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In Year 2 of SE TLP, the team developed the curriculum architecture which serves as the proposed architecture for a future DAU SYS 350 SE Technical Leadership course. The SYS 350 architecture is comprised of three loosely coupled lenses the systems (SYS 350A), business (SYS 350B), and enterprise (SYS 350C) lenses. Each of these lenses contains technical leadership focus areas, which reflect the key leadership learning areas believed critical in the context of defense systems acquisition. Additional Systems lens architectural detail was developed which included SYS 350A Syllabus storyboards, specific learning modules for each focus area, lecture topics, case studies, leadership threads focusing on personal and group effectiveness , and group-based in-class project work. The preceding artifacts were used to support the development of a baseline SYS 350A Instructor Pilot course which was conducted with OSD and DAU professionals at DAU Ft Belvoir, VA and subsequent to the SYS 350A Instructor pilot , a SYS 350A Student Pilot was conducted with US Army systems engineering professionals at the US Army Aberdeen Proving Grounds. Additional RT4 Y2 research work included the initial syllabus development for the SYS350B Business lens.

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ABSTRACT

In 2009, the Defense Acquisition University (DAU) contracted with the Systems Engineering Research Center (SERC) for Research Task (RT 4) to develop an extension of the DAU Systems, Programming, Research, Development, and Engineering (SPRDE) program that specifically focuses on Systems Engineering (SE) technical leadership. This Systems Engineeering Technical Leadership Program (TLP) specifically will provide leadership insights into SE activities and issues at the system, business, and enterprise levels. In the first year of the project (the Base Year), the team developed a competency model for systems engineering technical leadership, a high-level architecture for approaching technical leadership in the classroom, and an allocation of competencies within this architecture.

In Year 2 (Y2) of RT-4, the team developed the SE TLP curriculum architecture which serves as the proposed architecture for a future DAU SYS 350 SE Technical Leadership course. The SYS 350 architecture is comprised of three loosely coupled lenses the systems (SYS 350A), business (SYS 350B), and enterprise (SYS 350C) lenses. Each of these lenses contains technical leadership focus areas, which reflect the key leadership learning areas believed critical in the context of defense systems acquisition. Additional Systems lens architectural detail was developed which included SYS 350A Syllabus storyboards, specific learning modules for each focus area, lecture topics, case studies, leadership threads focusing on personal and group effectiveness , and group-based ino-class project work. Full summaries of each of these elements and a mapping between the “storyboards” and the systems engineering technical leadership competency model were developed. The preceding artifacts were used to support the development of a baseline SYS 350A Instructor Pilot course which was conducted with OSD and DAU professionals from 26-30 September 2011 at DAU Ft Belvoir, VA. Subsequent to the SYS 350A Instructor pilot , a SYS 350A Student Pilot was conducted with US Army systems engineering professionals at the US Army Aberdeen Proving Grounds (APG) from 14- 18 Nov 2011.

Additional RT4 Y2 research work included the initial syllabus development for the SYS 350B Business lens. Research artifacts included assessing a SY 350B Topical, Life Cycle, and Holistic content development approaches for assessment of the optimal paths to link SE Technical Leadership learning with the desired learning outcomes. This work will support future preparation SYS 350B Business Lens Storyboard Review in March 2012.

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1 EXECUTIVE SUMMARY

In 2009, the Defense Acquisition University (DAU) contracted with the Systems Engineering Research Center (SERC) for Research Task (RT 4) to develop an extension of the DAU Systems, Programming, Research, Development, and Engineering (SPRDE) program that specifically focuses on Systems Engineering (SE) technical leadership. The RT 4 Systems Engineering Technical Leadership Development research task is to conduct supporting research and development of a proposed SE Technical Leadership course to accelerate professional development of SPRDE Systems engineers by way of providing leadership insights into SE activities and issues at the system, business, and enterprise levels.

In Year 2 (Y2) of RT-4, the team developed the SE TL course curriculum architecture for a potential DAU SYS 350 SE TLP course comprised of a Systems, Business, and Enterprise 5-day modules, conducted two Systems Lens (SYS 350A) pilot courses, and initiated content development for the SYS 350B Business Lens pilot course.

The SYS 350A pilot course underwent two iterations and was conducted with two cohorts; Cohort 1 was comprised of senior OSD and DAU professionals and Cohort 2 was conducted with representative operational US Army Systems Engineers. The SYS 350A pilot courses focused on leadership at the system level, providing future SE technical leaders with insights into what to build and why; bringing solutions to life; ensuring systems work and are robust; and managing the evolution of a system. To address these areas, the course contained topics such as: technical uncertainty, applied systems thinking, leading others in creative problem solving, complexity, and why projects fail. These topics were additionally supported by case studies designed to give students real-world examples through which to explore these ideas. Each of these topics focused on the leadership aspects of a given topic. In addition, specific segments were devoted to students' exploration of their leadership skills, such as being a self-aware leader and creating a leadership development plan. Finally, the students participated in a project which was threaded throughout the four days and allowed students to focus on core values, exploring both the government and contractor perspectives.

SYS 350A research findings were sorted into the following categories; In-class project, Course topics, Course structure, and Recommended Course changes. The dominant feedback from these two pilots was highly favorable and included a recommendation for extending the length of the course and enhancements to government focus. Further, the US Army Redstone Arsenal, Huntsville has expressed interest in a SYS 350A Systems Course in 2012.

SYS 350A is the first of three technical leadership modules. Future pilots undergoing course development include the SYS 350B (business module) and SYS 350C (enterprise module) that expand the student's leadership experience into the broader technical and organizational domain demands of systems engineering leaders.

2 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[1]:

- 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[2] 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) 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[3] 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.

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[1] 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

[2] This report can be accessed at http://www.cpms.osd.mil/ASSETS/A48A22FD8C0347FCAF182758F283A450/DoDCivilianHumanCapitalStrategicPlan2006-2010.pdf.

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[4]. 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.

2.1 REVIEW OF BASE YEAR WORK

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.

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[3] Numerous definitions of SE exist. The DoD has adopted the following formal definition, derived from ANSI/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."

[4] 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.

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.

SE competency topics and elements were collected from a wide variety of sources, including NASA[6], 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[7].

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.

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[5] This report can be accessed at http://www.cpms.osd.mil/ASSETS/A48A22FD8C0347FCAF182758F283A450/DoDCivilianHumanCapitalStrategicPlan2006-2010.pdf.

[6] 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.

[7] The term "Level IV" is used throughout this report as defined in Table 1.8. SYS 302 should focus on 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. It should be noted, however, that the SYS350 series does not technically constitute "Level IV" at this time.

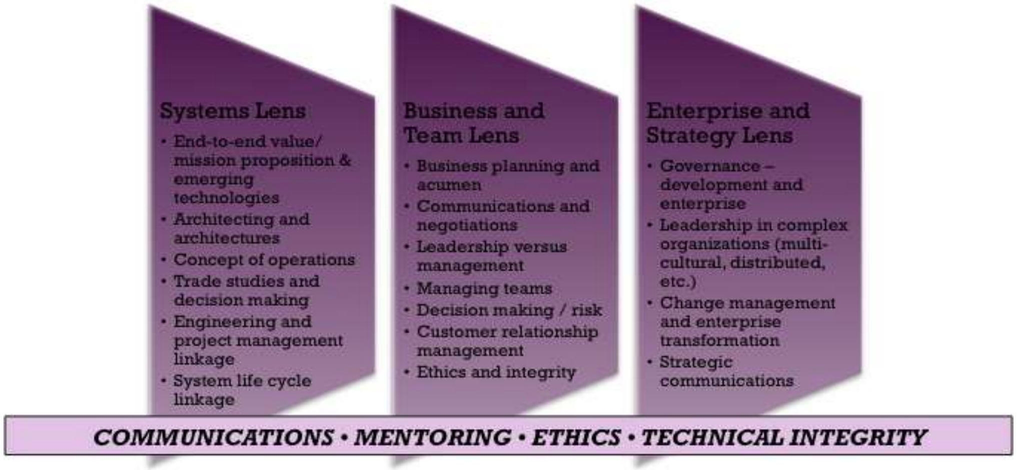

Systems Lens
• End-to-end value/ mission proposition & emerging technologies
• Architecting and architectures
• Concept of operations
• Trade studies and decision making
• Engineering and project management linkage
• System life cycle linkage
Business and Team Lens
• Business planning and acumen
• Communications and negotiations
• Leadership versus management
• Managing teams
• Decision making / risk
• Customer relationship management
• Ethics and integrity
Enterprise and Strategy Lens
• Governance – development and enterprise
• Leadership in complex organizations (multi-cultural, distributed, etc.)
• Change management and enterprise transformation
• Strategic communications
COMMUNICATIONS • MENTORING • ETHICS • TECHNICAL INTEGRITY

Figure 1. Baseline Architecture Developed during Base Year.

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.

2.2 PURPOSE OF REPORT

Based on the work from the Base Year, DAU chose to exercise it's option and continue the research for Year 2, the primary purposes of which were to develop a recommended curriculum for a SYS 350A Systems Lens module, deliver a pilot SYS 350A course to an instructor cohort and operational SPRDE student cohort, and conduct research to support development of a SYS 350B business lens module

This report details the RT4 research and findings over the period from 1 March 2011 to 17 Feb 2012 which supported two primary deliverables; an SYS 350A Systems Lens Instructor Pilot conducted at DAU, Ft Belvoir, VA from 26 – 30 Sep 12 and a SYS 350A Student Pilot conducted at the US Army Aberdeen Proving Grounds, MD from 14 – 18 Nov 12.

3 RT-4 YEAR 2 OVERVIEW

At the beginning of Year 2, the RT-4 team developed a roadmap for the development, delivery, and refinement of course materials for the SYS 350A systems lens of the DAU 350 Systems Engineering Technical Leadership. In addition, the team completed preparatory work to lay the foundation for the business and enterprise lenses (350B and 350C, respectively), which will be fully developed in Year 3. The major tasks for Year 2 are identified below along with a brief summary of the activities which are elaborated in later sections of this report.

1. **Define and document technical leadership.** The team developed a set of working definitions for technical leadership (TL) and a framework for discussing how leadership actions in a technical environment might differ from and also align with successful leadership found in other disciplines. These were presented to DAU, refined, and supported the foundation for the SYS350A courses. (Please see Section 4, below, for additional detail.)
2. **Reassess the architecture developed during the Year 1.** The team reviewed the draft architecture from Year 1; validated that the three-lens approach remained an appropriate framework for development and refined the architecture to include updated focus areas for each lens. (Please see Section 5, below, for additional detail.)
3. **Develop course descriptions for each of the lenses (SYS350A-C).** Using the architecture, the team developed a series of course descriptions to outline the goals, objectives, and key activities of each of the lenses. This was delivered to DAU in June 2011. (Please see Appendix D for the full course descriptions.)
4. **Develop SYS350A Pilot Approach and Materials**. The team utilized the architecture framework and 350A focus areas to identify key syllabus segment for SYS350A. These segments were a combination of foundational lectures (teaching key principles, methods, techniques, and tools), case studies (highlighting real world examples illustrating these principles), thread interventions (focusing on examination and development of critical non-technical leadership skills), and interactive/group sessions (including in-class exercises and an overarching project). The team then developed design review materials, termed SYS 350A Storyboards, to support a highly level design review of the planned SYS 350A segments. The SYS 350A Storyboards were then reviewed by a DAU-SERC red team in August, 2011 and set the design baseline for the SYS 350A Instructor pilot. The Instructor Pilot conducted with sponsors from DASD/SSE and faculty/researchers from DAU LCIC, CNE,DAU Mid-West Region, DAU South Region, DAU Mid-Atlantic Region, and DSMC was conducted 26-30 September 2011. Based on feedback from this instructor pilot, the course syllabus, teaching materials, and technical leadership learning emphasis were iterated resulting in a

student pilot version in preparation for the first student SYS 350A pilot. The SYS 350A student pilot, consisting of US Army engineering professionals from RDECOM, TARDEC, ECBC, Aviation MRDEC, Army Power, and the Chemical Material Agency, was conducted from 14-18 November 2011 at the US Army APG, MD. (Please see Section 6, below, for additional detail.)

5. **Begin initial development of SYS350B.** The team provided an initial approach, architecture, and materials for SYS350B to DAU on 12 December 2011. (Please see Section 7, below, for additional detail.)

The RT-4 team developed a schedule for completing these tasks, a staffing plan, and a budget for the Year 2 work. These were delivered to DAU at the In-Progress Review (IPR) on 5 April 2011, revised based on the IPR discussions, and reviewed with DAU at the 20 June 2011 IPR. Figure 1, below, represents the schedule along with key players for the associated actions. This schedule includes activities for Year 3 (assuming that this is funded).

