propositions***	***Customer Expectations***	***Resource Planning***
Contact Hours: DAU Program (40 total)	10	10	10	10
Independent Study Hours: DAU Program	25	25	25	25

Figure 4. Overview of the Systems Lens

Using this framework for the systems lens, the TLP development team examined relevant courseware from the SERC collaborators to determine where there is content that can be tailored to provide baseline material for the each focus area. The team dedicated to the systems lens expanded the analysis to include a rough estimate of how much tailoring would be required for materials to meet the needs of the systems lens. This initial analysis can be seen in Figure 5.

	Innovation	***Value Propositions***	***Customer Expectations***	***Resource Planning***
SDOE 625 - Fundamentals of Systems Engineering	O1	O2	O3	O4
SDOE 775 - Systems Thinking	O1			
SDOE 780 - Agile Development Strategy	O1			
EM 385 - Innovative System Design	*O1*			
SDOE 679 - Architecting the Extended Enteprise		O2		
SDOE 683 - Design of Agile Systms and Enterprises		O2		
EM 612 - Project Management of Complex Systems		O2	O3	O4
SDOE 660 - Decision and Risk Analysis		*O2*	*O3*	O4
EM 270 - Management of Engineering and Technology		*O2*	*O3*	*O4*
SDOE 605 - Systems Integration			O3	O4
SDOE 650 - System Architecture and Design			O3	O4

Figure 5. Mapping of current courseware to the systems lens focus areas.

This analysis provides a baseline for content development of the systems lens.

A third level of analysis was also conducted. This compares the focus areas of the systems lens to the competencies from the framework assigned to the systems lens. Figure 6 below shows the areas where competencies will be covered based on the current topical alignment of the focus areas. The competencies highlighted in pink are those that are not yet covered under the current instantiation of the focus areas. The TLP development team will work on adjusting the courseware to ensure that these competencies are included in the systems lens.

	Innovation	*Value Propositions*	*Customer Expectations*	*Resource Planning*
1.1. Leadership	√			
1.2. Communications	√		√	
1.3. Ethics		√	√	
1.4. Mentoring and Coaching	√			√
1.5. Team Dynamics and Management	√			√
3.0 Resource Management				
3.1. Technical Staffing and Performance	√			√
6.0 Program Assessment and Recovery				
6.2. Problem Solving and Recovery Approach	√	√	√	
6.3. Solution Definition and Lateral Thinking		√	√	
7.0 Project Conception				
7.3. Requirements Management	√	√	√	√
7.4. Acquisition Strategies, Procurements and Management				√
9.0 Systems Engineering, Thinking and Perspective				
9.1. Stakeholder Expectations and Management			√	
9.2. Technical Requirements Definition and Management	√	√	√	
9.3. Interface Definition	√		√	
9.4. Concept of Operations (CONOPS)	√		√	√
9.5. Systems of Systems (SoS) Architecture				
9.6. Concepts and Architecture	√		√	
9.7. Logistics Management			√	√
9.8. Trade Studies		√	√	
9.9. Design Solution Definition	√	√	√	
9.10. System Environments	√	√	√	√
9.11. Logical Decomposition				
9.12. PM/SE Procedures and Guidelines				√
9.13. Systems Engineering Management		√	√	√
10.0 Technical Management				
10.1. Technical Planning			√	√
10.2. Technical Risk Management		√	√	√
10.3. Technical Assessment		√		
10.4. Software Challenges and Solutions				
10.5. Configuration Management	√			√
10.6. Interface Management	√			√
10.7. Process Assessment and Control	√			√
10.8. Technical Data Management				√
10.9. Technical Decision Analysis		√		√
10.10. Quantitative Techniques		√		√
11.0 Production, Product Transition and Operations				
11.1. Operations	√		√	√
11.2. Product Transition			√	√
11.3. Product Integration	√			√
11.4. Product Verification	√			√
11.5. Product Validation	√		√	√

Figure 6. Alignment of the focus areas with the competency map for the systems lens.

As mentioned in Section 4, the initial concept for the structure of the systems lens starts with pre-reading assignments for students. The students will then meet in-person for a week-long (five day) interaction, which consists of a mixture of lecture, simulation, experience-based learning, and group work. This week will be followed by an individual group project. The overview for the architecture can be seen in Figure 7 below.

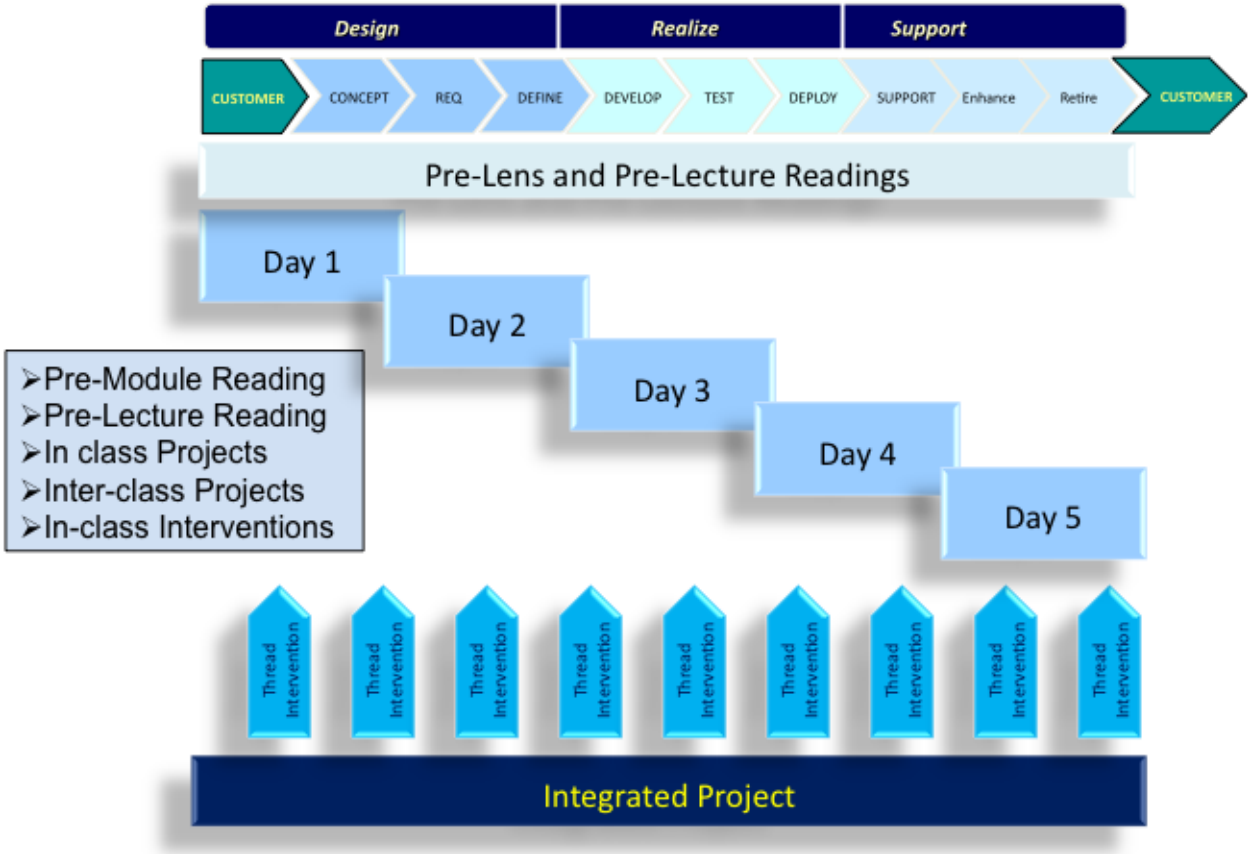


Figure 7. Structure of Student Interactions for In-Class Portion of the Systems Lens.

5.2.2 Business & Team Lens

The business and team (B&T) lens focuses on the business and teaming dynamics of a complete product, system, or systems of systems project and helps students develop the skills to take on the leadership challenges associated with the roles of Director of Engineering or Technical Director for processes and organizations through which a technical system is realized.

The learning experiences comprising this part of the curriculum will enhance individuals' ability to: independently lead teams to develop technology acquisition

strategies in support of the organizational business objectives; effectively communicate technology assessments and recommended responses in a value proposition space to marketing, business development, and senior operational executives; possess dexterity and acumen for financial reporting metrics and the relationships of cost-to-enterprise benefit; and lead the design and implementation technology for risk management processes and tools.

This part of the overall program prepares participants to take on leadership challenges most typically associated with the roles of Director of Engineering or Technical Director.

Figure 8, below, provides an overview of the B&T lens, starting with the objective for this module. From the objective, learning outcomes were developed. These outcomes map to focus areas that provide a way to group topics and content areas for the lens. An initial cut at the number of contact hours and student's independent study hours for the B&T lens was also created for planning purposes.

	Business and Team Lens Summary			
Lens Objective	focuses on the business and teaming dynamics of a complete product, system, or systems of systems project and helps students develop the skills to take on the leadership challenges associated with the roles of Director of Engineering or Technical Director for processes and organizations through which a technical system is realized.			
Learning Outcomes	independently lead teams to develop technology acquisition strategies in support of the organizational business objectives	effectively communicate technology assessments and recommended responses in a value proposition space to marketing, business development, and senior operational executives	possess dexterity and acumen for financial reporting metrics and the relationships of cost-to-enterprise benefit	lead the design and implementation technology for risk management processes and tools.
Focus Areas (derived from outcomes)	***Acquisition Strategy***	***Technology Assessment***	***Financial Acumen***	***Technology Implementation***
Contact Hours: DAU Program (40 total)	10	10	10	10

Figure 8. Overview of the Business & Team (B&T) Lens

Using this framework for the B&T lens, the TLP development team examined relevant courseware from the SERC collaborators to determine where there is content that can be tailored to provide baseline material for each focus area. This initial analysis can be seen in Figure 9.

	Acquisition Strategy	***Technology Assessment***	***Financial Acumen***	***Technology Implementation***
EMT 714 Technology Strategy	√	√		√
Mgt. 699 Strategic Management	√	√		
Mgt 671 Technology & Innovation Mgt.	√	√		√
EMT 677 Emerging Technologies	√	√		
Mgt 600-Accounting for Managers			√	
EMT 624-Financial Analysis for Technical Organizations		√	√	
EMT 635 -Managerial Judgment & Decision making				√
Mgt 612 -The Human Side of Project Leadership				√
Mgt 689 Organizational Behavior & Design				√
EMT 741 Innovation Process Management		√		√
Mgt 620 Statistical Models				√
EMT 755 - Process Management & Six Sigma Quality				√

Figure 9. Mapping of current courseware to the B&T lens focus areas.

A third level of analysis was also conducted. This compares the focus areas of the systems lens to the competencies from the framework assigned to the systems lens. Figure 10 below shows the areas where competencies will be covered based on the current topical alignment of the focus areas.

	Acquisition Strategy	*Technology Assessment*	*Financial Acumen*	*Technology Implementation*
1.0 Professional and Leadership Development				
1.1. Leadership	√	√		√
1.2. Communications	√	√		√
1.3. Ethics	√	√	√	√
1.4. Mentoring and Coaching				√
3.0 Resource Management				
3.2. Position Management		√		√
4.0 Business Acumen				
4.1. Budget and Full Cost Management			√	
4.2. Capital Management		√	√	
4.3. Business Engineering		√	√	√
4.4. External Relationships		√		
4.5. Integration of Technical Programs and Portfolios	√	√	√	
4.6. Lifecycle Perspective	√	√		√
4.7. Management of Research and Development	√	√		√
6.0 Program Assessment and Recovery				
6.1. Review and Assessment Process				
7.0 Project Conception				
7.1. Needs or Opportunity Management	√	√		
7.2. Project Proposal and Bid Management			√	√
7.4. Acquisition Strategies, Procurements and Management	√	√		√
8.0 Project Planning, Management and Control				
8.1. Project Review and Evaluation				√
8.2. Resource Management				√
8.3. Contract Management				√
8.4. Project Planning				√
8.5. Project Control				√
8.6. Lifecycle Cost Estimating			√	√
8.7. Tracking/Trending of Project Performance				√
8.9. Mission Assurance and Specialty Engineering				√
11.0 Production, Product Transition and Operations				
11.2. Product Transition	√	√		√

Figure 10. Alignment of the focus areas with the competency map for the B&T lens.

5.2.3 Enterprise & Strategy Lens

The Enterprise and Strategy Lens focuses on the entire enterprise and helps students develop the skills to take on the challenges associated with executive leadership roles of Chief Technology Officer, Deputy Director of Engineering or Technology, or Vice

President of Engineering to drive sustainable near and long term enterprise growth, optimize stakeholder and shareholder value, ensure enterprise competitiveness in the market place, and implement change initiatives through engineering and technology strategic planning. This includes exploring how to create, select and manage multiple projects over time to achieve business objectives and generate profitable growth over the long term.

The learning experiences comprising this part of the curriculum will enhance individuals' ability to: synthesize engineering and technology needs and investment strategies, objectives, and plans to support enterprise growth, adaptation or change objectives; identify and assess the maturity and application of emerging technologies to current and potential new products and systems; identify needs and develop strategies and objectives for enterprise engineering and technology professional development; effectively communicate enterprise engineering and technology strategies to the broad set of enterprise stakeholders, customers, and prospective enterprise partners; and act as the stakeholder and owner of strategically aligned enterprise engineering and technology human capital recruiting, retention, leadership development, and mentoring plans.

This part of the overall program prepares participants to take on leadership challenges most typically associated with senior executive positions in government and industry including Chief Technology Officer, Deputy Director of Engineering or Technology, or Vice President of Engineering or Technology.

Figure 11, below, provides an overview of the B&T lens, starting with the objective for this module. From the objective, learning outcomes were developed. These outcomes map to focus areas that provide a way to group topics and content areas for the lens. An initial cut at the number of contact hours and student's independent study hours for the B&T lens was also created for planning purposes.

	Enterprise & Strategy Lens Summary				
Lens Objective	focuses on the entire enterprise and helps students develop the skills to take on the challenges associated with executive leadership roles of Chief Technology Officer, Deputy Director of Engineering or Technology, or Vice President of Engineering to drive sustainable near and long term enterprise growth, optimize stakeholder and shareholder value, ensure enterprise competitiveness in the market place, and implement change initiatives through engineering and technology strategic planning. This includes exploring how to create, select and manage multiple projects over time to achieve business objectives and generate profitable growth over the long term.				
Learning Outcomes	synthesize engineering and technology needs and investment strategies, objectives, and plans to support enterprise growth, adaptation or change objectives	identify and assess the maturity and application of emerging technologies to current and potential new products and systems	identify needs and develop strategies and objectives for enterprise engineering and technology professional development	effectively communicate enterprise engineering and technology strategies to the broad set of enterprise stakeholders, customers, and prospective enterprise partners	act as the stakeholder and owner of strategically aligned enterprise engineering and technology human capital recruiting, retention, leadership development, and mentoring plans.
Focus Areas (derived from outcomes)	***Technological Enterprise Support***	***Technology Assessment***	***Professional Development Strategy***	***Technology Implementation***	***Technology Workforce Development***
Contact Hours: DAU Program (40 total)	8	8	8	8	8
Independent Study Hours: DAU Program	20	20	20	20	20

Figure 11. Overview of the Enterprise and Strategy (E&S) Lens

Using this framework for the B&T lens, the TLP development team examined relevant courseware from the SERC collaborators to determine where there is content that can be

tailored to provide baseline material for each focus area. This initial analysis can be seen in Figure 12.