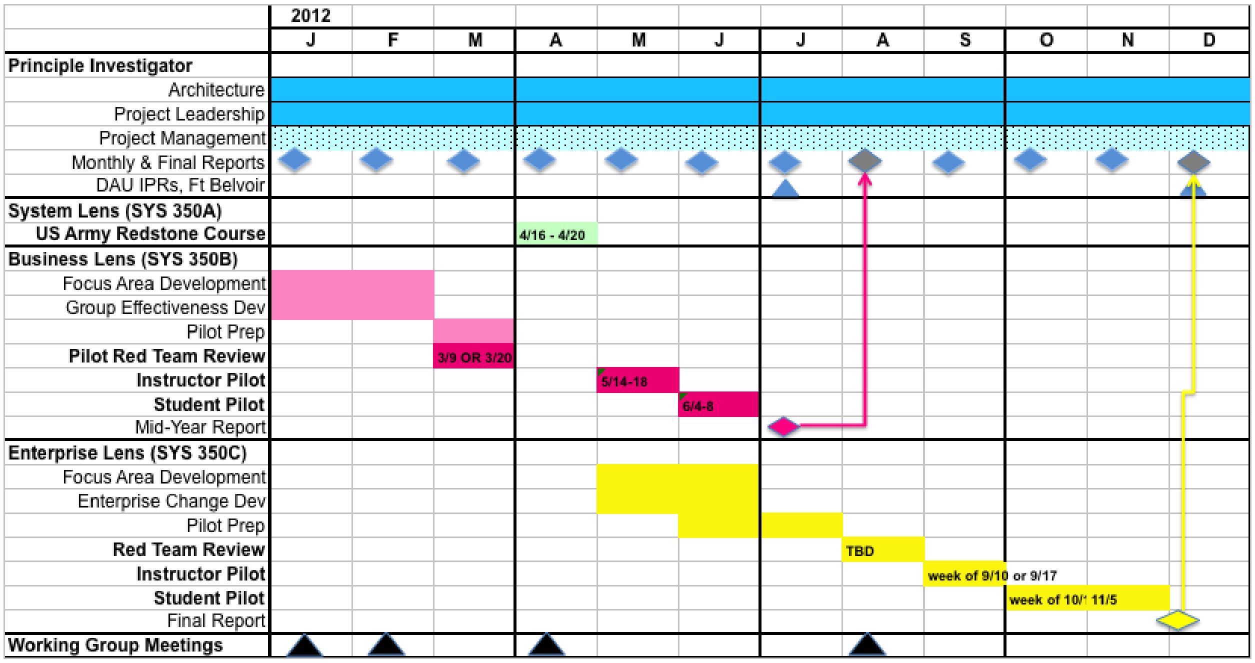


Figure 2. Overarching Schedule for RT4 Year 2 and Year 3.

Additional detail on the work plan and schedule can be found in Appendix B: Milestones. The following sections of this report detail the actions completed during Year 2.

4 DEFINING TECHNICAL LEADERSHIP

Early in Year 2, DAU requested that the RT-4 team spent some effort explicitly creating a clear and crisp definition of technical leadership, as well as some thoughts on how technical leadership may be measured. For the purposes of RT-4 and for delivery of the SYS350 pilots, technical leadership is defined as:

> *The ability to successfully motivate, influence, direct, & guide individuals, groups, organizations, and activities engaged in the practical or industrial arts of science, technology, product or systems strategic assessment, concept development, architectural design, prototype development, engineering, production, life cycle support, and change management of products, systems, or services.*

The systems engineering technical leadership competencies developed during the Base Year certainly support and provide detail for this concept of technical leadership. However, the RT-4 team determined that an additional, less complex rubric for technical leadership would be useful for fostering discussions. As a result, the RT-4 team developed Table 1. This table provides a list of high-order abilities that can be supported by the competencies developed in the systems engineering technical leadership competency model. In addition to the list of abilities, the systems-specific enablers for each are provided.

Table 1. Technical leadership abilities and enablers.

Technical Leaders have the ability to:	**Operative**	**Enabler**
Communicate complex technical issues at multiple levels	Communicate	Systems Thinking
Know when it is appropriate to focus on technical detail	Decide	Systems Thinking
Know when & how to use technical staff	Decide	Systems Integration
Identify, utilize, and shape top technical performers	Develop	Technical Acumen
Demonstrate superior technical competence	Demonstrate	Technical Acumen

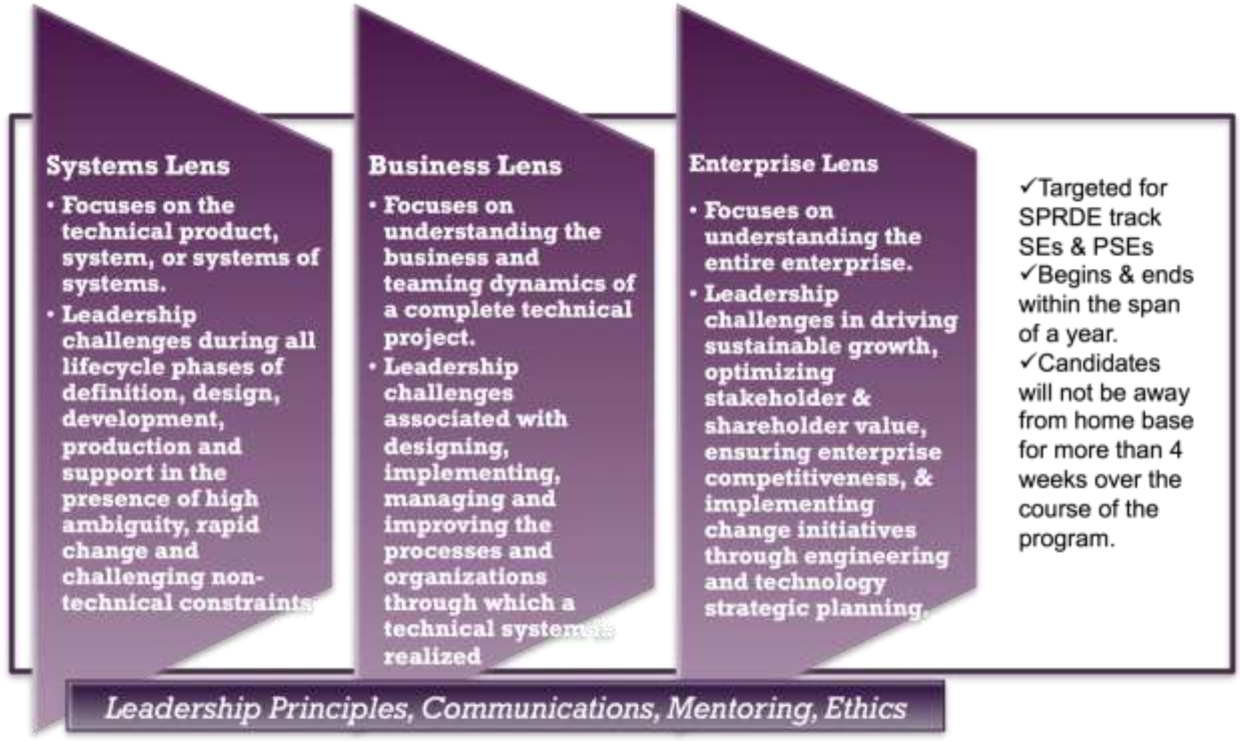
Technical Leaders have the ability to:	Operative	Enabler
Fully understand system scale and complexity and when it is improbable to know all aspects of a single system or product line	Understand	Systems Thinking
Rapidly identify & understand new technologies and when to insert those technologies into systems design & development	Understand	Technical Acumen
Oversee the requirements process & assure all requirements align with the user vision & purpose	Assure	Mission Thinking
Understand, develop, and promulgate a vision and the ability to get people to adhere to that vision	Vision	Communication
Inspire others by conveying mission and vision such that others get excited about the task(s) at hand.	Mission	Communications
Maintain control and authority under extreme uncertainty.	Accountability	Poise
Handle assignments in new domains, places, cultures, etc., and gain take lessons learned back to more traditional areas.	Robustness	Experience
Accept responsibility for failures and develop and implement strategies to recover from failures.	Accountability	Systems Thinking
Recognize and accept non-traditional ideas when appropriate.	Innovation	Experience

5 DETAILED SYS350 ARCHITECTURE

This section outlines the key attributes of the SYS350 course architecture.

5.1 BASELINE ARCHITECTURE

As stated in Section 2, during the Base Year, the RT-4 team developed a high-level architecture. This was the starting point for developing the detailed architecture for the SYS350 lenses. After the initial kick-off for Year 2, the Base Year architecture was updated slightly to reflect discussion with DAU. This can be found in Figure 3. The primary changes were to the descriptors of each lens, including a slight modification of the emphasis of strategy in the Business versus Enterprise lenses. The titles were also updated: business and team became "business" and enterprise and strategy became "enterprise". The RT-4 team also reviewed the competency alignment for the lenses, which was not altered.



Systems Lens

- Focuses on the technical product, system, or systems of systems.
- Leadership challenges during all lifecycle phases of definition, design, development, production and support in the presence of high ambiguity, rapid change and challenging non-technical constraints.

Business Lens

- Focuses on understanding the business and teaming dynamics of a complete technical project.
- Leadership challenges associated with designing, implementing, managing and improving the processes and organizations through which a technical system is realized

Enterprise Lens

- Focuses on understanding the entire enterprise.
- Leadership challenges in driving sustainable growth, optimizing stakeholder & shareholder value, ensuring enterprise competitiveness, & implementing change initiatives through engineering and technology strategic planning.

✓Targeted for SPRDE track SEs & PSEs
✓Begins & ends within the span of a year.
✓Candidates will not be away from home base for more than 4 weeks over the course of the program.

Figure 3. Year 2 High-Level Architecture.

5.2 DEVELOPMENT OF FOCUS AREAS

From the updated architecture, the team reviewed, refined, and revised the focus areas for each lens. A focus area is effectively a major subject area to be covered in the lens. For each focus area, a short descriptor was also developed, as shown in Table 2. These focus areas reflect feedback from the technical leadership forums held during the Base Year as well as DAU feedback provided in December 2010.

Table 2. Focus Areas for the SYS350 Lenses

Lens	Focus Area	Descriptor
Systems	Technical Innovation	Deciding What to Build and Why
	Technical Value Propositions	Bringing Solutions to Life
	Customer Expectation Management	Ensuring Systems Work and Are Robust
	Technical Resource Management	Managing Evolution – Deciding What's Next
Business	Business Acquisition Strategy	Deciding What Technology is Needed and How to Acquire It
	Technology Assessment	Analyzing Technology Maturity, Capabilities, and Futures
	Financial Acumen & Analysis	Ensuring System Decisions Fit within the Business Budget
	Enterprise Technical Leadership	Guiding Strategic Technology Decisions
Enterprise	Emerging Technology Strategies	Deciding When and How to Implement New and Emerging Technologies
	Technology Workforce Personal Development	Determining Needed Technical Capabilities and How to Improve Them
	Technology Development Strategies	Selecting Technology Families with the Best Operational Payoff

5.2 DEVELOPMENT OF COURSE DESCRIPTIONS

The RT-4 team began further refining the development of RT-4 curriculum by creating course descriptions for each lens (titled SYS350A-C). These course descriptions followed the outline provided by DAU and included an overarching description of the lens. In addition, learning objectives for each lens were developed. In the DAU context, learning objectives describe what students should be able to do at the end of the course. Table

Table 3. Objectives for Each of the SYS350 Pilots

Lens	Objectives
Systems (SYS350A)	After completing Technical Leadership Development: Systems, students will be able to: 1. Lead technical teams in analyzing complex problems, identifying technical and non-technical requirements and constraints, and deciding what solutions to pursue and why they should be built. 2. Help teams solve technical problems holistically, overcoming technical and non-technical challenges to bring solutions to life in spite of unforeseen obstacles and changing circumstances. 3. Ensure that the solutions developed by their teams work as intended, that they meet the needs of all stakeholders, and that they are robust across a wide range of planned and unplanned scenarios. 4. Establish and implement personal development plans for improving their technical leadership skills. 5. Lead the management and evolution of complex technical systems, deciding what and when enhancements and innovations are appropriate and how to secure the required resources to implement them.
Business (SYS350B)	After completing Technical Leadership Development: Business, students will be able to: 1. Perform a situation assessment of the business, through analysis of and interfacing with its complex external and internal constituents and environments. 2. Master analysis techniques such as cost volume profit analysis, financial forecasting and scenario planning. 3. Identify, analyze, and communicate the technology vision, mission, objectives, and strategy for their respective organizations. 4. Lead their organization to execute a specific technology strategy effectively. 5. Lead others in making ethically sound organization-wide technical decisions. 6. Apply basic principles of talent management in order to better align and leverage the technology workforce to fulfill the technology vision.

Enterprise (SYS350C)	After completing Technical Leadership Development: Enterprise, students will be able to: 1. Independently lead teams to develop enterprise technology acquisition strategies in support of organizational and business objectives. 2. Synthesize engineering and technology needs and investment strategies, objectives, and plans to support growth, adaptation, or change objectives. 3. Effectively communicate technology assessments and recommended responses to senior operational executives. 4. Effectively communicate enterprise engineering and technology strategies to the broad set of enterprise stakeholders, customers, and prospective enterprise partners. 5. Effectively act as the stakeholder and owner of strategically aligned enterprise engineering. 6. Apply principles of positive change management to help others recognize the need for change and pursue it constructively.

Development of the course descriptions allowed the team to come to consensus on the key learning points for each lens. The complete course descriptions can be found in Appendix D. As the RT-4 team continues to refine a recommended curriculum and develop course materials, the materials will be compared with the objectives to ensure appropriate alignment.

5.4 MAPPING OF CONTENT AND DELIVERY MODES TO FOCUS AREAS

Using the initial descriptions and the focus area alignment (**Error! Reference source not found.**), the teams began to map out high-level syllabus considerations. The first step of this was to determine the appropriate balance of delivery. The primary delivery modes include: lecture, case studies, threads, and project work.

The term "case study" here is used loosely to encompass many different types of case-based materials. During the Base Year, the RT-4 team developed a case-based framework to describe the different types of materials that could be incorporated. This framework is outlined in Figure 4.

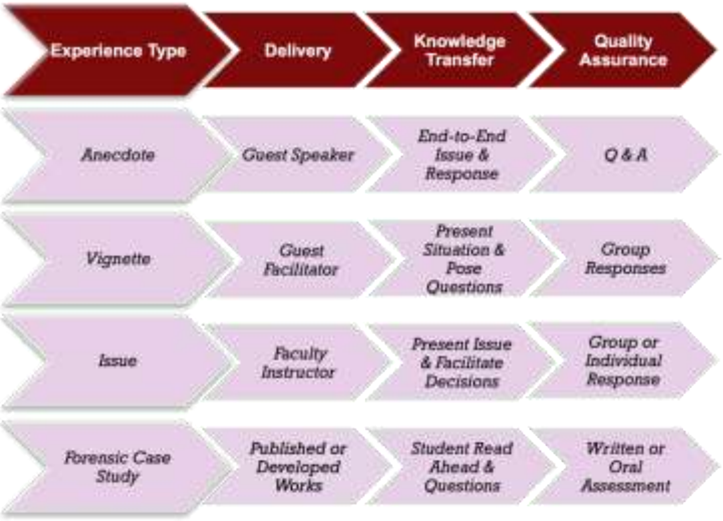

Experience Type
Delivery
Knowledge Transfer
Quality Assurance
Anecdote
Guest Speaker
End-to-End Issue & Response
Q & A
Vignette
Guest Facilitator
Present Situation & Pose Questions
Group Responses
Issue
Faculty Instructor
Present Issue & Facilitate Decisions
Group or Individual Response
Forensic Case Study
Published or Developed Works
Student Read Ahead & Questions
Written or Oral Assessment

Figure 4. Case-Based Learning Framework

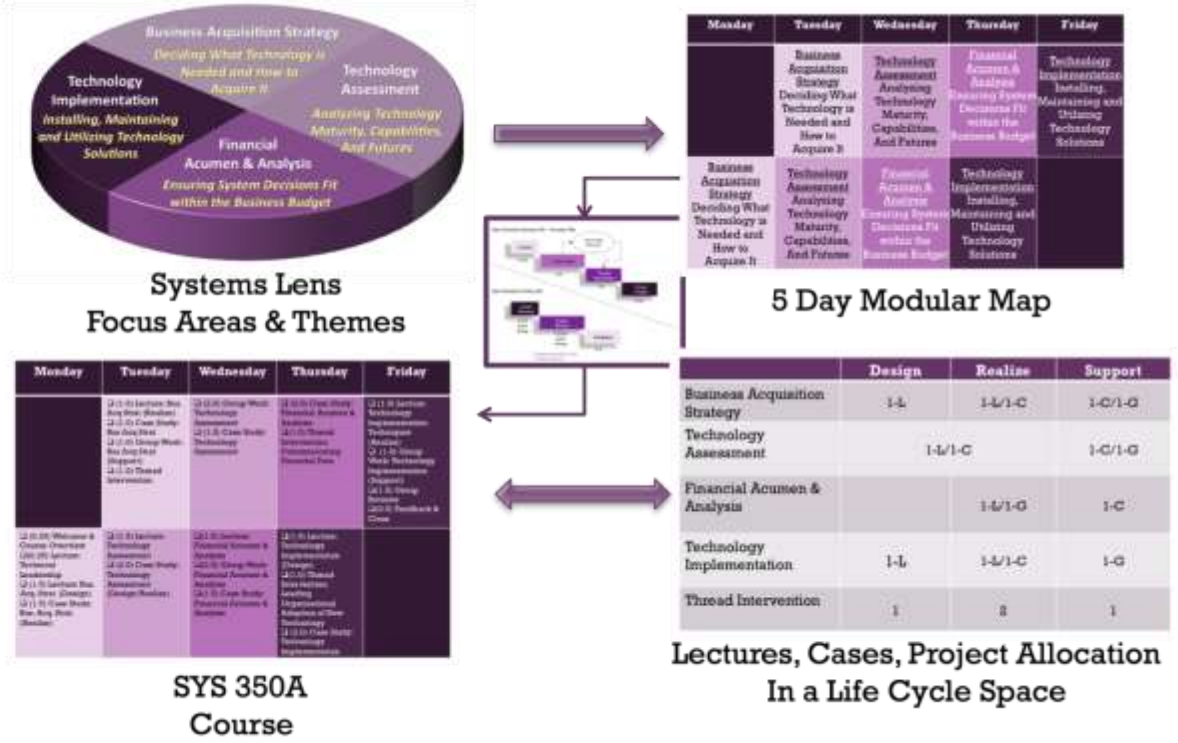
For the initial, high-level development of each lens, areas where case-based materials should be used were identified. Determination of the specific type of case-based material will be completed as the courses are further refined.

5.4.1. PROCESS FOR HIGH-LEVEL SYLLABUS DEVELOPMENT

For each lens, the RT-4 team went through a series of steps to develop a high-level syllabus. The first step was the development of focus areas and alignment of those focus areas over the allotted time for each lens, as shown in **Error! Reference source not found.** (above). These first steps are shown at the top of Figure 5 (below).

Once the 5-day "map" of the course was created, the RT-4 team developed an allocation of the types of delivery in the design space. As seen in Figure 5, below, for SYS350A this was also done across the life cycle space.

Finally, all of this information was used to create a high-level syllabus for each lens.

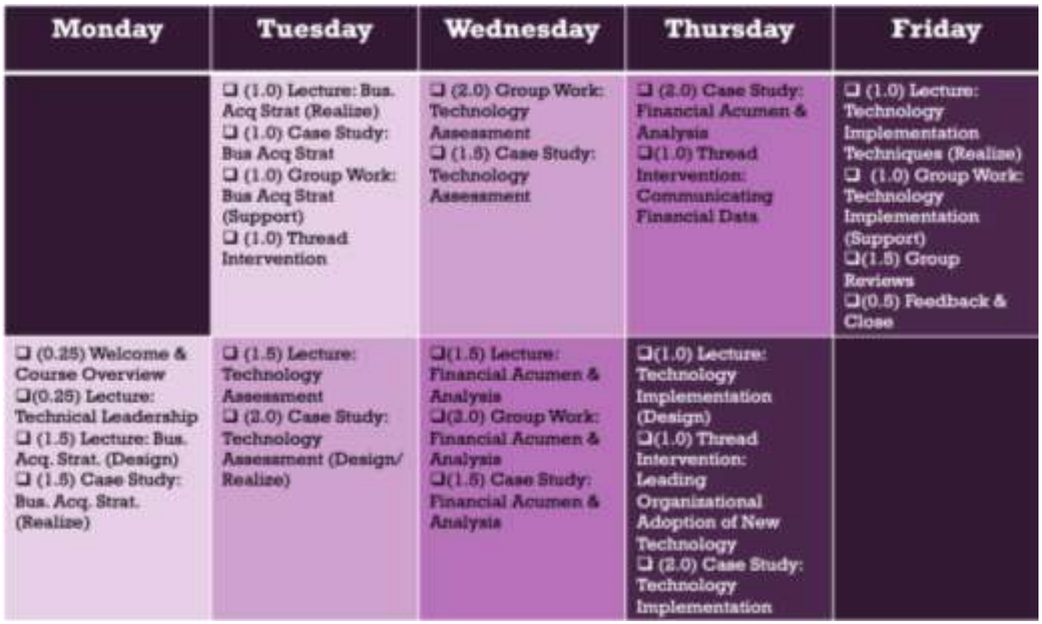

Business Acquisition Strategy
Deciding What Technology is Needed and How to Acquire It
Technology Assessment
Analyzing Technology Maturity, Capabilities And Futures
Financial Acumen & Analysis
Ensuring System Decisions Fit within the Business Budget
Technology Implementation
Installing, Maintaining and Utilizing Technology Solutions
Systems Lens
Focus Areas & Themes
Monday
Tuesday
Wednesday
Thursday
Friday
5 Day Modular Map
SYS 350A
Course
Lectures, Cases, Project Allocation
In a Life Cycle Space

	Design	Realize	Support
Business Acquisition Strategy	1-L	1-L/1-C	1-C/1-G
Technology Assessment	1-L/1-C		1-C/1-G
Financial Acumen & Analysis		1-L/1-G	1-C
Technology Implementation	1-L	1-L/1-C	1-G
Thread Intervention	1	2	1

Figure 5. Overarching Process for Developing Initial SYS350 Syllabus Allocations

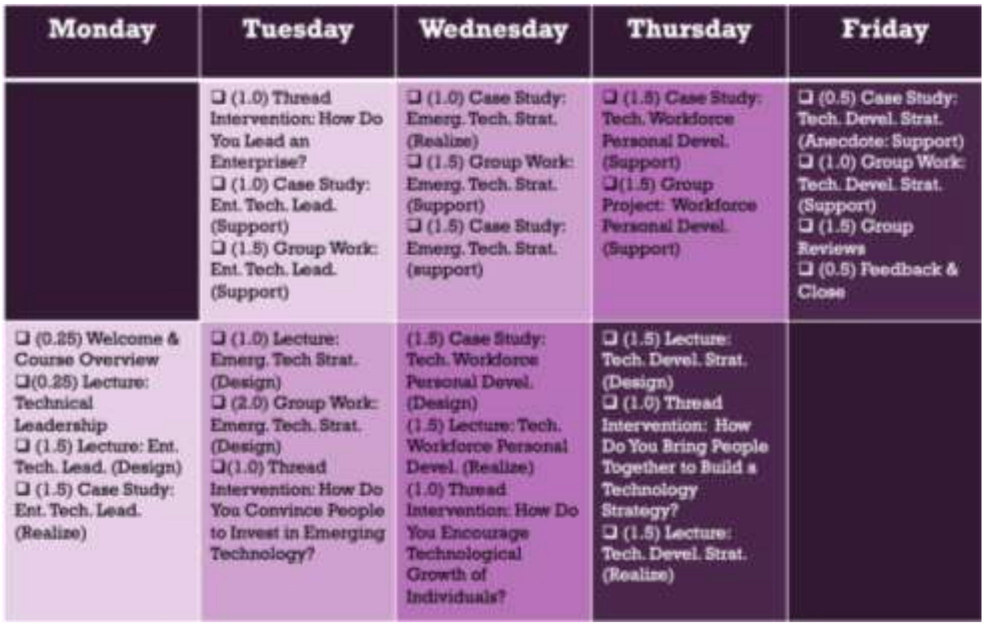
Each lens (SYS350A-C) has been developed to this level. The high-level draft syllabi for the SYS350B (Business) and SYS350C (Enterprise) pilots are shown in Figure 6 and Figure 7, respectively. This baseline structure will be used to develop a detailed syllabus for each of these lenses.

For SYS350A (systems), additional development has been done to prepare for the schedule initial Pilot in September 2011. Please see Section 6 SYS350A Development (below) for more detail.**Error! Reference source not found.**



Monday	Tuesday	Wednesday	Thursday	Friday
	☐ (1.0) Lecture: Bus. Acq Strat (Realize) ☐ (1.0) Case Study: Bus Acq Strat ☐ (1.0) Group Work: Bus Acq Strat (Support) ☐ (1.0) Thread Intervention	☐ (2.0) Group Work: Technology Assessment ☐ (1.5) Case Study: Technology Assessment	☐ (2.0) Case Study: Financial Acumen & Analysis ☐(1.0) Thread Intervention: Communicating Financial Data	☐ (1.0) Lecture: Technology Implementation Techniques (Realize) ☐ (1.0) Group Work: Technology Implementation (Support) ☐(1.5) Group Reviews ☐(0.5) Feedback & Close
☐ (0.25) Welcome & Course Overview ☐(0.25) Lecture: Technical Leadership ☐ (1.5) Lecture: Bus. Acq. Strat. (Design) ☐ (1.5) Case Study: Bus. Acq. Strat. (Realize)	☐ (1.5) Lecture: Technology Assessment ☐ (2.0) Case Study: Technology Assessment (Design/ Realize)	☐(1.5) Lecture: Financial Acumen & Analysis ☐(2.0) Group Work: Financial Acumen & Analysis ☐(1.5) Case Study: Financial Acumen & Analysis	☐(1.0) Lecture: Technology Implementation (Design) ☐(1.0) Thread Intervention: Leading Organizational Adoption of New Technology ☐ (2.0) Case Study: Technology Implementation	

Figure 6. Initial Allocation of Content over Delivery and Time for SYS350B.