	Technological Enterprise Support	*Technology Assessment*	*Professional Development Strategy*	*Technology Implementation*	*Technology Workforce Development*
EMT 715 Strategic Business Planning	√	√	√	√	
EMT 714 Technology Strategy	√	√	√	√	
Mgt 671 Technology & Innovation Mgt.	√	√		√	
EMT 677 Emerging Technologies	√	√			
Mgt 699 Strategic Mgt	√	√	√	√	
Mgt 699 Organization Behavior & Design			√	√	√
EMT 740 Team Leadership Development in Technical Organizations					√
Leadership in Complex Program Environments (new course)			√	√	√

Figure 12. Mapping of current courseware to the E&S lens focus areas.

A third level of analysis was also conducted. This compares the focus areas of the systems lens to the competencies from the framework assigned to the systems lens. Figure 13 below shows the areas where competencies will be covered based on the current topical alignment of the focus areas.

	Technological Enterprise Support	*Technology Assessment*	*Professional Development Strategy*	*Technology Implementation*	*Technology Workforce Development*
1.0 Professional and Leadership Development					
1.1. Leadership	√	√	√	√	√
1.2. Communications	√	√	√	√	√
1.3. Ethics	√	√	√	√	√
1.4. Mentoring and Coaching	√		√		√
1.6. Multinational and Multicultural Issues	√		√	√	√
2.0 Enterprise Leadership and Management					
2.1. Leading the Technical Enterprise	√	√	√	√	√
2.2. Governance for the Technical Enterprise	√	√	√	√	√
2.3. Organizational Structure, Mission, Internal Goals	√	√	√	√	√
2.5. International Standards and Political Implications	√	√	√	√	√
2.4. Knowledge Capture, IP, Capture and Sharing	√	√	√	√	√
5.0 Risk and Security					
5.1. Risk Management	√	√		√	
5.2. Safety	√		√		
5.3. Physical and Cyber Security	√			√	√
5.4. Environment and Ecology	√				
8.0 Project Planning, Management and Control					
8.8. Information Technology/Management Information Sys	√			√	

Figure 13. Alignment of the focus areas with the competency map for the B&T lens.

6 FUTURE WORK

6.1 DEVELOPMENT PLAN

This report provides the findings from the base year of the TLP development effort. The development team is recommending a two-year continuation to complete courseware for the program. This two-year timeline will include drafting of initial content, delivery of two pilots, refinement of the materials, and final delivery to DAU for instruction.

Additional details on the schedule can be found below.

6.1.1 Option Year 1 (12/16/10 – 12/15/11)

The TLP development team will research, synthesize, and validate curriculum content and structure for a preliminary systems lens and B&T lens curriculum and initiate research, synthesis, and validation of the B&T lens curriculum to include assessments of the systems and B&T lens alignment with previously developed SE leadership skills and competencies. The team will conduct two systems lens pilots and one B&T lens pilot at DAU, Ft Belvoir, VA and will initiate research and synthesis of the E&S lens. Researchers will document any changes to SE leadership skills, competencies and assessment methodologies needed to support and/or extend the DAU Level III Systems SPRDE-SE certificate offered by DAU.

The team will submit both interim and final reports documenting progress in curriculum research and synthesis. It will also include systems, B&T, and E&S lens alignments with previously developed SE leadership skills and competencies. The report will provide the results from pilots conducted and explain curriculum refinements based on these pilots.

Researchers will deliver a systems lens outline of study, defined as a systems lens syllabus with associated course materials to the DAU. It will also include recommended student experiential or immersion experiences that serve to support and accelerate SE technical leader learning

6.1.2 Option Year 2 (12/16/11 – 12/15/12)

The TLP development team will research, synthesize, and validate curriculum content and structure for the revised B&T lens curriculum will draft and finalize content for the E&S lens. The team will initiate research, synthesis, and validation of the B&T and E&S lenses to include assessments of the systems and B&T lens alignment with previously developed SE leadership skills and competencies. The team will conduct two systems

lens pilots and one B&T lens pilot at DAU, Ft Belvoir, VA and will initiate research and synthesis of the E&S lens. Researchers will document any changes to SE leadership skills, competencies and assessment methodologies needed to support and/or extend the DAU Level III Systems SPRDE-SE certificate offered by DAU.

The team will submit both interim and final reports documenting progress in curriculum research and synthesis. It will also include B&T, and E&S lens alignments with previously developed SE leadership skills and competencies. The report will provide the results from pilots conducted and explain curriculum refinements based on these pilots.

Researchers will deliver both the B&T and E&S lens outlines of study, defined as lens syllabi, with associated course materials, to the DAU. It will also include recommended student experiential or immersion experiences that serve to support and accelerate SE technical leader learning

At the end of options year 2, all materials required to instruct and deliver the DAU TLP will be handed off from the team to DAU faculty.

6.2 SCHEDULE

The specific planning schedule for the tasks listed above can be found in Figure 14, below.

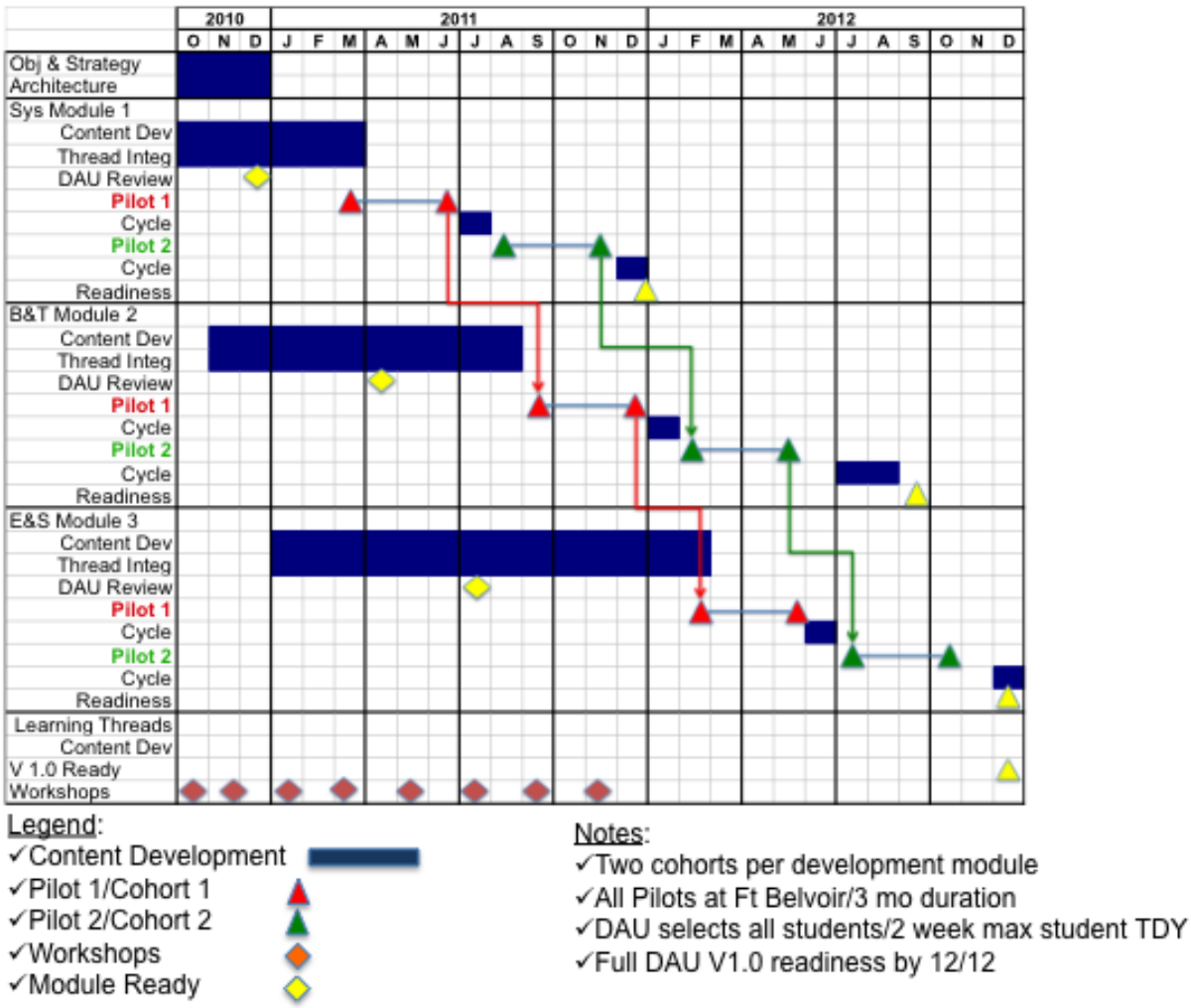


Figure 14. Schedule for development, finalization, and delivery of TLP content.

APPENDICES

APPENDIX A. INITIAL COMPETENCY LIST

	Competency Title	Level I (Participate)	Level II (Apply)	Level III (Manage)	Level IV (Guide)
1.0	**Concepts and Architecture**[11]	Awareness of the fundamentals of mission needs and system environments and applying this understanding to a viable and complete system architecture while supporting a Level II – IV engineer as a member of the project team.	Performing SE related activities for a simple project based on the understanding of the fundamentals of mission needs and system environments and applying this understanding to viable and complete system architecture.	Performs as a systems engineer for a complex project based on the understanding of the fundamentals of mission needs and system environments and applying this understanding to viable and complete system architecture.	Directs SE activities for a program with several systems and / or establishes SE policies at top organizational level based on the understanding of the fundamentals of mission needs and system environments and applying this understanding to a viable and complete system architecture.
1.1	**Needs or Opportunity Management**[12]	The ability to identify customer needs and articulate them to a Level II-IV engineer. Ensure that processes are followed to satisfy customer requirements.	The ability to organize, index and integrate information from various sources to identify customer needs.	The ability to organize, index and integrate information from various sources to identify customer needs. Articulate processes between teams and between products/projects based upon customer needs.	Ascertain the different levels of investment and even different sets of people involved in the process to support customer needs management.

[11] Squires, Alice, Wiley Larson, Brian Sauser, "Mapping space-based systems engineering curriculum to NASA – industry developed competencies for improved organizational performance", *Systems Engineering,* Article available online on 17th June, 2009

1.2	**System Environments**[1]	Participate and gain awareness of understanding of the system environment and the inherent constraints and the ability to establish design guidance for the expected environments.	Applying the understanding of systems environment and the inherent constraints and the ability to establish design guidance for the expected environments to perform SE activities using various SE tools and techniques.	Managing SE projects that utilizes the understanding of system environment and the inherent constraints and the ability to establish design guidance for the expected environments.	Directing SE activities / projects that incorporates the understanding of system environment and the inherent constraints and the ability to establish design guidance for the expected environments.
1.3	**Trade Studies**[1]	Understanding the value of performing trade studies as a part of the necessary capabilities for comparing and contrasting the identified viable level technical solutions. This capability includes creating, validating, operating and correlating (with operational model) the system data. The end product of this capability is the identification and selection of a well balanced (cost, schedule, technical, quality) systems level solutions.	Applying trade studies as a part of the necessary capabilities for comparing and contrasting the identified viable level SE solutions. This capability includes creating, validating, operating and correlating (with operational model) the system data. The end product of this capability is the identification and selection of a well-balanced (cost, schedule, technical, quality) systems level solutions.	Managing a set of SE projects that requires the application of trade studies in order to arrive at the most viable technical and/ or system level solution. This capability includes creating, validating, operating and correlating (with operational model) the system data. The end product of this capability is the identification and selection of a well balanced (cost, schedule, technical, quality) systems level solutions.	Directing SE activities / projects that involve the use of trade studies to as a part of the identification and selection process of a well balanced systems level solution. This capability includes creating, validating, operating and correlating (with operational model) the system data.

[12] Modified from Oracle at http://blogs.oracle.com/PLM/2008/10/customer_needs_management_cnm.html, accessed August 12, 2009

1.4	**System Architecture[1]**	Understanding the utility of developing the various systems architectural views beginning with establishing the proper bounds of the system and defining the external interfaces. This also includes the understanding of functional decomposition, performance analysis, identification of subsystem relationships and internal interfaces and documentation of the various (operational, functional, physical and data) architectural views.	Developing various systems architectural views beginning with establishing the proper bounds of the system and defining the external interfaces. This also includes the basic development of functional decomposition, performance analysis, identification of subsystem relationships and internal interfaces and documentation of the various (operational, functional, physical and data) architectural views.	Managing SE activities / projects that require the development and application of various systems architectural views beginning with establishing the proper bounds of the system and defining the external interfaces. The SE activities also include functional decomposition, performance analysis, identification of subsystem relationships and internal interfaces and documentation of the various (operational, functional, physical and data) architectural views.	Directing SE activities / projects that require the development and application of various systems architectural views beginning with establishing the proper bounds of the system and defining the external interfaces. The SE activities also include functional decomposition, performance analysis, identification of subsystem relationships and internal interfaces and documentation of the various (operational, functional, physical and data) architectural views.
1.5	**Concept of Operations (CONOPS)**	Understand how a system is utilized and deployed as expressed by a CONOPS. Use CONOPS to translate customer requirements into a subsystem or component level item.	Use CONOPS to communicate system characteristics to the customers, system developers, and other organizational elements. Use CONOPS to translate customer requirements into a system level entity.	Use CONOPS to communicate system characteristics to the customers, system developers, and other organizational elements. Translate CONOPS into integrated product teams.	Use CONOPS during the business case analysis/concept definition phase to understand resource and strategic implications.

APPENDIX B. FINAL COMPETENCY MODEL

Competency Element and Topic – Working Composite	*Definition*	*Experience*
1.0 Professional and Leadership Development		
1. Leadership	Directing / supervising complex projects that require effective leadership capabilities for its success. Leadership capabilities includes delegating of tasks and assigning technical work defining, tracking and managing success criteria for performance; influencing others including providing vision, direction, and guidance, motivating and inspiring individuals to perform technical work successfully, recognizing and rewarding accomplishments and establishing and maintaining a collaborative and open work environment; and strong decision making and problem solving including defining problems accurately, establishing solution criteria, evaluating alternatives and determining solution's) based on facts, evidence, criteria and risk.	Increasing project responsibilities with larger responsibilities and expanded organizational control. Education in program/project management of complex systems
2. Communications	Directing/supervising projects that utilizes effective communication as a part of its success. Communicating efficiently requires writing and presenting technical information and communicating technical decisions effectively; writing and presenting technical and status reports effectively; and practicing strong interpersonal communication through effective speaking, writing, and listening.	Demonstrated communication through multiple levels, both vertically and horizontally, through an organization. Assignment with multi-disciplinary team members in multiple locations.