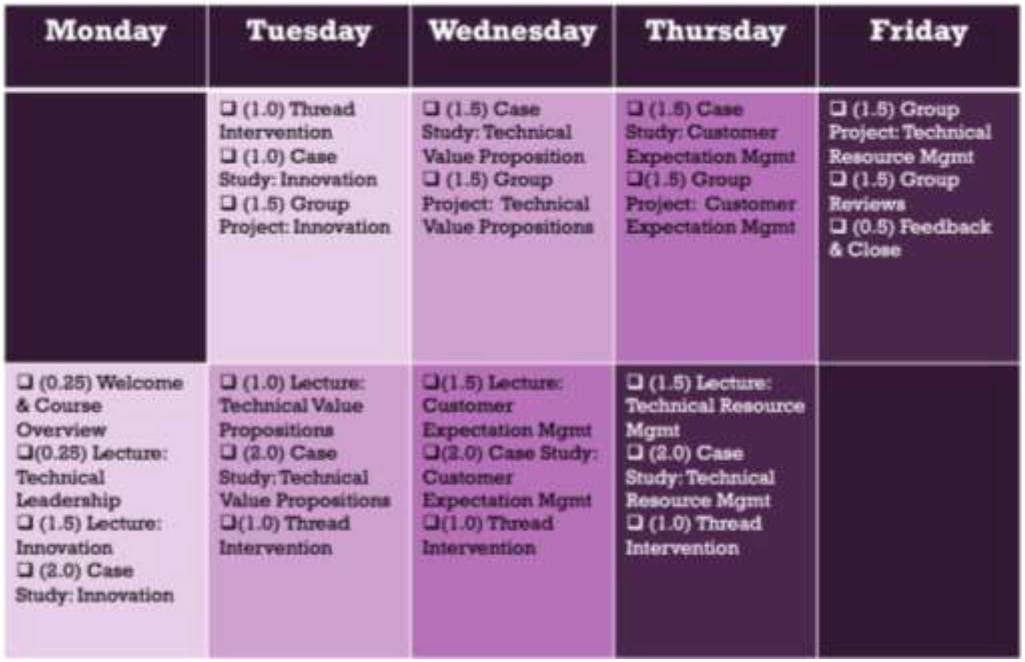


Monday	Tuesday	Wednesday	Thursday	Friday
	☐ (1.0) Thread Intervention: How Do You Lead an Enterprise? ☐ (1.0) Case Study: Ent. Tech. Lead. (Support) ☐ (1.5) Group Work: Ent. Tech. Lead. (Support)	☐ (1.0) Case Study: Emerg. Tech. Strat. (Realize) ☐ (1.5) Group Work: Emerg. Tech. Strat. (Support) ☐ (1.5) Case Study: Emerg. Tech. Strat. (support)	☐ (1.5) Case Study: Tech. Workforce Personal Devel. (Support) ☐(1.5) Group Project: Workforce Personal Devel. (Support)	☐ (0.5) Case Study: Tech. Devel. Strat. (Anecdote: Support) ☐ (1.0) Group Work: Tech. Devel. Strat. (Support) ☐ (1.5) Group Reviews ☐ (0.5) Feedback & Close
☐ (0.25) Welcome & Course Overview ☐(0.25) Lecture: Technical Leadership ☐ (1.5) Lecture: Ent. Tech. Lead. (Design) ☐ (1.5) Case Study: Ent. Tech. Lead. (Realize)	☐ (1.0) Lecture: Emerg. Tech Strat. (Design) ☐ (2.0) Group Work: Emerg. Tech. Strat. (Design) ☐(1.0) Thread Intervention: How Do You Convince People to Invest in Emerging Technology?	(1.5) Case Study: Tech. Workforce Personal Devel. (Design) (1.5) Lecture: Tech. Workforce Personal Devel. (Realize) (1.0) Thread Intervention: How Do You Encourage Technological Growth of Individuals?	☐ (1.5) Lecture: Tech. Devel. Strat. (Design) ☐ (1.0) Thread Intervention: How Do You Bring People Together to Build a Technology Strategy? ☐ (1.5) Lecture: Tech. Devel. Strat. (Realize)	

Figure 7. Initial Allocation of Content over Delivery and Time for SYS350C.

6 SYS350A DEVELOPMENT

Using the process shown in Figure 5 (above), the RT-4 team developed an initial SYS350A syllabus, as shown in Figure 8 (below).



Monday	Tuesday	Wednesday	Thursday	Friday
	☐ (1.0) Thread Intervention ☐ (1.0) Case Study: Innovation ☐ (1.5) Group Project: Innovation	☐ (1.5) Case Study: Technical Value Proposition ☐ (1.5) Group Project: Technical Value Propositions	☐ (1.5) Case Study: Customer Expectation Mgmt ☐(1.5) Group Project: Customer Expectation Mgmt	☐ (1.5) Group Project: Technical Resource Mgmt ☐ (1.5) Group Reviews ☐ (0.5) Feedback & Close
☐ (0.25) Welcome & Course Overview ☐(0.25) Lecture: Technical Leadership ☐ (1.5) Lecture: Innovation ☐ (2.0) Case Study: Innovation	☐ (1.0) Lecture: Technical Value Propositions ☐ (2.0) Case Study: Technical Value Propositions ☐(1.0) Thread Intervention	☐(1.5) Lecture: Customer Expectation Mgmt ☐(2.0) Case Study: Customer Expectation Mgmt ☐(1.0) Thread Intervention	☐ (1.5) Lecture: Technical Resource Mgmt ☐ (2.0) Case Study: Technical Resource Mgmt ☐ (1.0) Thread Intervention	

Figure 8. Initial Allocation of Content over Delivery and Time for SYS350A.

The RT-4 team then reviewed the materials available through development of the Stevens Institute of Technology Masters of Engineering in Technical Leadership (METL) program. Using this information the team determined what materials could be reused for RT-4 and what materials would need to be developed. Subsequently, the team developed a detailed syllabus for the SYS350A pilot with specific learning modules and allocated times. This was reviewed with DAU at the June 2011 IPR and updated based on discussion.

The team developed a complete set of storyboards – descriptions and learning objectives – for each segment of the syllabus. These storyboards were also reviewed with DAU and can be found in Appendix E. Each focus area is covered by one to two lecture segments, one thread intervention (specific focus on non-technical leadership skills), one to two case studies, and one project segment. The project was based on a real-world scenario, was conducted in teams, and each project segment built upon the previous segment. For full details, please see the storyboard descriptions in Appendix E.

Using the iterated version of the syllabus and the storyboards, the RT-4 team developed draft materials for each course module. These materials were used to deliver the instructor pilot (Pilot 1), which was conducted at the DAU campus on Ft. Belvoir, VA from 26 to 30 September 2011.

The initial syllabus was reviewed after completion of Pilot 1 and updated based on the feedback gathered at the workshop (please see Section 6.1, below, for additional detail). Table 4 shows the final SYS350A pilot syllabus, which outlines the modules delivered during the student pilot, which was conducted at the C4ISR Training Center, Aberdeen Proving Grounds, Aberdeen, MD.

Table 4. Systems Lens Pilot Syllabus

Day	Time	Title	Speaker
Mon	1:00-1:15	Welcome	Gelosh
Mon	1:15-2:00	Introductions, Leadership and Technical Leadership	Pennotti
Mon	2:00-2:15	Break	
Mon	2:15-2:45	SYS350 Overview	Gavito
Mon	2:45-3:00	Thread Concepts Overview	Dominick
Mon	3:00-3:15	Systems Lens Overview	Pennotti
Mon	3:15-3:30	Break	
Mon	3:30-4:45	Case Study: Technical Uncertainty	Gavito
Mon	4:45-5:00	Wrap-up	
Tu	8:00-8:15	Check-In	Pennotti
Tu	8:15-9:30	Thread: Being a Self-Aware Leader	Dominick
Tu	9:30-9:45	Break	
Tu	9:45-11:00	Lecture: Applied Systems Thinking	Pennotti
Tu	11:00-11:15	Break	
Tu	11:15-12:30	Case Study: DHS Container Security	Robinson
Tu	12:30-1:30	Lunch	
Tu	1:30-2:45	Thread: Leading Others in Creative Problem Solving	Dominick
Tu	2:45-3:00	Break	
Tu	3:00-4:30	Project: AR2D2: RFI	Robinson
Tu	4:30-5:00	Wrap-up	
Wed	8:00-8:15	Check-In	Pennotti
Wed	8:15-9:30	Lecture: Agile Development Methods	Pennotti
Wed	9:30-9:45	Break	
Wed	9:45-11:00	Lecture: When Good Wasn't Good Enough	Pennotti
Wed	11:00-11:15	Break	
Wed	11:15-12:30	Thread: Your Core Values	Dominick
Wed	12:30-1:30	Lunch	
Wed	1:30-2:45	Case Study: Why Projects Fail	Pennotti
Wed	2:45-3:00	Break	
Wed	3:00-4:30	Project: AR2D2: RFP	Robinson

Wed	4:30-5:00	Wrap-up	
Th	8:00-8:15	Check-In	Pennotti
Th	8:15-9:30	Case Study: Process Automation	Robinson
Th	9:30-9:45	Break	
Th	9:45-11:00	Lecture: Complexity	Pennotti
Th	11:00-11:15	Break	
Th	11:15-12:30	Thread: Your Plans for Developing as a Technical Leader	Dominick
Th	12:30-1:30	Lunch	
Th	1:30-2:45	Case Study: Project/Program Complexity	Pennotti
Th	2:45-3:00	Break	
Th	3:00-4:30	Project: AR2D2: IPT Competition	Robinson
Th	4:30-5:00	Wrap-up	
Fri	8:00-8:15	Check-In	Pennotti
Fri	8:15-9:30	Project: Leadership Recommendations	Robinson
Fri	9:30-9:45	Break	
Fri	9:45-11:15	Project: Final Presentations	Robinson
Fri	11:15-11:30	Break	
Fri	11:30-12:00	Feedback and Close	Pennotti

For each module, the RT-4 team developed specific materials:

- Lectures – Each lecture is supported by a slide deck, which includes lecture notes.
- Case Studies – Each case study is supported by a short (5-10 page) describing the case as well as a slide deck for presentation in the course.
- Thread Interventions – Each thread has supplemental materials, including student self-assessments, as well as a slide deck for presentation in the course.
- Project – The project is supported by many documents, including an RFP and RFI as well as competing responses to the RFP and RFI and CDR and IPR presentations from two competing "teams". In the project students role play as the government acquisition organization overseeing the project described in the RFP. Students were asked to identify lessons learned, areas for improvement, how these elements might apply to their current positions and, finally, recommend a way ahead if the project were currently being conducted.

All materials that were developed for RT-4 will be provided electronically to DAU in conjunction with this report. These materials have undergone a final update based on the 14-18 November 2011 Pilot 2 feedback.

6.1 350A FEEDBACK

Feedback from the students of both Pilot 1 and Pilot 2 was generally very positive and included constructive feedback, which was used to improve the course materials. Students provided verbal feedback with at both pilots. This included statements such as, "This was real world," and, "I have seen this before in my job." In addition, during

Pilot 2, the RT-4 team collected written evaluations from each student on their perceived learning. The feedback instrument can be found in Appendix F. Overall, the students rated the course, materials, and instructors highly. A small selection of the free text comments provided by the students is seen below.

In-class project:

- The project discussions [were] very insightful.
- Being exposed to the issues of technical leadership from the perspective of the contractor through the discussion of the AR2D2 project.

Diverse and relevant topics:

- [I appreciated] how it taught technical leadership form a variety of aspects (project examples, personal development, examples from history) . . . the focus on the "soft" personal skills and how they influence the outcome of a project. I would not have even considered these ideas without this course.
- Lots of thought-provoking subjects, interesting topics that are relevant to our work.

The structure:

- The structure was very well thought out. Courses are usually leadership oriented or SE oriented, but the combination was great for achieving the goals of this course.

If I could change one thing about this course, I would.

Make it longer:

- Make it longer.
- Probably make it two weeks to be able to cover all the info in more depth, though that might not be possible unless it was a local course on my post.
- More time for discussion within the class (i.e. teaming/discussion from "your plans for developing as a technical leader").
- Topics hot-wash could give way to more discussion by class to real world situations (the "now what" - how have people tackled the "complex" issues or "success stories" or "failure stories").
- Add more group "brief-outs."

More Government focus:

- Provide more of a government focus. Topics were geared toward industry and, while they provide great insight, it doesn't always apply to the government. I do understand that you are trying to shift the paradigm of government acquisition thinking, but that needs to start from the top as well.

Other:

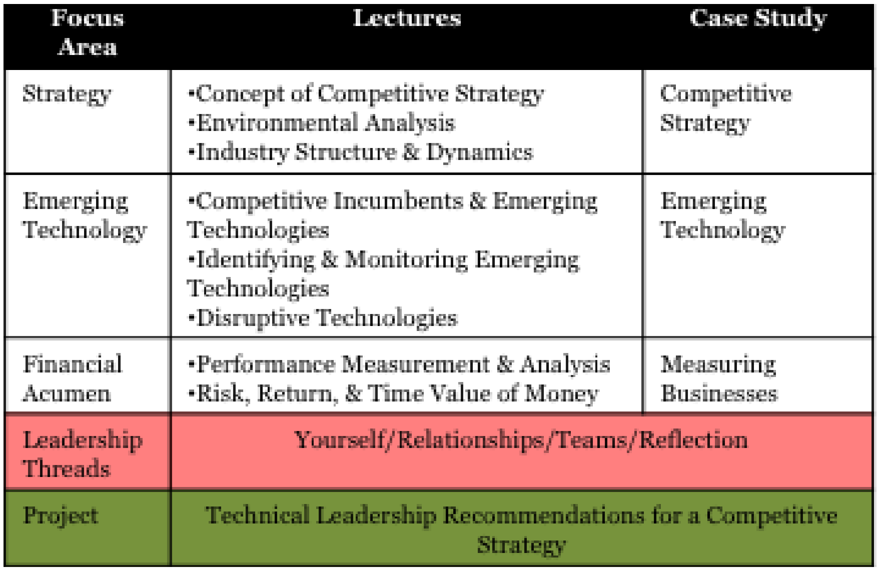
- Add a segment on generational differences and working with different generations. Given the varied demographics of the class, and the government in general, I think that could be useful.
- Use a similar situation like the project build or a hands-on approach that will allow us to experience everything (failure) at a personal level.
- Allow more time for reflection after each section (5-10 minutes) and for filling out the workbook (immediately after discussion while fresh) and to get the students to make notes to look back on when we get back to full speed at the office.
- Keep it the way it is. This was a great course.