3. Ethics	Ensures that business is conducted in accordance with all applicable laws, regulations and contractual obligations. Behave ethically and with integrity and always follow the principles of government laws and regulations, but adhere to a high standard of moral and ethical considerations when making business decisions. Ensures that this culture is persuasive throughout the organization.	Leadership position of a complex program.
4. Mentoring and Coaching	Supervising mentoring for a complex programs/projects. This includes serving as a mentor and coach and providing advice and guidance, teaching juniors, and receiving periodic personal coaching to improve identified weaknesses.	Lead a project that has several junior members or personnel who are new to the roles on that project.
5. Team Dynamics and Management	Directing / supervising complex projects that includes addressing team dynamics and management. Managing the technical team includes developing the team by motivating team members, rewarding high performance and managing relationships with the team; managing team processes by establishing and managing interfaces and relationships with technical team members, customers, stakeholders and partners, and facilitating brainstorming, conflict resolution, negotiation, problem solving, communication, collaboration and team member integration; and planning and facilitating effective technical team meetings.	Experience with multi- and interdisciplinary teams. Projects assignments that include project inception through delivery.
6. Multinational and Multicultural Issues	Promotes an environment that accommodates multinational and multicultural issues.	International assignment or mange a program with personnel from several cultures to include an international element
2.0 Enterprise Leadership and Management		

1. Leading the Technical Enterprise	Ensures that goods and services that are developed support the technical enterprise and are aligned with the strategic business interests of the organization. Can articulate to internal and external stakeholders how they support the larger technical enterprise. Ensures that resources, management information systems (MIS), etc., are allocated to support the technical enterprise.	Assignments to develop strategic product and technology road maps. Manage an enterprises portfolio management process for new products/programs
2. Governance for the Technical Enterprise	Ensures that individual development projects are managed consistent with development governance policies and practices of the organization. Ensures that a culture exist to track and monitor project performance.	Participated as a key member of an Integrated Product Team (IPT) or had oversight of representatives on IPTs of an acquisition program or fielded system
3. Organizational Structure, Mission, Internal Goals	Supervising / directing organizational structure, missions and internal goals in complex programs/ projects. This includes aligning activities with the organizational vision, mission, objectives, goals and plans and functioning within the organizational structure and culture.	Experience leading and/or managing engineering activities relating to the design, development, and/or analysis of software and information technology systems or systems components at the program office level or multiple projects.
4. Knowledge Capture, IP, Capture and Sharing	Directing / supervising complex projects that involve knowledge capture and sharing. This includes identifying, recording and evaluating lessons learned and best practices of system and other engineering activities and related significant studies; and capturing work products throughout the product life cycle and making these work products available to appropriate users and stakeholders.	Systems design or test and integration assignment to a complex systems effort where data collection and management is critical.
5. International Standards and Political Implications	Supervise the application of International partnerships and International Traffic in Arms Regulations (ITAR) constraints. Understand the role of Generally Accepted Accounting Principals (GAAP) in strategic business decisions.	Knowledgeable of export controls laws, international standards, etc., and responsible for implementing processes and monitoring mechanisms to ensure that the program/program is in compliance with all laws/regulations.
3.0 Resource Management		

1. Technical Staffing and Performance	Directing / supervising complex projects that include application of technical staffing and performance. This includes defining roles and responsibilities of the technical workforce and staffing the technical team, monitoring performance of the technical workforce and assuring required levels of performance are met.	Assignment to a start up project where key assignments and staffing decisions must be accomplished.
2. Position Management	Responsible for the clear delineation of duties and roles. Accountable for the attraction, retention, and motivation of senior personnel while ensuring their maximum development opportunities.	Assignment to a start up project where key assignments and staffing decisions must be accomplished. Correct the performance of a difficult major task or of an entire project.
4.0 Business Acumen		
1. Budget and Full Cost Management	Direct / supervise the budget development and execute for a complex project. Supervise and ensure accuracy of budget activities in the enterprise's accounting and financial systems for a large project.	Project engineer or assistant PM responsibility on a project that is being planned and/or executed.
2. Capital Management	Ensures that the capital assets (human, financial, infrastructure, etc) of a business are properly allocated to ensure project success and the risk is allocated based upon the strategic intent of the organizations leadership	Assignment as functional manager who is responsible for resource allocation across several programs.
3. Business Engineering	Ensure that controls and tracking tools are in place to meet project deliverables. Work with customers on cost expectations, monitoring using Earned Value Management (EVM), and timelines using a work breakdown structures (WBS).	Six-sigma assignment working on formal methods to capture and improve processes.

4. External Relationships	Directing / supervising complex projects that includes external relationship as a part of the process. This includes structuring technical activities to conform to industry and professional standards, participating in professional organizations, and contributing to the profession. When engineering systems for or with international partners, this capability also includes understanding and complying with the International Traffic in Arms Regulations (ITAR), as well as developing international partnerships, agreements, and standards. Effectively cultivates positive relationships with competitors, potential customers, clients, etc., to ensure the successful execution of a project and to build long-term strategic relationships.	Assignment to a program with complex external stakeholder relationships.
5. Integration of Technical Programs and Portfolios	Developed strategies to integrate products and services into a portfolio that align with the strategic direction of the organization. Clearly articulates this to organizational stakeholders.	New business development assignment or equivalent
6. Lifecycle Perspective	The ability to manage a project via the sequence of phases through which a project will evolve and to perform periodic progress reviews within the project lifecycle at business level to assess the technical, contractual, and financial health of the project.	Participate as a key member of an IPT for an acquisition program or fielded system with responsibility for clearly articulating program support requirements, implementing life cycle management practices, long term sustainment planning and execution, and developing strategies to best satisfy the stakeholders requirements.
7. Management of Research and Development	Shapes Research and Development (R&D) policy and priorities to ensure that they align with the strategic directions of the organization.	Assignment managing an organization conducting R&D or involved in performing strategic planning efforts
5.0 Risk and Security		

1. Risk Management	Direct / supervise complex projects that involved a risk management process and utilization of risk analysis to support decision-making to ensure the technical and business viability of a program/project.	Manage risk identification. Mitigation task and process on a program.
2. Safety	Responsible for protecting their employees and communities from workplace hazards. Ensure that a culture exists that promotes workplace safety as a corporate priority. Ensures that safety procedures were employed, including safety reviews, quality plans, and safety plans. Plans and manages system safety by identifying relevant safety regulations and procedures, assessing potential hazards, monitoring, controlling, eliminating or reducing hazards, performing system safety analysis, verifying system safety, and conducting failure resolution and reporting. This capability also includes identifying and managing test, operational and industrial safety; identifying mission assurance requirements and developing safety and mission assurance plans and implementation strategies; or other applicable safety reviews and processes.	Manage risk identification. Successfully identified tasks for mitigation and processes needed on a program. Ensured that program/project is in compliance with all Occupational Safety and Health Act (OSHA) regulations and workplace safety standards.
3. Physical and Cyber Security	Directing / supervising complex projects that include application of security. Organizing security includes identifying IT, physical, and other security requirements and developing and implementing the requisite security plan.	Identified physical and cyber security risks and implemented solutions to mitigate the risk.
4. Environment and Ecology	Responsible for stewarding the environment and protecting their employees and communities. Ensures that the organization is in compliance with all local, state, federal, etc., laws and regulations.	Knowledgeable of ethics and environmental laws and responsible for implementing processes and monitoring mechanisms to ensure that a program/program is in compliance with all laws/regulations.
6.0 Program Assessment and Recovery		