Based on this feedback, the Army in Huntsville at Redstone Arsenal is now interested in putting on another pilot, based on the feedback from their students who attended the Aberdeen Pilot. This additional pilot is tentatively scheduled for April 2012.

7 INITIAL DEVELOPMENT ACTIVITIES FOR SYS350B AND SYS 350C

The RT-4 team has begun initial development for the technical leadership Business (SYS 350B) and Enterprise (SYS350C) lenses. Initial concepts for 350B and 350C were presented 12 December 2011 at DAU; based on the DAU feedback from this meeting, the team has developed an initial syllabus for the pilots. Using this, the team is currently developing storyboards for 350B, which will be delivered to DAU for review early in Year 3.

Figure 9 below is a 'blueprint' of the SYS 350B course outlining the approach for aligning lecture and case study with technical and non-technical foundational Business Lens elements and the concept of an underlying project.



Focus Area	Lectures	Case Study
Strategy	•Concept of Competitive Strategy •Environmental Analysis •Industry Structure & Dynamics	Competitive Strategy
Emerging Technology	•Competitive Incumbents & Emerging Technologies •Identifying & Monitoring Emerging Technologies •Disruptive Technologies	Emerging Technology
Financial Acumen	•Performance Measurement & Analysis •Risk, Return, & Time Value of Money	Measuring Businesses
Leadership Threads	Yourself/Relationships/Teams/Reflection	
Project	Technical Leadership Recommendations for a Competitive Strategy	

Figure 9. SYS 350B Course Blueprint

Using Figure 9 as a summary guide, the RT4 team then developed the following syllabus approach for 350B:

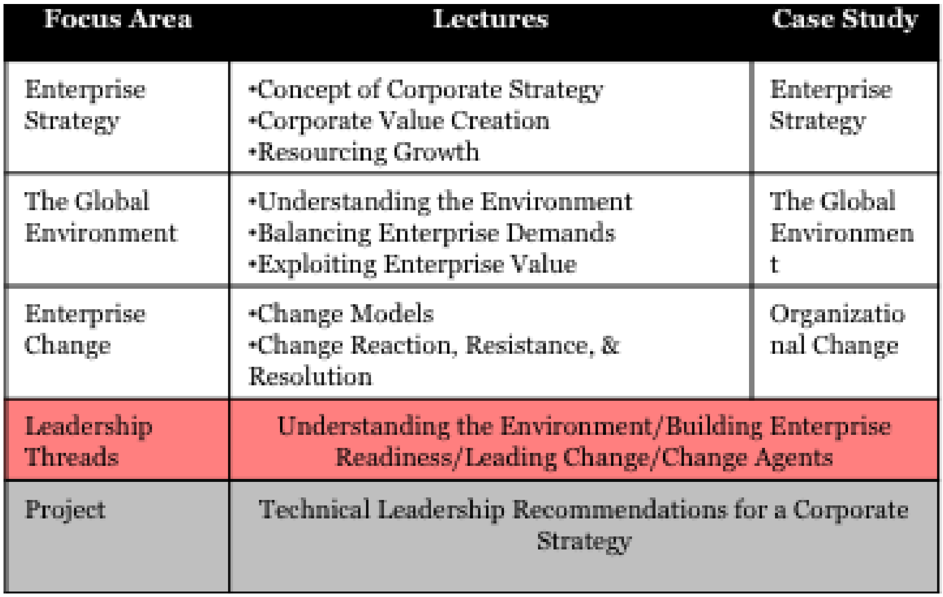
- **Pre-work.** Students will be provided materials 3-4 weeks prior to each pilot and will be required to submit brief assignments based on these materials:
    - *Pre-Readings* (4) – students will be asked to read and provide a one-page response to a question/prompt on each reading one week prior to the pilot. These readings will provide key reference points during the course.

  - *360 Feedback* – students will be provided access to tools that will allow them to collect feedback from colleagues at different levels of their parent organizations. Students should be prepared to examine this information the first day of the pilot.
  - *Student Biographies* – students will be asked to provide a short biography, which will inform both the instructors and the students about the cohort.
- **Pilot Structure.** The pilots are expected to begin on a Monday afternoon and end by noon on the following Friday. The general approach for each day is described below.
  - *Day 1.* The first day focuses on introducing students to the course, reviewing the tenets of technical leadership covered in 350A, and then moves into new materials. Non-technical leadership skills will be a major focus, including discussion of the 360 feedback students collected prior to the pilot as well as exploration of the balance and relationship between authority and influence. Students will also review a case study to begin understanding strategic decisions. Students will also be introduced to the course project.
  - *Day 2.* The second day focuses primarily on competitive business strategies, specifically how strategies may be conceptualized, communicated and implemented and how strategic decisions in industry may impact the seller/developer and buyer/acquirer spaces in DoD acquisition programs. Students will review a case study of a business which had to dramatically change its strategic approach due to external/market influences. The non-technical focus for Day 2 is on communication, and specifically on ways to effectively communicate strategic decisions.
  - *Day 3.* The third day focuses on emerging technology, specifically methods for predicting technology futures, understanding when a technology may be disruptive, and how emerging technologies may impact the defense industrial base. Students will examine a case study of a corporation that quickly captured a significant portion of an emerging telecommunications market. The non-technical focus for Day 3 is on coaching individuals as an element of professional development leadership.
  - *Day 4.* The fourth day of the course focuses on financial acumen. Specifically, students will explore how the financial health of companies may be measured and assessed, the relationship between risk and return, and how a company's risk posture may impact its long-term performance. Students will discuss how these principles may impact companies involved in DoD acquisition programs. The non-technical focus for Day 4 is on structuring teams, how to deal with complexity in a team environment, and how teams may effectively deal with emerging complexity in acquisition programs.

  - *Day 5*. The fifth day is primarily focused on providing students an opportunity to complete a technical leadership project focused on competitive strategy and present a final brief in the form of a technical leader's recommendation for a specific strategy element. In addition, students will be given an opportunity for personal reflection on what they have learned and their personal development plans for leadership growth. The course will close with assessment and feedback from the students.
- **Project.** Students will work on a group project over the course of the pilot. The details for the pilot have not yet been formalized, but the concept is to have students review a complex case, such as the Virginia Class Submarine Case Study[8] for example, as part of their pre-work and then build upon that case study throughout the course. Students may examine specific lessons learned from the case study and outline how those lessons learned may be applied to their current programs. Additional detail will be provided as the project is further developed.

Subsequent to the follow-on RT-4 contract award, the next major SYS350B development milestone will be a formal Red Team with DAU in March 2012.

Figure 10 below is a 'blueprint' of the SYS 350C course outlining the approach for aligning lecture and case study with technical and non-technical foundational Business Lens elements and the concept of an underlying project. It will be used as an overarching guideline for 350 content development in follow-on RT4 funded research.



Focus Area	Lectures	Case Study
Enterprise Strategy	•Concept of Corporate Strategy •Corporate Value Creation •Resourcing Growth	Enterprise Strategy
The Global Environment	•Understanding the Environment •Balancing Enterprise Demands •Exploiting Enterprise Value	The Global Environment
Enterprise Change	•Change Models •Change Reaction, Resistance, & Resolution	Organizational Change
Leadership Threads	Understanding the Environment/Building Enterprise Readiness/Leading Change/Change Agents	
Project	Technical Leadership Recommendations for a Corporate Strategy	

Figure 10. SYS 350C Course Blueprint

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[8] General Dynamics. 2002. *The VIRGINIA Class Submarine Program: A Case Study*. Groton, CT: General Dynamics Electronic Boat. February 2002.

8 RESULTS & RECOMMENDATIONS FOR FURTHER VALIDATION

RT4 research objectives include the development, synthesis, and validation of a Systems Engineering Leadership development curriculum content, course materials, and structure for a program to develop future DoD senior and executive SE and technical leaders. Based on the results from Year 2, the RT4 team has concluded that a variety of aspects of technical leadership can be adequately expressed and explored in an interactive classroom setting. SYS350A student pilot (Pilot 2) feedback validated that student's perspectives on what constitutes systems engineering technical leadership and on how a technical leader may be effective had been expanded as a result of the 5-day pilot.

Further validation of our initial conclusions that a variety of systems technical leadership aspects can be expanded in a classroom, it is recommended that individual student-supervisor or student-mentors develop agreed-to metrics[9] and make collaborative determinations on how the student's new perspectives and learned skills were manifested in their day to day roles and responsibilities. Possible collaborative processes include:

1. Establish systems engineering leadership developmental goals based upon SYS 350A content and conduct follow up with them on their progress.
2. Solicit senior leader and supervisory judgments of students' leadership strengths and potential development needs both pre-program and several months post program. To be most effective, this feedback would be structured around the definition of technical leadership presented during SYS350A.

By incorporating some of these techniques, the research will better be able to quantify the impacts of technical leadership development.

The structure of SYS350A incorporates many different methods of instruction, from traditional lectures to group exercises, projects, case studies, and self-evaluations. Materials delivered in these different ways are integrated to highlight common themes. In addition, the course incorporates time for students to reflect on and discuss how each lecture, exercise, case study, and exercise relates to other learning segments of SYS 350A. In this manner, student discovery of key technical leadership themes provide one element of personalized leadership development.

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[9] McGonagill, G. Pruyn, P.W. (2010). Leadership Development in the U.S.: Principles and Patterns of Best Practice, Bertelsmann Stiftung Leadership Series. www.bertelsmann-stiftung.de

Students are also provided time for self-assessment and self-reflection which support their individual leadership development plans. These plans identify areas where they can improve their technical leadership skills and possible methods for doing this.

9 CONCLUSIONS

RT-4 Year 2 successfully conducted two SYS 350A Systems Lens pilots receiving positive feedback from students and sponsors which resulted in a request for an additional SYS 350A course offering in 2012.. The SYS350B and SYS350C pilots, currently in development, will leverage the research findings to date and are being developed using similar methodologies to SYS 350A.

To enhance the RT4 research, findings, and recommendations, SYS 350A student follow-up would provide data on what specific pilot material was retained and how much was applied on the job. For those SYS 350A learning objectives that were not applied, it would be useful for future course enhancements to understand the causes. If future SYS 350B/C pilots are conducted with a consistent cohort of students, it may be most feasible to follow up on SYS350A in preparations for SYS350B and on SYS350B in preparations for SYS350C. Further, it would be highly beneficial to the RT4 research objectives, if an additional follow up is conducted after the student cohort has completed all three lenses..

APPENDICES

Appendix A. References

Appendix A. References

Appendix B. Year 2 Milestones
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Appendix C: Alignment of Focus Areas/Objectives
Appendix D. Course Descriptions
Appendix E: SYS350A – Storyboards
Error! Reference source not found.
Appendix F: Draft SYS350A Assessment Rubric

APPENDIX A. REFERENCES

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APPENDIX B. YEAR 2 MILESTONES

March 2011, Option Year 2 Kick-Off
- Development of Work Plan/Schedule for OY 1 and 2
- Development of Budget for Y2 and 2

April 2011
- Revision of budget and schedule
- Refinement of focus areas for SYS350A-C

5 April 2011, In-Progress Review (IPR) at DAU
- Review of proposed Budget and Schedule

May 2011
- Development of definition and possible metrics for technical leadership
- Development of presentation for DAU President McFarland

June 2011
- Development of assessment recommendations
- Development of Course Descriptions for SYS350A-C

20 June, 2011, IPR at DAU
- Review of additional architecture design
- Scheduling of SYS350A pilot 1

July 2011
- Development of storyboards for SYS350A

25 August 2011, Systems Lens Pilot I Red Team
- Joint review by RT-4 team and DAU faculty

August 31 2011, Status Report
- Interim report delivered to DAU

September 26-30, 2011, Systems Lens Pilot I

October 2011, Systems Lens Pilot II Red Team
- Joint review by RT-4 team and DAU faculty

7-11 November 2011, Systems Lens Pilot II

12 December 2011, 350A Review and 350B Kick-Off

February 14, 2012, End RT-4 Year 2

- Final Report

APPENDIX C: ALIGNMENT OF FOCUS AREAS/OBJECTIVES

The objectives for each of the lenses (SYS350A-C) are defined in the course descriptions. The focus areas are discussed in the architecture discussion. This appendix shows the rough alignment analysis conducted by the RT-4 team. The purpose of this exercise was to ensure that the objectives identified should appropriately support the focus areas identified in the architecture.