1. Review and Assessment Process	Manage and review process improvements at the macro level in ensure improved operational effectiveness. Based upon control feedback ensure that process improvements are implemented.	Assignment as a functional manager who is responsible for resource allocation across several programs.
2. Problem Solving and Recovery Approach	Can clearly identify the actual problem from often conflicting information and can then marshal the resources needed to solve the problem. Able to access problems that have the most impact and prioritize solving based upon a holistic view of their implications.	Correct the performance of a difficult major task or of an entire project. Develop risk identification and mitigation techniques
3. Solution Definition and Lateral Thinking	The ability to use a systematic process to determine a credible problem statement, create potential system solutions to solve the appropriate problem. This is often domain dependent and may require application of multiple domain knowledge. Able to solve problems through an indirect and creative approach by using reasoning that is not immediately obvious and about ideas that may not be obtainable by using only traditional approach.	Demonstrated creativity and problem solving skills on projects with significant responsibility and organizational control.
7.0 Project Conception		
1. Needs or Opportunity Management	Ascertain the different levels of investment and even different sets of people involved in the process to support customer needs management. Develops the partnering and marketing strategies required to not only win but also execute the project.	New business development assignment or equivalent.

2. Project Proposal and Bid Management	Ensure that projects proposals are aligned to strategic objectives and have a high probability of success. Work the lateral and vertical organizational and political issues needed to improve probability of proposal acceptance. The ability to direct/supervise the lifecycle phases leading up to contract award. This includes preparation of the proposal encompassing all aspects of the management, engineering, contract, manufacturing, and support data. Co-ordination of the marketing, lobbying, and negotiating activities that occur during the bid phase.	Work on a complex proposal effort. Served as program/project manager, chief engineer, or a lead systems engineer on a proposal.
3. Requirements Management	Direct / supervise complex projects pertaining to the development and iteration of requirements for project or large subsystem including stakeholder acceptance. Directed requirements base lining processes. This capability includes documenting requirements in their proper format, ensuring the requirements baseline is validated, and identifying and addressing out-of tolerance requirements; developing and maintaining requirements compliance matrices; reviewing engineering change proposals (ECPs), implementing formal change control and disseminating approved changes; and documenting requirements management activities.	Role on complex program as a systems engineer, managing requirements and closure of open issues
4. Acquisition Strategies, Procurements and Management	Direct / supervise activities for a complex project that includes overseeing technical acquisitions. Overseeing technical acquisition includes identifying the technical inputs to and developing acquisition strategies; writing, reviewing and evaluating technical proposals; and executing and managing acquisition instruments. Direct/supervise complex SE projects involving the development, implementation and monitoring acquisition strategies, contract Statement of Work (SOW), Test and Evaluation Master Plans (TEMPs), verification plans, and approval requirements to support hardware/software.	Assignment directing several systems engineers who are developing system requirements from a large group of stakeholders. Served as program/project manager, chief engineer, or a lead systems engineer on a proposal.

8.0 Project Planning, Management and Control		
1. Project Review and Evaluation	Use / perform project reviews to make decisions at the business unit level to assign risk to meet the strategic needs of the organization. Understands keys performance metrics need to assess project performance.	System or chief engineer on a complex system in charge of several systems groups. Assess the effective technical and programmatic contributions of program IPTs to key decision points in a program/project. Apply appropriate program data and metrics to make effective program decisions
2. Resource Management	Deploys and allocates resources across business units and programs to ensure that the strategic goals and profitability are met. Make functional versus cross-functional resource allocation decisions across multiple projects.	Assignment as a functional manager who is responsible for resource allocation across several programs.
3. Contract Management	Direct/supervise activities for a complex project that includes contract management. Contract management includes developing the technical penetration and insight required to monitor the technical performance of contractors and providing the technical inputs for project contract management including change control.	Manage the acquisition of a complex subsystem as either the lead systems engineer or project manager defining, negotiating, and controlling the technical and business terms for the subcontracted item.
4. Project Planning	Direct / supervise complex projects that involve development of a life cycle project plan including WBS, budget, schedule, staffing and project success criteria. Manage a large project, major system, or equivalent entity during formulation phase. As manager, had sole authority for program/project budget, schedule, and scope.	Project engineer or assistant PM responsibility on a project that is being planned. Participate in the planning and execution of an Integrated Baseline Review. Assess the adequacy of the baseline, appropriateness of controls, and potential issues that may arise in execution.

5. Project Control	Direct / supervise complex projects that include the application of tracking tools such as EVM and trend data to analyze programmatic and technical performance at the business unit level. Direct development, evaluation, and implementation of mitigation efforts to address performance variances. Tailor reserve and margin policy and manage its application.	Experience evaluating an existing or proposed program/project schedule for appropriate task organization, linkages, resource loading, and deliverables. Apply appropriate program data and metrics to make effective program decisions.
6. Lifecycle Cost Estimating	The ability to manage a project via the sequence of phases through which a project will evolve and to perform periodic progress reviews within the project lifecycle at business level to assess the technical, contractual, and financial health of the project.	Participate as a key member of an IT for an acquisition program or fielded system with responsibility for clearly articulating program support requirements, implementing life cycle management practices, long term sustainment planning and execution, and developing strategies to best satisfy the stakeholders requirements.
7. Tracking/Trending of Project Performance	Manage project reporting and evaluation of technical performance metrics, earned value, and risk management analysis. Conducted continual project monitoring and formal reviews.	System engineer or PM on a complex system in charge of several systems groups. Apply appropriate program data and metrics to make effective program decisions.
8. Information Technology/Management Information Systems	Define corporate strategy that determines both the strategic and operational capabilities of the firm in designing and developing information technology (IT) infrastructure and processes to ensure maximum customer satisfaction, corporate productivity, profitability and competitiveness.	Assist in the evaluation or conduct and assessment of IT needs and develop solutions.
9. Mission Assurance and Specialty Engineering	Implement safety, reliability, maintainability, and quality assurance activities throughout the project life cycle in accordance with safety and mission assurance strategies, policies, and standards.	Manage risk identification throughout the project lifecycle. Mitigation task and process on a program.
9.0 Systems Engineering, Thinking and Perspective		

1. Stakeholder Expectations and Management	Assessing and managing the expectations of persons vested in a program/project that can affect or be affected by the success or failure of a project, i.e., a stakeholder.	Systems design or test and integration assignment to a complex systems effort where data collection and management is critical.
2. Technical Requirements Definition and Management	Overseeing SE activities for a complex project that involves defining the technical requirements among others. Defining the technical requirements includes defining the technical problem scope and the related design and product constraints; converting functional and behavioral expectations to technical requirements; defining methods, processes, and tools (MPTs); and validating and base lining the technical requirements.	Guide several systems engineers on a complex project during development phase.
3. Interface Definition	Directing activities / projects that require the development and application of various architectural views beginning with establishing the proper bounds of the system and defining the external interfaces. The activities also include functional decomposition, performance analysis, identification of subsystem relationships and internal interfaces and documentation of the various (operational, functional, physical and data) architectural views.	Systems/chief engineer on a program that developed requirements from the operational scenarios.
4. Concept of Operations (CONOPS)	Utilize CONOPS during the business case analysis/concept definition phase to understand resource and strategic implications.	Systems/chief engineer on a program that developed requirements from the operational scenarios.
5. Systems of Systems (SoS) Architecture	Managing activities / projects that require the understanding of various SoS architectural views and applications. Understand the business implications of the emergent behavior and managerial independence of SoS.	Systems/chief engineer on a complex SoS program.
6. Concepts and Architecture	Direct SE and other engineering activities for a program with several systems and / or establish SE policies at top organizational level based on the understanding of the fundamentals of mission needs and system environments and applying this understanding to viable and complete system architecture.	Assignment, as a contributing engineer to a complex systems program that has several major systems.

7. Logistics Management	Ensure that the right processes, organizations, resources, and leadership exist to deploy the products and services on time and schedule throughout the entire product lifecycle.	Field assignment installing or maintaining a system or Logistics planning assignment.
8. Trade Studies	Directing activities / projects that involve the use of trade studies to as a part of the identification and selection process of a well balanced systems level solution. This capability includes creating, validating, operating and correlating (with operational model) the system data.	Assignment as a systems/chief engineer on a complex program where sub system design and allocation efforts are required.
9. Design Solution Definition	Directing/overseeing activities for a project that involves designing system solutions. The system design solution is developed by first defining, analyzing and selecting the best system design alternative; and then generating, verifying and base lining a full design description for the selected design solution.	Assignment as a systems/chief engineer on a complex program where Sub system design and allocation efforts are required.
10. System Environments	Directing SE activities / projects that incorporates the understanding of system environment and the inherent constraints and the ability to establish design guidance for the expected environments.	Guide several systems engineers on a complex project during development phase.
11. Logical Decomposition	Directing / overseeing SE projects that include logical decomposition of the system and its requirements. Under this capability, derived requirements are identified, allocated, validated and base lined. Derived requirement conflicts are identified and resolved and the baseline specifications are developed.	Guide several systems engineers on a complex project during development phase.
12. PM/SE Procedures and Guidelines	Supervising / directing complex SE projects while following the PM/SE procedures and guidelines. This includes structuring technical activities to comply with relevant organizational PM and SE processes and guidelines.	Served on a large project as the lead project engineer or chief systems engineer directing a group of engineers and design groups.

13. Systems Engineering Management	Direct / supervise complex SE management projects / activities. This includes managing the implementation of technical plans such as the SE Management Plan, monitoring and reporting the status of SE related activities, evaluating and improving the SE process, prioritizing technical team activities, distributing information across the subsystems, managing the SE deliverables and monitoring system build-up.	Lead a small group of systems engineers on a systems design and or test and integration effort.
10.0 Technical Management		
1. Technical Planning	Supervising / directing complex projects involving technical planning. Planning the technical effort includes scheduling, organizing and costing the technical work; preparing the SE Management Plan, the validation plan, the verification plan, and other technical plans and obtaining stakeholder buy-in to these plans; issuing authorized technical work directives and documenting technical planning activities.	Project assignment on a new project or a project being re-planned.
2. Technical Risk Management	Supervising / directing complex projects involving technical risk management. This involves developing a set of strategies for technical risk management; identifying the technical risks, assessing the risks for severity of consequences and likelihood of occurrence, developing the risk mitigation and contingency action plan, monitoring the risks, and implementing the technical risk mitigation and contingency action plans as triggered; and documenting the technical risk management activities.	Manage risk identification. Mitigation task and process on a program.

3. Technical Assessment	Supervising / directing complex projects involving technical assessment. This includes developing a set of strategies for conducting technical assessments; identifying, collecting and analyzing process measures to assess work productivity and product quality; identifying, conducting, and performing follow-up actions for technical reviews; and documenting assessment activities.	Assignment as a systems/chief engineer on a complex program where sub system design and allocation efforts are required.
4. Software Challenges and Solutions	Supervising / directing the process of evaluation, selection and implementation of software required to operate a complex project. Implement processes for configuration management, documentation, and other good software engineering practices.	Contributing systems/chief engineer or software developer with responsibility for defining SW requirements and or delivery of code.
5. Configuration Management	Supervising / directing complex projects involving configuration management. This includes developing a set of strategies for configuration management; identifying and base lining the configuration control items; establishing and implementing a configuration change process; documenting configuration descriptions, and maintaining change records and differences between configuration baselines; auditing baselines and tracking actions to address identified anomalies; and documenting configuration management activities.	Systems design or test and integration assignment to a complex systems effort where data collection and management is critical.
6. Interface Management	Supervising / directing complex projects involving requirements management. This includes preparing the procedures for interface management, managing interfaces during system design and system integration, managing interface changes and documenting interface management activities.	Contributing systems/chief engineer on a complex program managing the requirement capture and definition phase on a program with many stakeholders

7. Process Assessment and Control	Manage process improvements at the macro level in ensure improved operational effectiveness. Based upon control feedback ensure that process improvements are implemented.	Assignment as a functional manager who is responsible for resource allocation across several programs.
8. Technical Data Management	Supervising / directing complex projects involving technical data management. This includes developing a set of strategies for managing technical data which include collecting and storing the data, performing integrity checks on the data, maintaining and protecting the data, making the data accessible at the right levels to the right users, and recording and distributing lessons learned.	Systems design or test and integration assignment to a complex systems effort where data collection and management is critical.
9. Technical Decision Analysis	Supervising / directing complex projects involving technical decision analysis. This includes establishing guidelines for when and how to use a formal decision making process; defining types of criteria, acceptable range and scale of criteria and importance or ranking of each criteria; selecting evaluation methods, tools and techniques, identifying and evaluation alternatives, and selecting and recommending a solution; and documenting the decision analysis process.	Assignment as a systems/chief engineer on a complex program where sub system design and allocation efforts are required.
10. Quantitative Techniques	Supervise and direct the use of quantitative tools and techniques like modeling and simulation, statistical analysis, etc. to assess the feasibility of a project and conduct trade space studies.	Supervised the use quantitative tools to test CONOPs, trade space, architectures, etc., to assess to technical and business viability of a program/project.
11.0 Production, Product Transition and Operations		
1. Operations	Supervising / directing complex projects that require developing the operations plan and participating in and managing the development or operations of the system.	Contributing systems/chief engineer on a complex program managing the requirement capture and definition phase on a program with many stakeholders.

2. Product Transition	Supervising / directing complex projects that require product transitions as a part of the process. This include planning how the product will be transitioned; identifying special transition procedures; overseeing packaging, storing and moving of the product and product documentation; preparing the receiving site for acceptance of the product; and documenting product transition activities.	Contributing systems/chief engineer on a complex program managing the requirement capture and definition phase on a program with many stakeholders.
3. Product Integration	Supervising / directing complex projects that requires product integration as a part of the product development process. Integrating the product includes preparing the product integration strategy and plan; obtaining and validating the lower level products; preparing the product integration environment; and finally, assembling and integrating the products and documenting the process and support required.	Test and integration assignment to a complex systems effort. Participate on a risk/opportunity IPT (or similar) as a key functional leader, identifying, analyzing, and managing risks and opportunities.
4. Product Verification	Supervising / directing complex projects that require product verification as a part of the process. This process begins with preparing the verification environment. This capability includes verifying the product against technical requirements, analyzing the system verification outcomes and documenting the system verification activities.	Test and integration assignment to a complex systems effort. Participate on a risk/opportunity IPT (or similar) as a key functional leader, identifying, analyzing, and managing risks and opportunities.
5. Product Validation	Supervising / directing complex projects that require product validation as a part of the process. Validating the right product was built requires base lining the final system against the stakeholder expectations. This capability includes preparing to conduct the product validation, validating the product, analyzing the product validation outcomes and documenting the product validation activities.	Test and integration assignment to a complex systems effort. Participate on a risk/opportunity IPT (or similar) as a key functional leader, identifying, analyzing, and managing risks and opportunities.