D.1 SYS350A: SYSTEMS LENS

	Systems Lens Focus Areas			
Systems Lens Desired Learning Objectives	Architectural Innovation	Technical Value Proposition	Customer Expectation Management	Technical Resource Planning
Lead technical teams in analyzing complex problems, identifying technical and non-technical requirements and constraints, and deciding what solutions to pursue and why they should be built.	X	X	X	X
Help teams solve technical problems holistically, overcoming technical and non-technical challenges to bring solutions to life in spite of unforeseen obstacles and changing circumstances.		X		X
Ensure that the solutions developed by their teams work as intended, that they meet the needs of all stakeholders, and that they are robust across a wide range of planned and unplanned scenarios.		X	X	
Establish and implement personal development plans for improving their technical leadership skills				X
Lead the management and evolution of complex technical systems, deciding what and	X			X

when enhancements and innovations are appropriate and how to secure the required resources to implement				

D.2 SYS350B: BUSINESS LENS

	Business Lens Focus Areas			
Business Lens Desired Learning Objectives	Business Acquisition Strategy	Technology Assessment	Financial Acumen & Analysis	Technology Implementation
Perform a situation assessment of the business, through analysis of and interfacing with its complex external and internal constituents and environments.	X	X		
Master analysis techniques such as cost volume profit analysis, financial forecasting and scenario planning.			X	
Identify, analyze, and communicate the technology vision, mission, objectives, and strategy for their respective organizations.	X			X
Lead their organization to execute a specific technology strategy effectively.		X		X
Lead others in making ethically sound organization-wide technical decisions.	X	X		
Apply basic principles of talent management in order to better align and leverage the technology workforce to fulfill the technology vision.				X

D.3 SYS350C: ENTERPRISE LENS

	Enterprise Lens Focus Areas			
Enterprise Lens Desired Learning Objectives	Enterprise Technical Leadership	Emerging Technology	Technology Workforce Personal Development	Technology Development Strategies
Independently lead teams to develop enterprise technology acquisition strategies in support of organizational and business objectives.	X		X	X
Synthesize engineering and technology needs and investment strategies, objectives, and plans to support growth, adaptation, or change objectives.		X	X	X
Effectively communicate technology assessments and recommended responses to senior operational executives.		X	X	X
Effectively communicate enterprise engineering and technology strategies to the broad set of enterprise stakeholders, customers, and prospective enterprise partners.	X		X	
Effectively act as the stakeholder and owner of strategically aligned enterprise engineering.	X		X	
Apply principles of positive change management to help others recognize the need for change and pursue it constructively			X	X

APPENDIX D. COURSE DESCRIPTIONS

The following course descriptions were developed for DAU SYS350 courses and were delivered to DAU in May 2011.

E.1 SYS350A: SYSTEMS LENS

Description

This course provides foundational and pragmatic processes and methods for SPRDE systems engineers and program systems engineers who aspire to expand their technical leadership roles and responsibilities in Key Leadership Positions (KLPs). The student will be afforded the opportunity to develop and refine their skills in analyzing complex technical problems, synthesizing holistic solutions, and making sound judgments in the presence of high ambiguity, rapid change and challenging non-technical constraints. It provides a leadership perspective for experienced systems engineers who have demonstrated superior domain engineering or technology expertise, and who are likely to assume technical leadership positions in the near future. The course also introduces basic principles of personal leadership development. Students will gain deeper insight to their own strengths and development needs when it comes to leading others in technology driven projects and programs. Courses are taught in a highly interactive manner, using real world case studies and projects.

Objectives

After completing Technical Leadership Development: Systems, students will be able to:

5. Lead technical teams in analyzing complex problems, identifying technical and non-technical requirements and constraints, and deciding what solutions to pursue and why they should be built.
6. Help teams solve technical problems holistically, overcoming technical and non-technical challenges to bring solutions to life in spite of unforeseen obstacles and changing circumstances.
7. Ensure that the solutions developed by their teams work as intended, that they meet the needs of all stakeholders, and that they are robust across a wide range of planned and unplanned scenarios.
8. Establish and implement personal development plans for improving their technical leadership skills.
9. Lead the management and evolution of complex technical systems, deciding what and when enhancements and innovations are appropriate and how to secure the required resources to implement them.

Target Attendees

This is course is for individuals serving in or targeted for Key Leadership Positions (KLPs) within the SPRDE-SE or SPRDE-PSE career track.

Prerequisite(s)

- SYS 101, Fundamentals of Systems Planning, Research, Development, and Engineering
- SYS 202, Intermediate Systems Planning, Research, Development, and Engineering, Part I
- SYS 203, Intermediate Systems Planning, Research, Development, and Engineering, Part II
- SYS 302, Technical Leadership in Systems Engineering

Course Length

4 days

Additional Course Information

Delivery Mode: Resident

Pilot POC

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E.2 SYS350B: BUSINESS LENS

Description

This is a case-based, highly interactive course that focuses on the strategic business dynamics and leadership responsibilities required for acquiring systems that meet strategic organizational needs of technically focused businesses. Participants will be guided in how to rigorously assess the current state of the organization through analyzing, interfacing with, and gathering information related to external factors (e.g., regulatory and governing bodies; potential suppliers) and internal factors (e.g., internal core technologies and competencies; human and financial resources; intellectual property). Informed by this analysis, participants will then be exposed to methods for formulating and implementing future competitive strategy. Related activities include vision and mission analysis, goal setting, developing technology roadmaps, budgeting, planning for, and developing engineering and technical human capital, analyzing technology make or buy decisions, performing technology supply chain assessments, financial forecasting, and implementing change management.

Special emphasis in the course will be placed on emerging technologies. Students will contrast and compare approaches to assessing the maturity and systems applicability of emerging technologies versus mature technologies. A broad overview of today's relevant emerging technologies will be conducted through an examination of emerging technologies that have the potential to transform defense-related industries. This course also helps individuals build their interpersonal skills and leadership techniques for developing others, and guiding them in complex system decision-making.

Objectives

After completing Technical Leadership Development: Business, students will be able to:

7. Perform a situation assessment of the business, through analysis of and interfacing with its complex external and internal constituents and environments.
8. Master analysis techniques such as cost volume profit analysis, financial forecasting and scenario planning.
9. Identify, analyze, and communicate the technology vision, mission, objectives, and strategy for their respective organizations.
10. Lead their organization to execute a specific technology strategy effectively.
11. Lead others in making ethically sound organization-wide technical decisions.
12. Apply basic principles of talent management in order to better align and leverage the technology workforce to fulfill the technology vision.

Target Attendees

This course is for individuals serving in or targeted for Key Leadership Positions (KLPs) within the SPRDE-SE or SPRDE-PSE career track.

Prerequisite(s)

- SYS 101, Fundamentals of Systems Planning, Research, Development, and Engineering
- SYS 202, Intermediate Systems Planning, Research, Development, and Engineering, Part I
- SYS 203, Intermediate Systems Planning, Research, Development, and Engineering, Part II
- SYS 302, Technical Leadership in Systems Engineering

Course Length

4 days

Additional Course Information

Delivery Mode: Resident

Pilot POC

Ann Mooney Murphy, PhD
Associate Dean and Director of Undergraduate Studies
Wesley J. Howe School of Technology Management
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E.3 SYS350C: ENTERPRISE LENS

Description

This course covers topics for enterprise leaders of groups of technically-focused businesses. It focuses on the role of the technology leader in formulating and executing corporate strategy, and in leading change within it.

It is organized into two parts. Part 1 develops students' ability to apply concepts and tools in order to support 1) valuing existing technological and related resources 2) creating value by leveraging existing technological and other resources and minimizing transaction costs, 3) creating value through geographical expansion, 4) creating value through product expansion, and 5) creating value by acquiring new technological and related resources.

Part 2 develops students' capacity to apply principles, tools and techniques for understanding and diagnosing organizations as dynamic social systems and methods for leading organization-wide change, be it for creating something new or for revitalizing dormant capabilities and potential.

The course stresses experiential learning and draws heavily interactive cases, group discussion and simulations.

Objectives

After completing Technical Leadership Development: Enterprise, students will be able to:

7. Independently lead teams to develop enterprise technology acquisition strategies in support of organizational and business objectives.
8. Synthesize engineering and technology needs and investment strategies, objectives, and plans to support growth, adaptation, or change objectives.
9. Effectively communicate technology assessments and recommended responses to senior operational executives.
10. Effectively communicate enterprise engineering and technology strategies to the broad set of enterprise stakeholders, customers, and prospective enterprise partners.
11. Effectively act as the stakeholder and owner of strategically aligned enterprise engineering.

12. Apply principles of positive change management to help others recognize the need for change and pursue it constructively

Target Attendees

This is course is for individuals serving in or targeted for Key Leadership Positions (KLPs) within the SPRDE-SE or SPRDE-PSE career track.

Prerequisite(s)

- SYS 101, Fundamentals of Systems Planning, Research, Development, and Engineering
- SYS 202, Intermediate Systems Planning, Research, Development, and Engineering, Part I
- SYS 203, Intermediate Systems Planning, Research, Development, and Engineering, Part II
- SYS 302, Technical Leadership in Systems Engineering

Course Length

4 days

Additional Course Information

Delivery Mode: Resident

Pilot POC

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APPENDIX E: SYS350A – STORYBOARDS

SYS350A Syllabus

Day 1

1. Administrative-1: Welcome & Course Overview
2. Innovation-1: Lecture: Systems Approaches for Problem Owners
3. Innovation-2: Case Study: Boundaries

Day 2

4. Innovation-3: Thread Intervention: Being a Self-Aware Leader
5. Innovation-4: Case Study: Container Security (DHS)
6. Innovation-5: Group Project: AR2D2 RFI
7. Technical Value-1: Lecture: Discipline and Agility
8. Technical Value-2: Case Study: Air Launch
9. Technical Value-3: Thread Intervention: Leading Others in Creative Problem Solving

Day 3

10. Technical Value-4: Case Study: When Good Wasn't Good Enough
11. Technical Value-5: Group Project: AR2D2 RFP
12. Customer Expectation-1: Lecture: Why Systems Fail
13. Customer Expectation-2: Case Study: Process Automation
14. Customer Expectation-3: Thread Intervention: Your Core Values

Day 4

15. Customer Expectation-4: Case Study: The Hubble Space Telescope
16. Customer Expectation-5: Group Project: AR2D2 IPT Competition
17. Technical Resource Management-1: Lecture: Managing Complexity
18. Technical Resource Management-2: Case Study: Complex Solutions Leadership
19. Technical Resource Management-3: Thread Intervention: Your Plans for Developing as a Technical Leader

Day 5

20. Technical Resource Management-4: Group Project: Source AR2D2 Final Proposals
21. Student Presentations: AR2D2 TLT Final Presentations
22. Administrative-2: Feedback and Close

Syllabus Segment 1: Welcome and Course Overview

Time: 0.5 hours
Responsible: Mike Pennotti
Support: Val Gavito
Speaker: Mike Pennotti

Summary

This segment will introduce the students to the goals and structure of the course, including learning outcomes, expectations related to the threads, and requirements for group work. The segment will also explain how 350A may be taken in context with 350B and 350C (wider technical leadership curriculum perspective).

Objective

- Provide participants with a clear understanding of the objectives of the course and set expectations for how it will be conducted.

Return to Syllabus

Syllabus Segment 2: Systems Approaches for Problem Owners (Lecture)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: John Boardman
Speaker: Mike Pennotti

Summary

The technical leader is often confronted by problems that are extremely important and for which existing solutions are clearly not working, yet the urgency to "do something" is inescapable. Such problems are often created by the convergence of valid individual perspectives and ironically by the attempts of these individuals to solve what they see as a problem. No one likes to think they are the problem or that what they see as a solution will cause problems. Yet problems are the emergent property of a community in action, and the enemy of this community is, paradoxically, its very constituents and the separate (problem-solving) actions these constituents take. The only valid response to this is for each to discover what it means to take a holistic approach, and to share this holism amongst the community. If individuals see themselves as constituents and share their individual views of that community, this at least elevates the debate to the 'system' level. It also gives access to each individual to see themselves as potential problem contributors and to see the problems that others have as a consequence of the existence of constituents per se. This lecture introduces three concepts for dealing with this kind of complexity: ownership, validity and simultaneity.

Objectives

- Allow participants to explore the broadest dimensions of complex problems
- Provide generalized approaches that leaders can use in helping their teams tackle such problems

Return to Syllabus

Syllabus Segment 3: Boundaries (Case Study)

Time: 2.0 hours
Responsible: Val Gavito
Support: Mike Pennotti
Speaker: Val Gavito

Summary

Within the context of engineering and technology, uncertainties and ambiguities describe the unknown and unpredictable states and interactions among people, processes, tools and realizations of products and systems. Systems development risks and issues can be viewed as the bounded domain of the known or likely. Uncertainty can be viewed as that space of events and interactions that inevitably lies beyond that bounded domain. This case study introduces the concept of 'Boundaries' to help leaders explore uncertainty and ambiguity from multiple viewpoints, with particular emphasis on system development for a specific application. Qualitative and quantitative perspectives of uncertainty are examined to help the technical leader develop innovative approaches for identifying and responding to uncertainty within their application, product or system domains. The case study concludes with a group exercise on characterizing and responding to uncertainties that might exist for a specific technology development or technology implementation.

Objectives

- Acquaint participants with multiple ways to identify, characterize, and respond to the uncertainty and ambiguities inherent in systems development.
- Enhance their ability to effectively communicate the complexities of uncertainty and ambiguity.
- Help them develop innovative approaches for influencing the way the technical team responds and mitigates risks or issues that result from uncertainty or ambiguity.

Return to Syllabus

Syllabus Segment 4: Being a Self-Aware Leader (Thread Intervention)

Time: 1.5 hours
Responsible: Pete Dominick
Support: Mike Pennotti
Speaker: Pete Dominick

Summary

At its core, leadership development is a personal change process rooted in self-awareness. In spite of its importance, however, self-awareness is not always a skill that comes naturally to people. This module introduces participants to this underlying skill, describes how it impacts technical leader effectiveness and explains how they will practice applying it throughout the rest of the course. Key facets of self-awareness including the roles of reflection, feedback and self-regulation will be introduced. Participants will be guided in understanding how to use these facets of self-awareness for self-development and to develop others. A particular emphasis will be placed upon helping participants understand their own attitudes toward change, learning and uncertainty. They will explore how these attitudes influence their approaches to leading and making decisions in complex system environments.