Competency Element and Topic – Working Composite	***Definition***	***Experience***
0.0 Technical Acumen		
1. Technical Discipline Expertise	Has a working knowledge of a specific engineering tools and project management concepts and performed tasks and activities to support and contribute to a project. Has a demonstrated an awareness and understanding of the organization's tools, techniques, and lexicon.	Demonstrated ability to work in a large technical enterprise.
2. Domain Application Areas	Has discipline specific technical knowledge and apply it to the domain of practice. Has a demonstrated an awareness and understanding of the organization's tools, techniques, and lexicon.	Demonstrated ability to work in a large technical enterprise.
3. Domain Methods, Processes, and Tools	Used and/or supervised the use of quantitative tools and techniques specific to the domain of practice. This includes traditional domain methods, processes and tools (MPTs).	Demonstrated ability to work in a large technical enterprise.

APPENDIX C. ALIGNMENT OF COMPETENCIES WITH DAU SPRDE OUTCOMES

The learning outcomes from the DAU SPRDE courses were examined to determine their alignment with the TLP competency model. The SPRDE course objectives were pulled from SYS 101, SYS 202, SYS 203, and SYS 302.

The following were identified as outcomes that provide a critical baseline for achieving the competencies outlined in the TLP (as seen in Appendix B). These materials were pulled from the DAU online course materials.

- SYS 101
  - Identify the eight Technical Processes.
  - Identify the eight Technical Management Processes.
  - Indentify current DoD SE initiatives and policies.
  - Awareness of Ethical issues.
  - Explain what 'trade space' is.
  - Given a systems engineering scenario, investigate an implementation strategy that yields an optimal solution.
- SYS 202
  - Recognize the relationship among Business Planning, Technical Planning, and other Technical Management Processes.
- SYS 203
  - Assess the impact of SEP [Systems Engineering Plan] shortfalls on a program's systems engineering effort.
  - Recognize the policies involved in SEP requirement.
  - Relate the requirements for a Technology Development Strategy to the systems engineering activities in the Technology Development phase.
  - Select the applicable Technical Review(s) for this phase and select the entrance and exit criteria that address the technical risk.
  - Given performance shortfalls in a program prior to a milestone review, use systems engineering processes to select best alternatives.
    - Select the applicable Technical Review(s) for this phase and select the entrance and exit criteria that address the technical risk.
  - Given competing priorities and constraints, defend recommended systems engineering actions.
    - Select the applicable Technical Review(s) for this phase and select the entrance and exit criteria that address the technical risk.
  - Relate the government SEP to the contractor SEMP (Systems Engineering Management Plan).
- SYS 302
  - Define Enterprise Architecture.

- Describe the DoD Enterprise Architecture.
- Demonstrate selection of the correct strategy for a given program.
- Demonstrate the selection of the correct method for a given program.
- Assess system concepts, including enabling/critical technologies.
- Develop requirements in an Integrated Framework.
- Describe how statutory/regulatory requirements constrain design solutions.
- Evaluate the treatment of the user's interoperability requirements for a system in an acquisition program.
- Develop proper control and reporting mechanisms for leadership of the overall technical effort, for systems engineering, for requirements, management, and for systems integration.
- Develop appropriate strategies and documentation associated with the management of technical baselines in a program.
- Critique the appropriate systems engineering efforts required to achieve acceptable levels of risk for entry into the next acquisition phase.
- Evaluate process and produce oversight mechanisms to ensure insight into technical risk at each technical phase effort
- Assess implementation of technical review chairmanship/leadership to include the application of technical review best practices.

These skills will provide a critical baseline for the TLP. The TLP development team will review these baseline abilities to determine how they will influence the content of the TLP.

APPENDIX D. COMPETENCY ALLOCATION TO THE LENSES

D. 1 SYSTEMS LENS COMPETENCIES

1.1. Leadership
1.2. Communications
1.3. Ethics
1.4. Mentoring and Coaching
1.5. Team Dynamics and Management
3.0 Resource Management
3.1. Technical Staffing and Performance
6.0 Program Assessment and Recovery
6.2. Problem Solving and Recovery Approach
6.3. Solution Definition and Lateral Thinking
7.0 Project Conception
7.3. Requirements Management
7.4. Acquisition Strategies, Procurements and Management
9.0 Systems Engineering, Thinking and Perspective
9.1. Stakeholder Expectations and Management
9.2. Technical Requirements Definition and Management
9.3. Interface Definition
9.4. Concept of Operations (CONOPS)
9.5. Systems of Systems (SoS) Architecture
9.6. Concepts and Architecture
9.7. Logistics Management
9.8. Trade Studies

9.9. Design Solution Definition
9.10. System Environments
9.11. Logical Decomposition
9.12. PM/SE Procedures and Guidelines
9.13. Systems Engineering Management
10.0 Technical Management
10.1. Technical Planning
10.2. Technical Risk Management
10.3. Technical Assessment
10.4. Software Challenges and Solutions
10.5. Configuration Management
10.6. Interface Management
10.7. Process Assessment and Control
10.8. Technical Data Management
10.9. Technical Decision Analysis
10.10. Quantitative Techniques
11.0 Production, Product Transition and Operations
11.1. Operations
11.2. Product Transition
11.3. Product Integration
11.4. Product Verification
11.5. Product Validation

D.2 Business and Team (B&T) Lens Competencies

1.0 Professional and Leadership Development
1.1. Leadership

1.2. Communications
1.3. Ethics
1.4. Mentoring and Coaching
3.0 Resource Management
3.2. Position Management
4.0 Business Acumen
4.1. Budget and Full Cost Management
4.2. Capital Management
4.3. Business Engineering
4.4. External Relationships
4.5. Integration of Technical Programs and Portfolios
4.6. Lifecycle Perspective
4.7. Management of Research and Development
6.0 Program Assessment and Recovery
6.1. Review and Assessment Process
7.0 Project Conception
7.1. Needs or Opportunity Management
7.2. Project Proposal and Bid Management
7.4. Acquisition Strategies, Procurements and Management
8.0 Project Planning, Management and Control
8.1. Project Review and Evaluation
8.2. Resource Management
8.3. Contract Management
8.4. Project Planning
8.5. Project Control

8.6. Lifecycle Cost Estimating
8.7. Tracking/Trending of Project Performance
8.9. Mission Assurance and Specialty Engineering
11.0 Production, Product Transition and Operations
11.2. Product Transition

D.3 Enterprise and Strategy (E&T) Competencies

1.0 Professional and Leadership Development
1.1. Leadership
1.2. Communications
1.3. Ethics
1.4. Mentoring and Coaching
1.6. Multinational and Multicultural Issues
2.0 Enterprise Leadership and Management
2.1. Leading the Technical Enterprise
2.2. Governance for the Technical Enterprise
2.3. Organizational Structure, Mission, Internal Goals
2.5. International Standards and Political Implications
2.4. Knowledge Capture, IP, Capture and Sharing
5.0 Risk and Security
5.1. Risk Management
5.2. Safety
5.3. Physical and Cyber Security

5.4. Environment and Ecology
8.0 Project Planning, Management and Control
8.8. Information Technology/Management Information Sys

APPENDIX E: REFERENCES

Farr, John, Stuart Walesh, George Forsythe, "Leadership Development for Engineering Managers," *Journal of Management in Engineering*, Vol. 13, No. 4, July/August 1997, pp. 38-41.

Kranz, Gordon, DUSD(A&T)/SSE Director, Technical Management Functional Leader, "Human Capital Strategy and Planning for SPRDE-SE & PSE, DT&E, and PQM," https://acc.dau.mil/GetAttachment.aspx?id=280166, August 28, 2009.

Rost, Joseph C., *Leadership for the Twenty-First Century*. New York, NY: Praeger, 220 pages.