Throughout SYS 350A, each student will be asked to examine and understand leadership concepts, how these impact his or her performance, and how these principles may be applied to improve his or her leadership abilities.

Objectives

- Introduce participants to self-awareness as a requisite skill for ongoing self-directed leadership development.
- Help participants appreciate the connection between their own attitudes and beliefs, and their ability to lead others in complex system environments.
- Reinforce the Mentoring thread component of the overall program.

Return to Syllabus

Syllabus Segment 5: DHS Container Security (Case Study)

Time: 1.0 hour
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

After the events of 9/11/2001, Congress was concerned with the potential terrorist threat represented by 10 million uninspected shipping containers entering the United States each year. The concern was that weapons and/or terrorists might enter the United States concealed in shipping containers, thereby avoiding security measures implemented at airports, border checkpoints, and other conventional means of entry into the United States. Accordingly, Congress enacted legislation and initiated the Container Security Initiative (CSI) program. One of the key aspects of the CSI Program is the Container Intrusion Detection Project to develop and globally deploy "smart", tamper-evident containers. Some questions that will be discussed include:

- What is the mission need which is being addressed here?
  Is it really intrusion detection, as the program plan indicates?
- Who are the key stakeholders?
- How early in the system life cycle do you undertake an analysis of alternatives?
  How do you assess alternative CONOPS as well as alternative system concepts?
- What alternative approaches might have been overlooked by the team as they focused on detection of container intrusions?

Objective

- To engage participants in a practical, relevant case that reflects the complexity, ambiguity and uncertainty of contemporary development and technical leadership challenges.

Return to Syllabus

Syllabus Segment 6: AR2D2 RFI *(What do we submit?)* (Group Project)

Time: 2.0 hours
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

The "Autonomous Remote Routing for Defensive Driving System" (AR2D2) is a fictitious program that will be used to immerse the students in a realistic simulation of a complex system design and formal proposal development.

The AR2D2 system is defined as a suite of small Unmanned Vehicles (UMVs) that travel in conjunction with a High-Valued Asset (HVA), such as a Humvee, supply truck, or ambulance, and assist in identifying and locating hazardous obstacles. Sensors on the UMV platforms transmit data back to a portable central processor (PCP) carried on-board the HVA, which in-turn provides safe routing information via graphical display with map overlays to the user.

This Segment will be the *first* of 5 integrated sessions that will span the System Design and Proposal cycles.

The class will break into working teams, each of which will play the role of the Technical Leadership Team (TLT) of a Company. They will each run an internal "competition" between two internal Integrated Product Teams (IPTs) in order to choose the most powerful design for their proposal entry.

In this Segment, the TLTs will evaluate and provide feedback on the IPTs individual inputs (White Papers) to the DRAFT RFI.

(The DRAFT RFI, as well as the DRAFT RFP/SOW will be distributed to the students as pre-reading the evening prior to this Segment. The IPT White Papers will be distributed in class at the beginning of this Segment).

Objectives

- Students will be exposed to complexity, confusion, decision making and leadership of a very complex System Design and Proposal development project
- Throughout the 5 integrated sessions of this in-class project, students will be immersed in a competitive simulation environment where different design approaches will be assessed against the following key factors:
    - System Overview & Performance
    - System Architecture
    - Hardware Design
    - Software Design

  - Technical Analysis & System Tradeoffs
  - Requirements Traceability
  - Verification and Validation
  - Risks & Opportunities
  - RM&A
- Students will provide individual and collaborative leadership to a very complex and formal DoD Proposal development effort (including RFI, Draft RFP/SOW, Final FRP/SOW, Proposal submission)

Return to Syllabus

Syllabus Segment 7: Discipline and Agility (Lecture)

Time: 1.0 hour
Responsible: Mike Pennotti
Support: Dinesh Verma, Jon Wade, Rich Turner
Speaker: Mike Pennotti

Summary

Traditional Systems Engineering practices were developed in simpler times, when requirements could be defined in advance of development, acquisition cycles were reasonably stable, and technology evolved at a slow and predictable pace. Under these circumstances, planning was paramount, development tasks could be executed sequentially, and progress could be measured against a pre-determined schedule. While in practice, development was always an iterative process and multiple tasks frequently undertaken concurrently, such deviations from the initial plan could be viewed as minor perturbations rather than fundamental revisions.

Today's world is not nearly so well behaved. Requirements are difficult to discern and change frequently, technology evolves at a dizzying pace, and both competitors and adversaries quickly respond to innovations with advances of their own. Today's technical leader must reconcile the need for discipline in bringing solutions to life on time and within budget, with the agility required to adapt to ever changing circumstances. This lecture reviews the principles that underlie agile development and presents two specific approaches that have been of benefit in commercial practice: platform-based and model-based development.

Objectives

- Explain the principles underlying agile development and familiarize participants with various methods that have been used to implement them.
- Describe several case studies of platform- and model-based development approaches and share lessons learned in each.
- Explore the implications of agile development for technical leaders

Return to Syllabus

Syllabus Segment 8: Air Launch Case Study

Time: 2.0 hours
Responsible: Debra Facktor Lepore
Support: Mike Pennotti
Speaker: Mike Pennotti

Summary

How do solutions come to life? What happens after we decide what to build – how do we do it? Yes, there is process to implementing a design – including issues involving technical, contracting, legal, business, manufacturing, testing, etc. But there is also a magic to this it. This lecture takes the participant through the experience that creates the emotional involvement and passion for turning an idea into reality. It will draw upon examples from the entrepreneurial space launch industry. Participants will select an idea of their own and articulate how they would capture their own enthusiasm in creating a team and the plan to bring their solution to life.

Objectives

- Learn the role of the technical leader in creating and maintaining the environment for success
- Understand how the technical leader sets the tone for the emotional connection to meeting the project's goals and desired outcomes, handling anticipated and unanticipated challenges, fostering commitment of the team and other stakeholders, and keeping the team aimed toward ultimate success

Return to Syllabus

Syllabus Segment 9: Leading Others in Creative Problem-Solving (Thread Intervention)

Time: 1.0 hours
Responsible: Pete Dominick
Support: Mike Pennotti
Speaker: Pete Dominick

Summary

This segment focuses on how to understand creativity and innovation as a social processes. Participants will explore intrapersonal and interpersonal barriers to creativity and decision making. They will examine key components of creative performance and learn how to describe and recognize barriers to innovation in themselves and others. Next, they will be introduced to key facilitation techniques for fostering open and informed communication within the teams and groups they lead– such as balancing advocacy and inquiry and fostering creative abrasion.

Objectives

- Understand the role that communication and interpersonal dynamics play in enabling others to innovate and solve problems.
- Become familiar with tools and techniques for fostering open communication and collaborative problem solving.
- Reinforce the communications thread within the overall course.

Return to Syllabus

Syllabus Segment 10: When Good Wasn't Good Enough (Case Study)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: Pete McQuade
Speaker: Mike Pennotti

Summary

This segment addresses the counter-balancing argument to Voltaire's famous quote, "The better is the enemy of the good." We certainly don't diminish the need to eliminate wasteful "polishing" and striving for unnecessary perfection. However, the successful Systems Engineer must develop an accurate vision of what "good enough" really means—over the system's anticipated life cycle. We'll present five case studies from the Defense world, in which expensive, much-anticipated systems failed, for setting the bar too low for quality or functionality. In some cases, modest additional effort and cost might have been the difference between failure and success. The case studies are:

- The British R.E. 8 reconnaissance aircraft, World War I. (Slow and difficult to fly, it was easy prey for enemy fighters. Yet it was deployed in large numbers.)
- The US Army's Douglas B-18 Bolo bomber (Met all Government requirements, yet was obsolete before first delivery.)
- The Norden bombsight of World War II. (Touted to be capable of "hitting a pickle barrel from 30,000 ft," this gyro-stabilized, optical tracking marvel never lived up to the billing, largely due to unplanned-for realities of war. In 1944, the average miss-distance for US bombs dropped with the Norden in Europe was about two miles.)
- The Manned Orbiting Laboratory. (A two-person, Air Force space station, announced in 1963, for space-based reconnaissance. Cancelled in 1969, after 6 years of effort and $300 million dollars expended. Unmanned reconnaissance satellites were more capable—and cheaper.)
- Space Launch Complex 6. (The Air Force's planned launch facility for Space Shuttles, at Vandenberg AFB, CA. Re-constructing the abandoned launch facilities from the cancelled Manned Orbiting Laboratory, SLC-6 was doomed never to actually be used by the Shuttle, due to cost overruns and unforeseen errors in design and construction.

Objective

- Reinforce in the participants the need to establish what "good enough" really means for a given mission or system.
- Learn to distinguish which parts of a system need to be "beyond good"—and which don't.
- Explore the role of the requirements-development process in condemning a project to be "not good enough".

- Understand the lessons-learned from the five case studies, and how they apply in today's environment.

Return to Syllabus

Syllabus Segment 11: AR2D2 RFP (*What do we propose?*) (Group Project)

Time: 2.0 hours
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

This Segment will be the *second* of 5 integrated sessions that will span the System Design and Proposal cycles.

The class will, once again, break into working teams, each of which will play the role of the Technical Leadership Team (TLT) of a Company. They will each run an internal "competition" between two internal Integrated Product Teams (IPTs) in order to choose the most powerful design for their proposal entry.

In this Segment, the TLTs will evaluate and provide feedback on the IPTs individual design detailed proposals (Technical Volumes of the Proposal) to the Final RFP and SOW.

(The Final RFP and SOW will be distributed to the students as pre-reading the evening prior to this Segment. The IPT design proposals (detailed Technical Volumes, Design Presentations and Executive Summaries) will be distributed in class at the beginning of this Segment).

Objectives

- Students will be exposed to complexity, confusion, decision making and leadership of a very complex System Design and Proposal development project
- Throughout the 5 integrated sessions of this in-class project, students will be immersed in a competitive simulation environment where different design approaches will be assessed against the following key factors:
    - System Overview & Performance
    - System Architecture
    - Hardware Design
    - Software Design
    - Technical Analysis & System Tradeoffs
    - Requirements Traceability
    - Verification and Validation
    - Risks & Opportunities
    - RM&A
- Students will provide individual and collaborative leadership to a very complex and formal DoD Proposal development effort (including RFI, Draft RFP/SOW, Final FRP/SOW, Proposal submission).

Return to Syllabus

Syllabus Segment 12: Why Systems Fail (Lecture)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: Spiros Pallas, Pete McQuade
Speaker: Mike Pennotti

Summary

This segment explores the many reasons that systems fail. We'll look at failures that occur in each of the life-cycle stages: system definition, development, production, and operations. Reasons for failure include:

- Improper mission/need definition
- Incorrect or incomplete understanding of the development challenges
- Imposition of erroneous or ham-stringing requirements
- Mismanagement of cost/funding or schedule
- Poor quality of production
- Inappropriate operation of the system
- Early-than-planned obsolescence
- Political considerations

We present eight illustrative case studies:

- The Langley Aerodrome of 1903. (Built under contract to the US War Department as a potential reconnaissance aircraft, this competitor to the Wright Brothers failed to fly.)
- The Boulton-Paul Defiant. (This World War II British fighter used an innovative approach to armament—and proved beyond doubt that the conventional approach was the right one.)
- The Short Stirling of World War II. (Britain's first four-engined heavy bomber, the Stirling was hamstrung with requirements that the wing-span be no greater than the doors of existing RAF hangars, and the fuselage fit on standard railroad cars. The resulting performance shortfalls committed the Stirling to mediocrity.)
- The USS Thresher. (Nuclear-powered attack submarine of the early 1960s. The sinking of the Thresher revealed serious flaws in the operations of US submarines.)
- The AH-56 Cheyenne helicopter. (The Army's first dedicated attack helicopter, the Cheyenne embodied much new technology. Cost, schedule, and performance problems plagued the program, until a changing acquisition climate led to cancellation, in favor of the simpler, more survivable AH-64 Apache.)
- The US Division Air Defense (DIVAD) self-propelled air-defense gun. (This 1980s weapon system used much COTS hardware and software, to save cost and improve reliability. It was cancelled for cost overruns and failure to perform.)

- The US Navy’s A-12 Avenger II attack aircraft. (Excessive weight and other technical problems resulted in massive cost and schedule overruns. This program was cancelled by the Secretary of Defense in 1992.)
- The Army’s Future Combat System (This will cover one or more cancelled elements of FCS)

Objectives

- Highlight the importance of getting the mission-need right.
- Underscore the necessity for ensuring the requirements are right—and achievable.
- Demonstrate the effects of sloppy cost and schedule estimates.
- Show the ultimate impacts of unclear understanding of system operations.
- Demonstrate the importance of maintaining the necessary level of quality.
- Show how lessons can be un-learned from one generation of designers to the next.
- Illustrate the role of politics in system development.

Return to Syllabus

Syllabus Segment 13: Process Automation (Case Study)

Time: 1.0 hour
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

In response to a communications service crisis, two systems were launched:

1. A system that stored the communications record and recorded customer troubles called Mechanized Line Records (MLR) and
2. A very simple mechanized testing system called Line Status Verifier (LSV) that determined whether a communications line was working or not

Several activities lead to a system that automated the repair process:

- System engineers essentially lived in the Customer's repair service bureaus for weeks on end doing detailed work flows and understanding the various customer needs – the repair service attendant who took the trouble, the tester who isolated the failure, the dispatcher who controlled the repair work forces, the manager who had to prepare regulator-required reports, etc.
- System scope was carefully controlled to include just enough to solve the customer problem of out-of-control repair processes, but not include so much as to explode development time and cost. For example, very complex communications services like those that cross state lines for business data communications were excluded.
- The Customer loaned the R&D organization several people who moved to North Carolina for two years. They were expert in repair service bureau and computer center operations. This, perhaps, was the key to project success.
- Performance models and test systems, both regression and load, were developed based on the workflows. As is often the case, a separate back-of-the-envelope model estimated peak load within a few percent.
- A culture of small teams staffed with a few excellent people was established.

The system was completely deployed and reduced operating costs by several 100 million dollars/year and made company several billion dollars.

Objectives

- To engage participants in a practical, relevant case that reflects the complexity, ambiguity and uncertainty of contemporary development and technical leadership challenges.
- Students will examine:
    - How to build a system that can be used effectively

  - Imbed the customer in the organization and
  - Carefully model the work flow – before and after system – and insure all scenarios can be supported; even if manual intervention is needed
  - How to build a system that would work for the customer, and then insure that it did
  - Based on work flows and scenarios, develop cost benefit economics for *all* system capabilities
  - How to evolve the system to correct major deficiencies
  - How to insure the System architecture stayed resilient

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Syllabus Segment 14: Your Core Values (Thread Intervention)

Time: 1.0 hour
Responsible: Pete Dominick
Support: Mike Pennotti
Speaker: Pete Dominick

Summary

This module offers participants a framework for understanding how their core values impact their effectiveness as technical leaders. Distinctions between terminal values – those which refer to end states and outcomes - and instrumental values – those which refer to processes and approaches - will be explored and participants will be guided through a process for helping them to recognize which values matter most for them.

The module will also examine key interpersonal and intrapersonal factors that help to explain why and when leaders derail/fail. They will then be introduced to some key ways in which value-based leadership can help to keep them on the right track as technical leaders. This segment will help students to understand how their own values are or are not aligned with the values of their organizations, to aid students in better identifying what they value, and in helping students understand how to use that awareness to become more committed and influential.

Objectives

- Increase participants' personal awareness of how their values impact their approach to leading and influencing.
- Learn why aspiring leaders can derail and deepen participants' understanding of how self-awareness can help prevent personal and team failures.
- Reinforce the Ethics and Mentoring thread within the overall course.

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Syllabus Segment 15: The Hubble Space Telescope (Case Study)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: Pete McQuade
Speaker: Mike Pennotti

Summary

The story of the Hubble Space Telescope is well known. Initially launched in 1990, it was designed to provide astronomers with unprecedented images of the universe. During in-orbit checkout, however, it became obvious that the anticipated resolution could not be achieved due to a flaw in the optical system, which prevented proper focusing. Three years later, NASA launched a successful repair mission to correct the problem, and since then, Hubble has more than lived up to expectations.

The problem with Hubble's optical system and how it came about is thoroughly explained in a 1990 NASA report and the entire Hubble story is well documented in a 2005 case study prepared by the Center for Systems Engineering at the Air Force Institute of Technology. The latter includes five "Learning Principles" derived from the experience, one of which relates to integration and states, "Provision for a high degree of systems integration to assemble, test, deploy and operate the system is essential to success and must be identified as a fundamental program resource need as part of the program baseline."

This case study picks up where the previous reports leave off, requiring that participants explore why the integration learning principle was not followed in the case of Hubble, and develop approaches to ensure that it is incorporated into programs that they lead in the future.

Objectives

- Expose participants to the backstory that led to the problems with the well known case of the Hubble Space Telescope
- Force them to think beyond ready platitudes and simple answers to struggle with the "how" of leadership in complex technical problems.

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Syllabus Segment 16: AR2D2 IPT Competition (*Now what do we do?*) (Group Project)

Time: 2.0 hours
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

This Segment will be the *third* of 5 integrated sessions that will span the System Design and Proposal cycles.

The class will, once again, break into working teams, each of which will play the role of the Technical Leadership Team (TLT) of a Company. They will each run an internal "competition" between two internal Integrated Product Teams (IPTs) in order to choose the most powerful design for their proposal entry.

In this Segment, the TLTs will discuss and evaluate the Final IPT Design Presentations and witness the actual Competition video. They will discuss and decide on a strategy for *'what to do now?"*

(The Final IPT Design Presentations will be distributed to the students as pre-reading the evening prior to this Segment. The Competition video will be presented in class at the beginning of this Segment).

Objectives

- Students will be exposed to complexity, confusion, decision making and leadership of a very complex System Design and Proposal development project
- Throughout the 5 integrated sessions of this in-class project, students will be immersed in a competitive simulation environment where different design approaches will be assessed against the following key factors:
    - System Overview & Performance
    - System Architecture
    - Hardware Design
    - Software Design
    - Technical Analysis & System Tradeoffs
    - Requirements Traceability
    - Verification and Validation
    - Risks & Opportunities
    - RM&A
- Students will provide individual and collaborative leadership to a very complex and formal DoD Proposal development effort (including RFI, Draft RFP/SOW, Final FRP/SOW, Proposal submission).

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Syllabus Segment 17: Managing Complexity (Lecture)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: Jon Wade
Speaker: Mike Pennotti

Summary

> *"I think that the next century (21^{st}) will be the century of complexity"*
> *– Stephen Hawking*

The 20th century was a time when we mastered technological advances in a number of fronts including agriculture, transportation, communication, computation, energy, medicine and the like. However, the 21st century is one of complexity in which these technologies, humans and nature form new and evolving systems. To be successful in the design, analysis and leadership of these systems, one will need to embrace complexity and address it on its own terms. But what is complexity? What are its characteristics? And, how can these be addressed? This session will describe the root causes of the recent exponential growth of complexity. Definitions of complexity and complication will be provided along with some examples of how they may be used. Some complexity management techniques will then be described along with some examples of how they have been applied to complex systems. Next, the concept of evolving complexity will be introduced along with some of its implications. Finally, the implications of these concepts to technical leadership will be described. This will conclude with an assignment given to the class to analyze a complex system challenge and determine appropriate actions that can be taken to address a specific set of issues.

Objectives

- Acquaint participants with the concepts of complication and complexity, and evolving complexity, particularly in the context of technical organization and strategy
- Provide some techniques for complexity management
- Provide examples of the evolving complexity of organizations with implications on how they might be led

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Syllabus Segment 18: Complex Solutions Leadership (Case Study)

Time: 1.5 hours
Responsible: Mike Pennotti
Support: Tony Barrese
Speaker: Mike Pennotti

Summary

As Technical Leaders advance in their careers, they need to develop skills appropriate for the increasing scale and complexity of the programs they will lead. This case study based module begins with a group exercise on, and discussion of, the dimensions of solution program complexity. The role of successful Technical Leaders in key complex solution program activities is profiled: their role in framing the problem and solution, their role in setting the delivery strategy and plan, and their role in assessing the solution thru the development process.

Characteristics of successful complex solution program Technical Leaders are introduced and discussed in the concluding segment of this module.

Objectives

- Acquaint participants with the breadth of a technical leaders role in Complex Solution programs, and with techniques to efficiently use their personal time.
- Enhance participant's ability to effectively lead Complex Solution programs by identifying attributes of successful technical leaders.
- Help participants develop personal plans for key areas of focus in Complex Solution Programs.

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Syllabus Segment 19: Your Plans for Developing as a Technical Leader (Thread Intervention)

Time: 1.0 hour
Responsible: Pete Dominick
Support: Mike Pennotti
Speaker: Pete Dominick

Summary

This segment will provide participants with time to synthesize and summarize key learning points from the course. It is designed to ensure that participants leave the program having established personal development goals pertaining to self-awareness and systems lens issues and challenges. During this segment participants will also be introduced to additional tools and resources they can use for obtaining multisource feedback, and establishing developmental objectives. This part of the course will also include skill practice on how to engage in meaningful conversations with mentors and coaches.

Objectives

- Practice applying principles of self-awareness and reflection.
- Be able to use self-management principles to establish leadership developmental goals and objectives.
- Reinforce the Mentoring thread component of the overall course.

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Syllabus Segment 20: AR2D2 Final Proposals (*What do we propose?*) (Group Project)

Time: 1.5 hours
Responsible: Bill Robinson
Support: Mike Pennotti
Speaker: Bill Robinson

Summary

This Segment will be the *fourth* of 5 integrated sessions that will span the System Design and Proposal cycles.

The class will, once again, break into working teams, each of which will play the role of the Technical Leadership Team (TLT) of a Company. They will each run an internal "competition" between two internal Integrated Product Teams (IPTs) in order to choose the most powerful design for their proposal entry.

In this Segment, the TLTs will develop their Final Proposal Presentations.

(The Final Proposal Presentations will be developed by the students (the TLTs) during the evening before this Segment and during the first portion of the Segment).

Objectives

- Students will be exposed to the complexity, confusion, decision making and leadership of a very complex System Design and Proposal development project
- Throughout the 5 integrated sessions of this in-class project, students will be immersed in a competitive simulation environment where different System design approaches will be assessed against the following key factors:
    - System Overview & Performance
    - System Architecture
    - Hardware Design
    - Software Design
    - Technical Analysis & System Tradeoffs
    - Requirements Traceability
    - Verification and Validation
    - Risks & Opportunities
    - RM&A
- Students will provide individual and collaborative leadership to a very complex and formal DoD Proposal development effort (including RFI, Draft RFP/SOW, Final FRP/SOW, Proposal submission).

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Syllabus Segment 21: AR2S2 TLT Final Presentations (Student Assessment)

Time: 1.0 hour
Responsible: Bill Robinson
Support: Mike Pennotti
Facilitator: Bill Robinson

Summary

This Segment will be the *fifth* of 5 integrated sessions that will span the System Design and Proposal cycles.

In this Segment, the TLTs will present their Final Proposal Presentations and the entire class will discuss the in-project and define lessons-learned gained from it.

Objectives

- Students will be exposed to the complexity, confusion, decision making and leadership of a very complex System Design and Proposal development project
- Throughout the 5 integrated sessions of this in-class project, students will be immersed in a competitive simulation environment where different System design approaches will be assessed against the following key factors:
  - System Overview & Performance
  - System Architecture
  - Hardware Design
  - Software Design
  - Technical Analysis & System Tradeoffs
  - Requirements Traceability
  - Verification and Validation
  - Risks & Opportunities
  - RM&A
- Students will provide individual and collaborative leadership to a very complex and formal DoD Proposal development effort (including RFI, Draft RFP/SOW, Final FRP/SOW, Proposal submission).

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Syllabus Segment 22: Feedback and Close (Course Assessment)

Time: 1.0 hours
Responsible: Nicole Hutchison, Pete Dominick
Support: Mike Pennotti, Bill Robinson, Val Gavito, Debra Lepore
Speaker: Mike Pennotti

Summary

The final segment of SYS350A will allow students and instructors the opportunity to provide feedback on the course. Instructors will provide feedback on the group presentations as well as a general review of the lessons learned during the course. Students will be asked to provide feedback on their reactions to the course and their perceived level of learning through a written questionnaire. Students will also have the opportunity to discuss any final questions or areas of concern.

Objectives

- Provide students' with feedback on their performance (as a group)
- Gauge student's reactions to the course (Kirkpatrick Level 1)
- Gauge student's learning in the course (Kirkpatrick Level 2)

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APPENDIX F: DRAFT SYS350A ASSESSMENT RUBRIC

The following is the rubric distributed to students in each SYS350A pilot to assess student reactions to the course materials, course delivery, and the instructors.

Course Assessment and Evaluation

Course Number and Title: SYS 350A Technical Leadership
Course Location: Dates:

Instructors: Pennotti, Robinson, Dominick, Gavito

Your Name (optional): ___________________________________

Question					
A. Instructor Evaluation					
(1 is Strongly Disagree; 5 is Strongly Agree)	**1 Strongly Disagree**	**2**	**3**	**4**	**5 Strongly Agree**
Explain the objectives of the course clearly	☐	☐	☐	☐	☐
Are prepared for the class	☐	☐	☐	☐	☐
Present material in an organized manner	☐	☐	☐	☐	☐
Has command of their subject	☐	☐	☐	☐	☐
Successfully communicate the subject	☐	☐	☐	☐	☐
Are fair and consistent	☐	☐	☐	☐	☐
OVERALL – The Instructors were Effective Teachers	☐	☐	☐	☐	☐
B. Course Evaluation					
(1 is Strongly Disagree; 5 is Strongly Agree)	**1 Strongly Disagree**	**2**	**3**	**4**	**5 Strongly Agree**
The course is well structured	☐	☐	☐	☐	☐
The course material (notes and books) are well organized	☐	☐	☐	☐	☐
The material was adequately covered in the allotted time	☐	☐	☐	☐	☐
The course was structured to facilitate discussion and participant contribution	☐	☐	☐	☐	☐
The subject matter has significant relevance and usefulness to my organization	☐	☐	☐	☐	☐
I can apply what I have learned in this course on projects (underway or future) in my organization	☐	☐	☐	☐	☐

The course will enable me to enhance my future career objectives	☐	☐	☐	☐	☐
OVERALL – This was an Excellent Course	☐	☐	☐	☐	☐

Questions:

The thing that I liked best about this course was:

If I could change one thing about this course, I would…

General Comments: