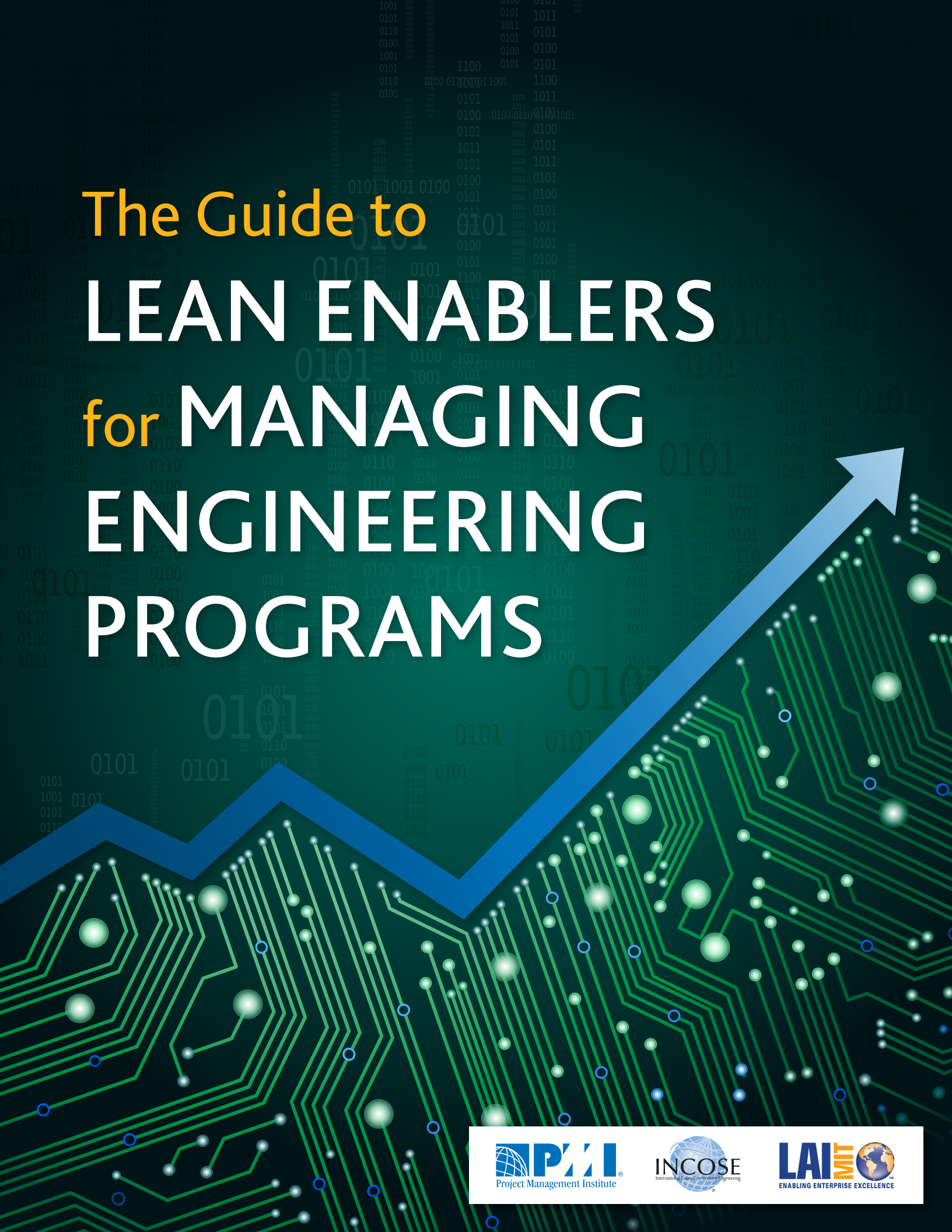
The Guide to LEAN ENABLERS for MANAGING ENGINEERING PROGRAMS



Project Management Institute

INCOSE International Council on Systems Engineering

LAI MIT ENABLING ENTERPRISE EXCELLENCE

The Guide to Lean Enablers for Managing Engineering Programs

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The Guide to Lean Enablers for Managing Engineering Programs ("*Guide*") was prepared by a volunteer group of contributing authors from within the joint International Council on Systems Engineering (INCOSE), Project Management Institute (PMI®) and Massachusetts Institute of Technology Lean Advancement Initiative (MIT-LAI) Community of Practice (the "COP"). The *Guide* is released through that collaborative effort as "Technical Data." It is subject to change without notice and may not be referred to as an INCOSE Technical Product.

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Please contact us with your feedback

We welcome your feedback. Please contact us through our website at http://www.lean-program-management.org/. The guide will be continuously developed, and your feedback will help us to improve it and make it more relevant. We are also always looking for dedicated professionals to join the group—contact us if you are interested.

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Use this Guide and Lead your Program to Excellence

Imagine running a program that inspires you every day: A program where everybody understands how they make a difference for their customers, their internal organization, and society at large; where professionals collaborate seamlessly over functional and organizational boundaries; where processes run like clockwork, delivering what is needed and when it is expected; And where your greatest worry is ironing out a few slight imperfections. In short: A Lean program! *You* can run this world-class program, and this guide has been written to help you do that.

We have come to accept that big programs mean big problems, big bills, and big delays. In addition, we accept that there is constant bickering between functional silos; conflicts among customers, contractors, and suppliers that lead to frequent irritations, animosity, and open hostility; lawyers and bureaucrats run the programs; and no work other than writing reports gets done. Conveniently, the excuses for doing so are endless (e.g., no time for managing the program better because everyone is busy fixing problems, requirements change all the time, regulations and compliance replace efficiency, new technologies fail, suppliers do not stick to their promises, and qualified people are impossible to find).

This guide has been written for managers and engineers who are willing to take on the challenge to lead their program to excellence.

In the 1940s, the three knowledge domains of operations research, systems engineering, and project management emerged to allow the execution of the first truly large-scale and complex technology and engineering programs. Now, 70 years later, the Lean Advancement Initiative (LAI) at the Massachusetts Institute of Technology (MIT), Project Management Institute (PMI), and International Council on Systems Engineering (INCOSE) joined forces to form a group of subject matter experts to distill and integrate the best ideas and practices from those areas and address today's challenges.

Over the last year, this group of subject matter experts from industry, academia, and government identified and prioritized the **top challenges that engineering programs face today**, and consolidated them into 10 major themes (Section 4). Guided by the Lean Thinking philosophy (introduced in Section 2), the group identified and extensively validated approximately 300 best practices in 40 categories to address these challenges, drawing on both program management and systems engineering. The result is the **Lean Enablers for Managing Engineering Programs** (Section 5).

The biggest transformation journey starts with a single step—taking just one of our Lean Enablers can make a difference (see 6.2.6 on Start Small by Selecting the Most Beneficial Lean Enablers for Your program.). We encourage you to begin by reviewing our good sense recommendations in Section 5, pick two or three, and turn them into common sense practices in your program (Section 7 also discusses more formal change management approaches).

Successful programs prove that it can be done—and you can do it in your program too!

Josef Oehmen, PhD
May 2012, Cambridge, MA (USA)

Executive Summary

This guide provides the findings of the Joint MIT-PMI-INCOSE Lean in Program Management Community of Practice that are based on a 1-year project executed during 2011 and 2012. The community was made up of selected subject matter experts from industry, government, and academia. The findings reported in this guide are based on known best practices from the literature, program experience of the subject matter experts, and input from an extensive community of professionals.

The findings of the Joint Community of Practice were extensively validated through community and practitioner feedback, multiple workshops at INCOSE and PMI conferences, LAI-hosted web-based meetings, and surveys of the extended professional community. ***The survey results clearly show that programs that use the Lean Enablers show a significantly stronger performance in all dimensions—from cost, to schedule and quality, as well as stakeholder satisfaction.***

The core of this document contains (1) the 10 themes for major engineering program management challenges, and (2) the 43 Lean Enablers with 286 subenablers to overcome these challenges, better integrate program management and systems engineering, and lead engineering programs to excellence.

The main engineering program management challenges that were identified and addressed By Lean Enablers in this guide are reported in detail in Section 4 and summarized as follows:

Major Challenge Themes in Engineering Programs that Lean Enablers Help to Address
1. Firefighting—Reactive program execution
2. Unstable, unclear, and incomplete requirements
3. Insufficient alignment and coordination of the extended enterprise
4. Processes are locally optimized and not integrated for the entire enterprise
5. Unclear roles, responsibilities, and accountability
6. Mismanagement of program culture, team competency, and knowledge
7. Insufficient program planning
8. Improper metrics, metric systems, and KPIs
9. Lack of proactive program risk management
10. Poor program acquisition and contracting practices

The Lean Enablers for Managing Engineering Programs—actionable best practices—can be found in Section 5 and are summarized as follows:

Lean Enablers (LE) Structured Along Six Lean Principles (LP)	No. of Lean Enablers	No. of Subenablers	Page
LE 1.x: Respect the people in your program (LP6)	6	38	35
LE 2.x: Capture the value defined by the key customer stakeholders (LP1)	6	44	46
LE 3.x: Map the value stream and eliminate waste (LP2)	11	75	53
LE 4.x: Flow the work through planned and streamlined processes (LP3)	10	64	68
LE 5.x: Let customer stakeholders pull value (LP4)	2	10	81
LE 6.x: Pursue perfection in all processes (LP5)	8	55	84
Total	**43**	**286**	

Acknowledgements

The research that underlies this guide was executed by the Joint MIT-PMI-INCOSE Community of Practice on Lean in Program Management between January 2011 and March 2012. The group started through conversations with MIT-LAI members. It consists of a core group of subject matter experts who met weekly to develop the content, as well as an extended professional community representing industry, government, and academia with 140 members from more than 80 organizations. The core subject matter experts are as follows:

Name	Title	Affiliation
Mark Bowie	Lean Strategist	Boeing Defense, Space & Security Industry-Co-Chair of the Group
Jim Davis	Solution Manager, Aerospace & Defense Industry	SAP Labs
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Peer Reviewers

The authors are grateful to all the peer reviewers for the extensive and insightful feedback on various drafts of this guide from many of our colleagues. In particular, we would like to acknowledge the following peer reviewers, in alphabetic order (the responsibility for the content and all errors remains solely with the authors): Janaina Costa, Quoc Do, Deniz Eralp, Roberto Follador, Roland Frenck, Bob Kenley, Juan Esteban Montero, Adam Naramore, George Rebovich, Jean-Claude Roussel, Avi Shtub, Jerome Sobetski, Michel Thiry, Stephen Townsend, Quynh Woodward, Richard Wray, Lori Zipes, and John Zlockie.

Supporting Organizations

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We also gratefully acknowledge Wiley for its kind permission to adapt an excerpt of Bohdan Oppenheim's book *Lean for Systems Engineering* for the introduction section to Lean Thinking in this guide. We also acknowledge the Project Management Institute for adapting content from *The Standard for Program Management* – Third Edition (exposure draft version) for this project as well as the use of PMI's Project of the Year Award recipients' case studies to demonstrate the application of the lean enablers contained in this guide.

1 Introduction to the Guide on Lean Enablers for Managing Engineering Programs

1.1 How to Use This Guide

1.1.1 Overview of the Content

The purpose of this document is to provide suggestions for managers and engineers who want to improve the performance of their programs. The authors jointly collected and synthesized data to provide the best available guidance on how to lead engineering programs to excellence.

We strongly recommend reading the entire guide to get an overview of the multi-faceted challenges and solutions that it contains. The casual reader may refer to Table 1 as a guide to the most relevant sections for their interest.

Table1: Quick Reading Guide

Section	Topics of Interest				
	Overview of Lean in Program Management	Integrating Systems Engineering and Program Management	Checklist of Program Risks	Checklist of Program Improvement Opportunities	Structured Improvement Suggestions
1. Introduction	●	●			●
2. Lean Thinking	●				●
3. Integrating Program Management and Systems Engineering		●			●
4. Top 10 Challenges			●		●
5. Lean Enablers	●	●		●	●
6. Complementary Approaches		●			●
7. Implementation Suggestions					●
8. Possible Barriers to Implementation					●

Section 1 (this section) discusses the context of the document. This includes the motivation for developing this guide, development process, applicability of the recommendations (beyond engineering programs, to projects, and different life-cycle phases), as well as the relationship to the INCOSE "Lean Enablers for Systems Engineering."

Section 2 introduces the concept of Lean Thinking. It discusses the relationship of Lean value and program benefits, outlines the types of program management waste, and introduces the six Lean principles that are used to develop and structure the enablers for engineering programs.

Section 3 summarizes the key concepts and defines the main terms for better integrating program management and system engineering. It briefly discusses the roles of program manager and system engineer, introduces the two domains of program management and system engineering, discusses the types of program stakeholders, and summarizes a framework used to measure value and benefits in programs.

Section 4 contains the major engineering program management challenges that were identified during the collaboration project. They are presented in 10 main categories: (1) firefighting—reactive program execution; (2) unstable, unclear and incomplete requirements; (3) insufficient alignment and coordination of the extended enterprise; (4) processes are locally optimized, not integrated for the entire enterprise; (5) unclear roles, responsibilities, and accountability; (6) mismanagement of program culture, team competency and knowledge; (7) insufficient program planning; (8) improper metrics, metric systems, and KPIs; (9) lack of proactive program risk management; and (10) poor program acquisition and contracting practices.

Section 5 describes the corresponding Lean Enablers for Managing Engineering Programs. The section contains all of the 329 Lean practices for improving program performance (43 Lean Enablers (LE) with 286 sub-enablers). They are structured along the 6 Lean Principles (LP): LE1.x: Respect the people in your program (LP6); LE2.x: Capture the value defined by the key customer stakeholders (LP1); LE3.x: Map the value stream and eliminate waste (LP2); LE4.x: Flow the work through planned and streamlined processes (LP3); LE5.x: Let customer stakeholders pull value (LP4); and LE6.x: Pursue perfection in all processes (LP5).

Section 6 highlights the relationship of the Lean Enablers for Managing Engineering Programs to other complementary views and improvement approaches. They include Agile Development, Capability Maturity Model Integration (CMMI), and Earned Value Management.

Section 7 gives some concrete advice on how to implement the Lean Enablers. It covers strategic program enterprise transformation efforts, programs that are being newly started, and continuous improvement of existing programs.

Section 8 highlights several barriers to the use of the Lean Enablers in the current program environment. It summarizes the structural and strategic issues in the government and the corporate and academic spheres that need to be addressed to make it easier for program managers and systems engineers to lead their program to excellence.

The **Appendix** contains references to other helpful documents, the complete list of program management challenges, an overview of the programs used in the content analysis to validate the Lean Enablers, a reference list to the Lean Enablers, and a number of detailed mappings of the Enablers (to the Program Management Performance Domains, to the program management challenges, the 26 INCOSE and ISO/IEC 15288 Systems Engineering processes, and the Lean Enablers for Systems Engineering).

1.1.2 Getting Started with the Lean Enablers

The best practices for managing engineering programs, which have been condensed into the Lean Enablers, are basically “good sense”. It is expected that this guide will contribute to making them “common sense” as well. The Lean Thinking philosophy was used as the framework to identify those best practices that add value to program management and systems engineering, as well as those practices that have the ability to integrate the two domains across all functional and organizational boundaries. Lean excels at this and was therefore a natural choice. Lean does not contradict other improvement approaches, provided that they too focus on delivering more value for the customer stakeholders—the buyers and users. For example, in Section 6.1, we briefly discuss the complementary relationship to the Agile approach.

It is not necessary (or advisable) to implement all Lean Enablers at once. Lean Enabler 6.2.6 states: “Start small by selecting the most beneficial Lean Enablers for your program.” And 6.1.2 says: “Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.” This advice also applies to these guidelines. Clearly prioritize the improvement needs for your program based on the 10 major challenges discussed in this guide. Then select those Lean Enablers for implementation which promise the highest level of improvement for the implementation effort.

This guide contains a number of mappings to assist in identifying the enablers that are most relevant for your program:

- Mapping of Lean Enablers against **engineering program challenges** (Section 5 and Section A.5.1)
- Mapping of Lean Enablers against **program management performance domains** (Section 5 and Section A.5.2)
- Mapping of Lean Enablers against the **INCOSE Systems Engineering Processes** (Section 5 and Section A.5.3) and the Lean Enablers for Systems Engineering (Section A.5.4)
- High-level mapping of Lean Enablers against Agile Development (Section 6.1)
- High-level mapping of Lean Enablers against the **Capability Maturity Model Integration (CMMI)** (Section 6.2)
- High-level mapping of Lean Enablers against **Earned Value Management (EVM)** (Section 6.3)

1.1.3 Program Roles and Application Examples for the Lean Enablers

This guide provides valuable insights for a number of different stakeholders in an engineering program as follows:

- **Program managers**: Tailor management approach and processes when prioritizing and implementing Lean Enablers.
- **Functional managers**: Design the interface between functional domains (and their management) and program management by implementing the corresponding Lean Enablers, for example, project management, product development, engineering and systems engineering, corporate leadership, marketing, and supply chain management, etc.
- **Continuous improvement and auditing functions**: Update existing guidelines and checklists or design process improvement workshops using the Lean Enablers.
- **Risk managers**: Identify program risks using the engineering program management challenges as a checklist and develop mitigation actions using corresponding Lean Enablers.
- **Customer and government perspective**: Evolve and mature requirements with the assistance of the enablers relating to customer stakeholders. Define expectations and rules for communication and interactions with contractors and suppliers using similar enablers.
- **Corporate leadership**: Apply the Lean Enablers to corporate transformation and improvement programs and use them to help design internal best-practice standards for increasing the efficiency and effectiveness of engineering programs.
- **All professionals in an engineering program**: Apply the recommendations in this guide to all facets of program management and benefit by increasing knowledge improving work performance, and enhancing the growth of you career.

A more detailed discussion on the implementation of the Lean Enablers is contained in Section 7.

1.2 Motivation: Why Do We Need Lean Enablers?

Taking on large-scale engineering programs is one of the most difficult, risky, and—when done well—rewarding undertaking a government or company can attempt. It not only pushes the envelope of what is possible, but defines a new envelope. It generates capabilities, technologies, products, and systems that are innovative and unique, and generates tremendous societal benefits—from hybrid cars to a trip to the moon, from road networks to GPS navigation, and from carbon-neutral electricity sources to the “smart” city.

On the other hand, large-scale engineering programs present formidable challenges. As an example, let us consider the U.S. Department of Defense engineering development programs (mainly because detailed cost and performance data are freely available[1]; reports of large-scale civil engineering programs provide similar information.[2] The accumulated cost overrun of the largest 96 engineering programs has reached nearly $300 billion, a staggering amount, and the average schedule overrun is close to 2 years (see Figure1). Clearly, both cost and schedule underperformance are not sustainable. So, what are the major challenges in these large-scale engineering programs and how can we counter them?

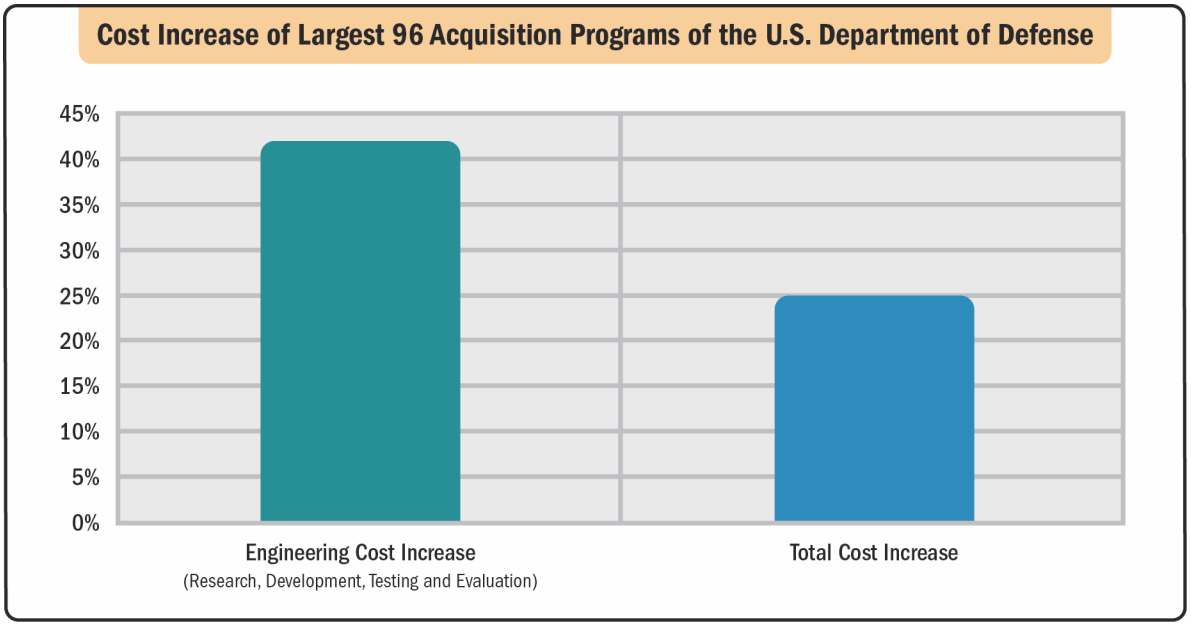

Figure 1: Engineering programs are plagued by significant cost overruns.

In the 1940's, the execution of engineering programs of this scale and complexity were comprised of three disciplines: operations research, project and program management, and systems engineering.[3] In the last 70 years, there have been major advancements in each of these disciplines. There are an impressive number of books, magazines, and journals on each discipline; there are numerous masters' degree programs for each discipline, and there are various professional societies dedicated to the continuous development of these disciplines. However, there is no single source for information that combines the knowledge from all three fields. The Joint Community of Practice set out to close this gap and integrate the expertise from the three fields (see Figure2). Using the operations management theory of Lean Thinking, program management and systems engineering are integrated with it to develop a set of unique, relevant, and actionable recommendations for program managers—The Lean Enablers for Managing Engineering Programs.

[1] United States Government Accountability Office: Assessments of Selected Weapon Programs. Report to Congressional Committees. GAO-09-326SP. 2009

[2] Cantarelli et al.: Cost overruns in large-scale transportation infrastructure projects: Explanations and their theoretical embeddedness. European Journal of Transport and Infrastructure Research, 2010, Issue 10, No. 1, pp. 5-18.

[3] A highly interesting and readable history and background to this study is: Johnson, Stephen B. 1997. "Three Approaches to Big Technology: Operations Research, Systems Engineering, and Project Management," *Technology and Culture* 38 (4): 891-919.

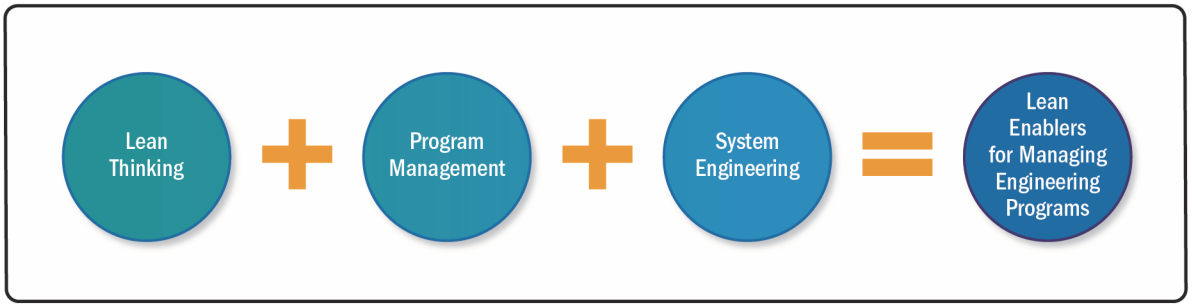

Figure2: The three foundations of this guide.

The application of the Lean Enablers allows you to:

- Set yourself up for success by creating a program culture with highly dedicated and motivated professionals.
- Focus a program on delivering the value and benefits that will delight your customer stakeholders.
- Eliminate all waste from your program and minimize necessary, non-value-added activities.
- Create seamless integration between process steps and integration, leading to process flow and customer pull.
- Institutionalize excellence by constantly striving to improve and perfect the delivery of value to customer stakeholders.

Many of the Lean Enablers will not be surprising or novel to you as you read them, because they are all good sense. Let's turn them into common sense as well!

1.3 The Development and Validation Process of the Lean Enablers

From the beginning, the development of the Lean Enablers for Managing Engineering Programs was driven by three principles:

- Ensure the highest level of applicability of the results to industry and government program management practitioners.
- Operate as a joint MIT-PMI-INCOSE working group to unite the best of lean management, program management, and systems engineering.
- Bring together subject matter experts from industry, government, and academia.

To this end, the group executed the following development and validation activities:

- The content of this guide was developed during a 1-year project by a group of subject matter experts from industry, government, and academia (see page vii), with weekly project meetings that were moderated by MIT-LAI.
- The program management challenges and Lean Enablers incorporate both the practical experience of the subject matter experts, as well as the latest knowledge from academic literature on engineering program management[4].

[4] For an overview of the current literature, please see: Oehmen, J. et al.: Program Management for Large-Scale Engineering Programs. MIT-LAI Whitepaper Series "Lean Product Development for Practitioners". Massachusetts Institute of Technology, 2011. Available at http://lean.mit.edu; Kinscher, K.: Identification of Lean Enablers for Program Management. Master's thesis, Massachusetts Institute of Technology and RWTH Aachen, 2011. Available at http://lean.mit.edu; Steuber, M.: Success Criteria and Enabler for Engineering Programs. Master's thesis, Massachusetts Institute of Technology and TU Munich, 2012. Available at http://lean.mit.edu; and Oppenheim, B.: Lean for Systems Engineering with Lean Enablers for Systems Engineering. Wiley, 2011.

- Each month, findings and progress were reported to the larger Joint Community of Practice which grew to 140 practitioners, and their feedback guided the development process.
- Four workshops were organized during the year (one through MIT, two at INCOSE conferences, and one at the PMI Global Congress) to engage in customer and stakeholder dialogue and elicit feedback from more than 180 participants.
- Two surveys of industry and government practitioners validated the findings of the group's work: one prioritized the program management challenges, and the other validated the suggested Lean Enablers for Managing Engineering Programs.
- The Lean Enablers were validated further by comparing these recommendations with the management practices of highly successful programs (see Section A.3 in the Appendix for a list of the programs).

The core results of these activities are the themes for major program management challenges reported in Section 4, as well as the Lean Enablers for Managing Engineering Programs reported in Section 5. Additional insights of the project are captured in Section 3, discussing various aspects of the integration of program management and systems engineering. Section 6 contains a discussion (and mapping) to other approaches for improving the performance of engineering programs, while Section 7 discusses a number of implementation suggestions. Section 8 concludes the guide with the summary of a number of policy barriers that stand in the way of the Lean Enablers.

While the subject matter experts are somewhat U.S.-centric, strong attempts were made to incorporate a global perspective through the extended Joint Community of Practice and the international workshops where the results were discussed.

1.4 The Impact of Using Lean Enablers in Engineering Programs[5]

During the first phase of the validation, the extent to which "best in class" programs (see Section A.3) employed the suggested Lean Enablers for Managing Engineering Programs was analyzed. This analysis included published program documentation, studies, and application material submitted to PMI for its Project of the Year Award. The three most highly successful programs where detailed information was available used between 60 and 75% of the recommended enablers, which was a very encouraging result. Even in those programs where only brief documentation was publicly available, we found evidence that the programs used approximately 30% of the enablers.

We also found that all enablers were used at least once, and some were more popular than others. Some of the most frequently used enablers were:

- Build a program culture based on respect for people (Lean Enabler 1.1).
- Frequently engage the stakeholders throughout the program life cycle (Lean Enabler 2.3).
- Develop a Communications Plan (Lean Enabler 3.11).
- For every program, use a program manager role to lead and integrate the program from start to finish (Lean Enabler 4.3).
- Proactively manage uncertainty and risk to maximize the program benefit (Lean Enabler 6.6).

This relatively rough analysis was followed up with a detailed survey on the performance of successful and unsuccessful programs, as well as the degree to which they use the Lean Enablers. Figure 3 shows the significant difference in performance between programs considered to be successful and those considered to be unsuccessful. Not surprisingly, successful programs on average overachieved in all performance dimensions, whereas unsuccessful programs fell significantly short.

[5] For additional details on the validation studies, please refer to: Steuber, M.: Success Criteria and Enabler for Engineering Programs. Master's thesis, Massachusetts Institute of Technology and TU Munich, 2012. Available at http://lean.mit.edu.

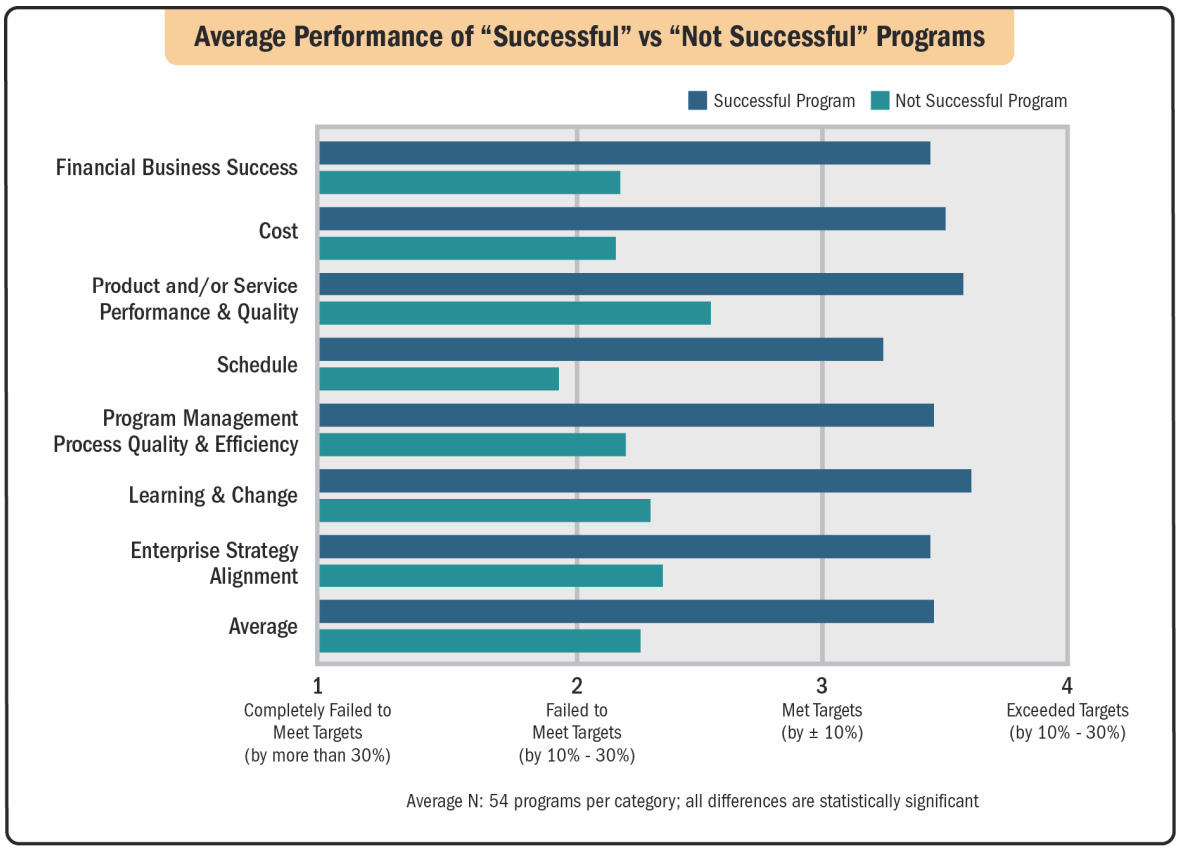

Figure3: Successful programs show significantly higher performance than unsuccessful programs (Steuber 2012).

One obvious question is: Do the successful programs use more of the Lean Enablers more regularly? Figure 4 summarizes the strong survey results: Across the board, successful programs are ahead in using the Lean Enablers, and these are presented in greater detail in Section 5.

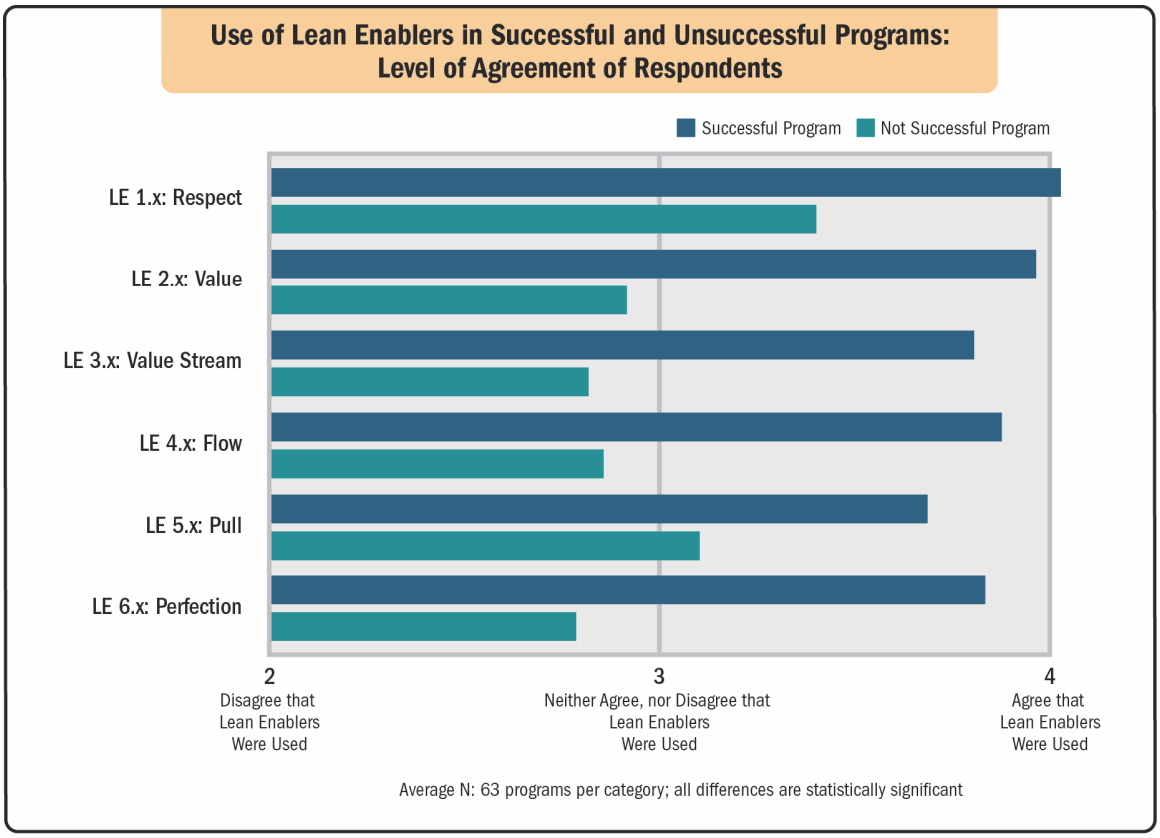

Figure4: Successful programs make better use of lean enablers (Steuber 2012).

1.5 Applicability of the Lean Enablers

1.5.1 Applicability to Different Types of Programs

Lean Thinking aims to create the best value for the program stakeholders, with minimum waste and in a minimum of time. This is common to all types of programs: commercial and government, engineering and social transformation, large and small. The Lean Enablers presented in this guide were developed from the challenges observed in recent large-scale engineering programs, requiring millions to several billions of dollars, which included aerospace and defense programs, systems or missions, large-scale infrastructure developments, development and integration of complex IT systems, and development of new commercial product lines. Most of the programs studied were ultimately contracted by a government customer; therefore the challenges may be indicative of these types of programs. Government and commercial programs place different importance on the challenges and, therefore, on the resultant enablers. However, this difference is believed to be largely a matter of priority and not fundamental applicability.

The group of experts who developed the enablers made a significant effort to ensure that the enablers were applicable to other types of programs, for example, organizational change programs (i.e., cost reduction, restructuring, post-merger integrations, etc.), and social transformation programs (i.e., reducing childhood obesity or preventing and treating post-traumatic stress disorder). Large-scale engineering programs are usually large-scale socio-technical programs due to the significant influence they exert (e.g., redefining the way companies of the program enterprise work together, opening new production and service facilities, improving the quality of life of its users, etc.). It then becomes clear why the enablers presented here also apply to important aspects of organizational and social transformation programs. A more detailed discussion of different program types can be found in the general program management literature discussed in Section A.1.3.

1.5.2 Applicability to Different Life Cycle Phases of Engineering Systems

The applicability of the Lean Enablers to managing and improving engineering programs rises and falls with the systems engineering content of the programs[6]. While several aspects of the Lean Enablers are applicable throughout the entire life cycle of an engineering system, all of them apply to the early phases of concept generation and development (see Figure5).

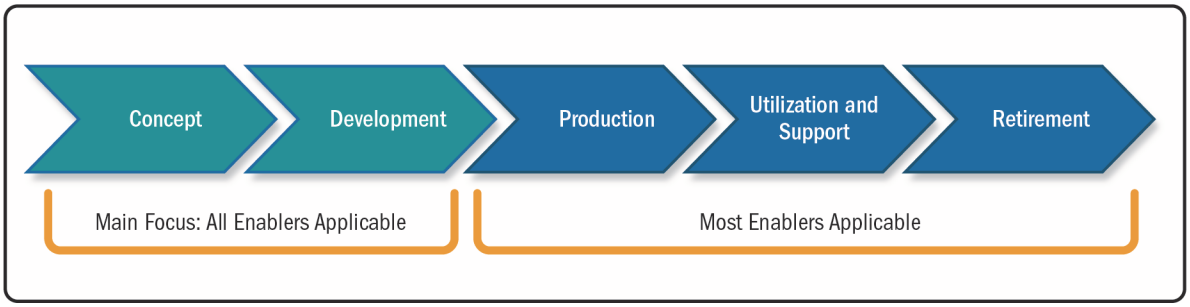

Figure 5: Life-cycle phases of an engineering system and applicability of lean enablers.

The overall goal of the Lean Enablers in the early phases is to focus the program on achieving the maximum overall life cycle benefits for the customer stakeholders—not to locally optimize any particular life cycle phase or any particular stage gate.

While all Lean Enablers relating to Lean Principles 6, 3, and 5 apply to all life cycle phases, some of the enablers addressing Lean Principles 1, 2, and 4 are specific to the concept generation and development phases (see Table 2).

Table 2: Applicability of Lean Enablers in System Life-Cycle Phases

Lean Enablers grouped by Lean Principles	Concept	Development	Production	Utilization and Support	Retirement
LE 1.x: Respect the people in your program	●	●	●	●	●
LE 2.x: Capture the value defined by the key customer stakeholders	●	●	⊙	⊙	⊙
LE 3.x: Map the value stream and eliminate waste	●	●	⊙	⊙	⊙
LE 4.x: Flow the work through planned and streamlined processes	●	●	●	●	●
LE 5.x: Let customer stakeholders pull value	●	●	⊙	⊙	⊙
LE 6.x: Pursue perfection in all processes	●	●	●	●	●

● All enablers apply ⊙ Some enablers do not apply

1.5.3 Applicability of Lean Enablers to the Management of Engineering Projects

A significant fraction of the enablers is also applicable to the management of engineering projects, under the following circumstances:

[6] See INCOSE Systems Engineering Handbook, v. 3.2.2, October 2011, chapter 3 for a detailed discussion of the life-cycle phases of an engineering system and the role of systems engineering.

1. **All of the Enablers apply to a project, if the project is a program**. There is a significant variance in the perception and use of the terms *projects* and *programs* in both industry and government. In this guide, the difference between project management and program management is based on PMI's standard definitions. Program management work is described in detail in PMI's *The Standard for Program Management* – Third Edition which will be published in the coming months. It is aligned with a large-scale Role Delineation Study conducted by PMI in 2010 that is documented and published as part of PMI's Program Management Professional (PgMP) Exam Content Outline[7]. The exam content outline clearly describes the work in terms of domains, tasks, skills, knowledge and competencies that sets programs and the roles of program managers apart from projects and project managers. We introduce our definition of *programs* in Section 3.2. If a *project* aligns with this definition of programs, all enablers apply.
2. **If the project includes the execution of program-level activities, the corresponding enablers apply to the program**. Some organizations do not have a program management organization, so that projects include most or all of the program management functions as well. Many programs start out as projects and evolve into programs during their execution. If a program executes activities that fall within any of the five Program Management Performance Domains, the corresponding enablers apply to your project as well. The performance domains are (1) Program Strategy Alignment, (2) Program Benefits Management, (3) Program Stakeholder Engagement, (4) Program Governance, and (5) Program Life Cycle Management (see Section 3.2 for a more detailed discussion). All of the enablers in Section 5 are mapped against these Program Management Performance Domains, so the domains that are relevant to a specific project can be easily identified (see also Section A.5.2 in the Appendix).
3. **The enablers address dependencies and interfaces between projects and programs.** Many programs suffer from a lack of defined boundaries, poor integration of processes and benefits, and no coordination of the projects within the program. The Lean Enablers help both program managers and project managers to identify and properly define boundaries to enable integration across these interfaces and coordination of mutual responsibilities. Therefore, the enablers can serve as a starting point for a structured review and optimization of the integration between the projects within the program and the program itself, as well as between the projects within one program. In particular, all Lean Enablers addressing the Program Life Cycle Management performance domain have a direct impact on projects.

1.6 Relationship to the INCOSE Lean Enablers for Systems Engineering

The INCOSE Lean Systems Engineering Working Group[8] first published the *Lean Enablers for Systems Engineering* under the leadership of Bohdan Oppenheim and Deborah Secor in 2009.[9] The results formed an important input for the work of the joint MIT-PMI-INCOSE Community of Practice on Lean in Program Management, which developed the Lean Enablers for managing engineering programs described in this guide.

All of the 147 enablers published as the *Lean Enablers for Systems Engineering* were integrated into the 329 enablers reported in this document. Minor edits were applied to make the formulations applicable to both program management and systems engineering. This work was overseen by Bohdan Oppenheim and Deborah Secor who served as subject matter experts in developing the Lean Enablers for managing engineering programs. A detailed mapping can be found in the Appendix in Section A.5.4.

[7] The Project Management Institute: The Program Management Professional (PgMP) Exam Content Outline. Newtown Square, PA, 2010.
[8] Web page of the INCOSE Lean Systems Engineering Working Group: http://cse.lmu.edu/about/graduateeducation/systemsengineering/INCOSE.htm
[9] Oppenheim, B., Murman, E., Secor, D.: Lean Enablers for Systems Engineering. Systems Engineering, vol 14, is 1, pp. 29-55, 2011

The *Lean Enablers for Systems Engineering* received the 2011 Shingo Award for Operational Excellence and the 2010 INCOSE Product of the Year Award. They have been widely disseminated to nearly 2,000 individuals in about 50 workshops, seminars and lectures delivered in 12 countries on three continents.

Bohdan Oppenheim's book *Lean for Systems Engineering with Lean Enablers for Systems Engineering*[10] contains detailed explanations for each of the 147 enablers, with examples, promoted value, prevented waste, implementation suggestions, lagging factors, and reading lists. A video lecture, powerpoint presentation, reference guide, promotional brochure, case studies, student competition, and mapping of the 147 enablers to the 26 INCOSE and ISO/IEC 15288 systems engineering processes can be found on the INCOSE Lean Systems Engineering Working Group website.

[10] Bohdan W. Oppenheim: Lean for Systems Engineering with Lean Enablers for Systems Engineering. Wiley, 2011.

2 Lean Thinking: A Brief Introduction[11]

2.1 Overview

Three concepts are fundamental to the understanding of Lean Thinking: value, waste, and the process of creating value without waste, which are captured in the six Lean Principles. These concepts are described in this chapter in the general context of product development and are explained in enough detail so that to the reader does not need to refer to other sources. However, any reader who is new to the concepts of Lean Thinking would benefit from reading an introductory book to Lean Thinking.[12]

Lean Thinking adopts a number of practices previously known by other names, such as Six Sigma, total quality management, concurrent engineering, test-as-you-fly, and others. The criterion we use for adoption is simple, stated as follows:

> If a best practice promotes value, reduces waste, and can be described by the 6 Lean Principles, it is called **Lean**, and if the described best practice falls within the scope of the 5 Program Management Performance Domains, it is considered here as a **Lean Enabler** for managing engineering programs.

2.2 Lean Value and Program Benefits

Value is what the customer says it is, considers important, and is willing to pay for. In simple applications, the customer states what is required, and the contractor makes it and delivers it, hopefully satisfying or even delighting the customer. This works well when buying ice cream, but is much more challenging when developing a new, complex technological system.

In large-scale engineering programs (such as government programs), there may be thousands of stakeholders in numerous communities of users, acquisition stakeholders, prime contractor and suppliers throughout the value chain, and other stakeholders, such as politicians, lobbyists, shareholders, and banks, etc. Stakeholders promote those aspects of value which are important to them, and are often in conflict with other stakeholders' requirements. These factors make the value capture and contract formulation a significant challenge and a costly process. Yet, value must be defined precisely, or the subsequent program will suffer delays, added costs, frustrations, and, in extreme cases, program closure or failure. It is critical for everyone involved in the process to be focused on capturing the final value proposition with the absolute best of competence, wisdom, experience, and consensus. A value definition must be crystal clear, unambiguous, and complete, representing the customer needs during a system life cycle and allowing effective channels for value clarification without causing requirements creep.

In program management, the term *benefits* is often used to describe a concept similar to that of value. Benefits in program management are defined as the achievement of explicit objectives and lasting change specified and approved by customer stakeholders.

[11] This section has been adapted by the author from chapter 3 of his book: Oppenheim, B. W. (2011). *Lean for Systems Engineering with Lean Enablers for Systems Engineering*. New York: Wiley. It is used here with the kind permission of the publisher.

[12] See Section A.1.1 in the Appendix, for example: Womack, J. & Jones, D. (2003). *Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, (2nd ed.). New York: Simon & Schuster.

2.3 Waste

The ability to identify and eliminate waste is a critical skill for Lean Thinking; all work activities are classified into the following three categories:[13]

1. **Value-added (VA) activities**, which must satisfy the following three conditions:
   - Transform information or material, or reduce uncertainty (cannot be an unnecessary bureaucratic task that creates no value).
   - The customer must be willing to pay for it (explicitly, or, in more complex programs, implicitly, that is, if the customer understood the details, the customer would approve of this activity).
   - It is done right the first time. (This does not exclude legitimate, value-adding engineering iterations, trial-and-error, etc.)
2. **Required (also called necessary) non-value-added (RNVA) activities**, which do not meet the previous definition, but which cannot be eliminated because they are required by law, contract, company mandate, current technology, or other similar reason.
3. **Non-value-added (NVA) activities**, which consume resources and create no value. They are pure waste (e.g., unneeded reports and e-mails, idle time, defects that require rework, etc.)

Taiichi Ohno classified waste in manufacturing into seven categories. Several authors have adapted Ohno's seven production wastes for engineering programs[14].

Table 3 lists the wastes in the context of engineering programs.

2.4 The Six Lean Principles

The process of creating value without waste is captured into six Lean Principles: Value, Map the Value Stream, Flow, Pull, Perfection, and Respect for People.[15] The effectiveness of the Lean Principles has been demonstrated in a broad range of work environments, including production, engineering, systems engineering, supply chain management, finance and general administration, education, and health.[16]

The best practices, which we call Lean Enablers, that implement the six Lean Principles in engineering programs, are presented in Section 5. We introduce the Lean Principles in the following subsections in the established order (starting with Value, ending with Respect). However, when discussing the Lean Enablers in Section 5, we moved the section on implementing "Respect for People" to the top, as we believe that those enablers are the most relevant, and the most often overlooked (the other Enablers then follow in the usual order).

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[13] Womack, J., & Jones, D. (2003). *Lean thinking: Banish waste and create wealth in your corporation*, (2nd ed.). New York: Simon & Schuster.

[14] Oehmen, J., & Rebentisch, E. (2010). *Waste in lean product development*. MIT-LAI Whitepaper Series, Boston, MA: Massachusetts Institute of Technology; Morgan, J., & Liker, J. (2006). *The Toyota product development system: Integrating people, process and technology*. Boca Raton, FL: CRC Press (formerly Productivity Press); and Oppenheim, B. W. 2011. Lean for Systems Engineering with Lean Enablers for Systems Engineering. Hoboken, NJ: Wiley.

[15] In addition to Womack & Jones (2003) and Oppenheim's works (2011), refer to Sugimori, Y., Kusunoki, K., Cho, F. & Uchikawa, S. (1977): *Toyota Production System and Kanban Systems—Materialization of Just-In-Time and Respect-For Human Systems*. International Journal of Production Research, Vol. 15, No. 6, pp. 553–564.

[16] See Womack & Jones (2003); Oppenheim (2011); and Murman, E. et al. (2002). Lean enterprise value: Insights from MIT's lean aerospace initiative. New York: Palgrave.

Table 3: Seven Types of Engineering Program Waste with Examples

Seven Wastes	Engineering Program Examples
Overproduction of Information	• Producing more than needed by next process • Creating documents that were not requested • Redundant tasks, unneeded tasks • Over-dissemination, that is sending information to too many people (e.g., excessive e-mail distribution) • Sending a volume when a single number was requested • Work on an incorrect release (information churning) • Lack of reuse of expertise, reinventing the wheel
Waiting	• Waiting for information or decisions • Information or decisions waiting for people to act • Large queues throughout the review cycle • Long approval sequences • Unnecessary serial effort
Unnecessary Movement of Information	• Hand-offs • Excessive information distribution • Disjointed facilities, politically motivated geographical distribution of work (e.g., "made in 50 states"), lack of colocation
Over-Processing of Information	• Refinements beyond what is needed • Point design used too early, causing massive iterations • Uncontrolled iterations (too many tasks iterated, excessive complexity) • Lack of standardization • Data conversions • 2-D drawings (3D should be used consistently) • Use of excessively complex software "monuments" for no apparent reason (e.g. use of complex software when a spreadsheet would be acceptable)
Inventory of Information	• Keeping more information than needed • Excessive time intervals between reviews • Poor configuration management and complicated retrieval • Poor 5 S's (sorting, straightening, systematic cleaning, standardizing, and sustaining) in office or databases
Unnecessary Movement of People	• Unnecessary movement during task execution • People having to move to gain or access information • Manual intervention to compensate for the lack of process
Rework, Defects	• The killer “re’s”: Rework, Rewrite, Redo, Re-program, Retest... • Unstable requirements • Uncoordinated complex task taking so much time to execute that it is obsolete when finished and has to be redone • Incomplete, ambiguous, or inaccurate information • Inspection to catch defects

2.4.1 Principle 1: Value

Capture the value defined by the customer stakeholders, who may be either external or internal. The external customer who pays for the system or service defines the final value for the deliverable. Internal customers receive the output of a task or activity and usually do not explicitly pay. In both cases, the customer stakeholder is the one who defines what constitutes value. The importance of capturing both task and program value with precision, clarity, and completeness cannot be overemphasized, to create a clear program strategy and avoid unnecessary rework before resource expenditures ramp up. For programs with a very long duration (such as

complex technology acquisition programs by the government), external factors can change, and customer value expectations may need to be revisited, updated, or revised.[17] Clearly, a careful balance is needed. On the one hand, constant change and instability must be avoided or the system costs will grow and the schedule will lengthen (e.g., the Space-Based Infrared System (SBIRS) program[18]). On the other hand, customer value expectations or threats may change, and an original value proposition could become obsolete (e.g., cancellation of further F-22 aircraft production). This is the strongest argument for shorter program schedules. The Lean Enablers that operationalize this principle are designated "2.x" and are presented in Section 5. (The Lean Enablers start with those relating to Lean Principle 6, because of its importance (see also Section 2.4.6).

2.4.2 Principle 2: Value Stream

Map the value stream (plan the program) and eliminate waste. Map all end-to-end linked tasks, control/decision nodes, and the interconnecting flows necessary to realize customer value. During the mapping process, identify and eliminate all non-value-added activities, minimize all necessary non-value activities, and enable the remaining activities to flow without rework, backflow, or stopping (the flow is described in Principle 3). A key concept to grasp in moving from the manufacturing to the engineering domain is that in manufacturing, material is being transformed and moved, while in the latter, information is being transformed and moved. The term information flow refers to the packets of information (knowledge) created by different tasks, which flows to other tasks (design, analysis, test, review, decision, or integration) for subsequent value adding. There are a number of implications when applying Lean Thinking principles, techniques, and tools to a medium that is as fluid as information. Careful detailed planning and program front loading, common or interoperable databases, rapid and pervasive communication of decisions using Intranets or personal communication and frequent integrative events for efficient real-time resolution of issues and decision making, stand-up meetings, or virtual reality reviews are some techniques to keep information flowing. Each task adds value if it increases the level of useful information and reduces risk in the context of delivering customer value. There exist practical guides for value-stream mapping in engineering programs.[19]

The generic term *planning* includes two distinct phases: (1) enterprise preparation and (2) program planning. Lean corporate enterprises prepare resources (people, processes, and tools) that will serve all programs. These resources include an infrastructure for continued employee education and training; creation of the communities of practice; central databases with former design and program data, lessons learned, and knowledge shared; standardization of processes; preparation of the program infrastructure, equipment, and tools; rotation of key people; strategic decisions for subsystem reuse in future programs; and training of employees in the best communication and coordination practices. These activities will serve all programs and should be handled at the corporate level, enhancing the long-term competitiveness of the enterprise. In contrast, program planning refers to the planning effort for a specific engineering program. The Lean Enablers that operationalize this principle are "3.x" and are presented in Section 5.3.

2.4.3 Principle 3: Flow

Flow the work through planned and streamlined value-adding steps and processes, without stopping or idle time, unplanned rework, or backflow. To optimize flow, plan for the maximum concurrency of tasks—up to near capacity of an enterprise. Robust capture of value, good enterprise-level preparations, and good program

[17] Murman et al. (2002).
[18] United States Government Accountability Office: Defense Acquisitions (March 2007). *Assessments of Selected Weapon Programs*, GAO-07-4065SP, Washington D.C.
[19] See for example: McManus, H. (2004). *Product development value stream mapping manual*. Lean Advancement Initiative, Massachusetts Institute of Technology.

planning are among the necessary conditions for subsequent Lean execution of a program. Although difficult, detailed planning of a complex program is critical for Lean. For example, it took Toyota several decades to perfect its system, and Toyota employees still routinely claim that they are far from perfect.

In engineering programs, legitimate engineering iterations are frequently needed to address "chicken versus egg" technical problems, but they tend to be time consuming and expensive if they cross disciplines. Lean flow encourages an efficient methodology of "fail early – fail often" through rapid architecting and discovery techniques during the early design phases. The Flow Principle also encourages techniques that obviate lengthy iterations, for example through design front-loading, trade space explorations, set-based designs, modular designs, legacy knowledge, and large margins. Where detailed cross-functional iterations are necessary, Lean flow optimizes the iteration loops for overall value, while limiting the tasks within the loops to those that experience changes of state and optimizing their execution for best value. The Lean Enablers that operationalize this principle are "4.x" and are presented in Section 5.4.

2.4.4 Principle 4: Pull

Let customer stakeholders pull value. In manufacturing, the ideal pull principle is implemented as the Just-in-Time (JIT) delivery of parts and materials to the needing station and to the external customer. In program applications, the pull principle has two important meanings: (1) the inclusion of any task in a program must be justified by a specific need or request from an internal or external stakeholder and coordinated with them; and (2) the task should be completed when the stakeholder needs the output because excessively early completion leads to shelf-life obsolescence, including possible loss of human memory or changed requirements, and late completion leads to schedule slip and destabilization of carefully planned task sequences in the program. Therefore, every task owner should be in close communication with the internal customers to fully understand their needs and expectations and to coordinate work, modalities, and deliverables. Programs that are complex enough to require systems engineering need both a Lean-Thinking customer as well as a Lean-Thinking creator. A customer who makes arbitrary demands prevents a Lean outcome, and uncontrolled pull tends to create chaos. The Lean Enablers that operationalize this principle are "5.x" and are presented in Section 5.5.

2.4.5 Principle 5: Perfection

Pursue perfection in all processes. Global competition is a brutal "race without a finish line," requiring continuous improvements of processes and products. Yet, no organization can afford to spend resources improving everything on a continuous basis. To clarify the issue, there is a distinction between processes and process outputs. Perfecting and refining the work output in a given task must be bounded by the overall value or benefit proposition (system or mission success and program budget and schedule), which defines when an output is good enough. Otherwise, the notorious waste of overprocessing may occur. Judgments should be made by experienced domain specialists and engineers in close coordination with systems engineers and program managers who are responsible for overall flow of value. In contrast, engineering and other processes must be continuously improved for never-ending competitive reasons. It is important for the enterprise to understand the distinction between process and product perfection and provide resources accordingly. Two features of Lean help in prioritizing processes for improvement: (1) making all imperfections in the workplace visible to all; and (2) prioritizing to eliminate the biggest impediments to flow. Seeing problems as they appear in real time is conducive to making better decisions on corrective actions and better prioritization of improvements. When noticed early, imperfections tend to be easier and less expensive to fix; unnoticed early they tend to grow to crisis proportions and require extensive actions to mitigate. Making imperfections visible is

a motivator for applying continuous improvement in real time.[20] The enterprise should create an effective infrastructure for capturing knowledge and lessons learned and for promoting continuous education to make each program better than the last. The Lean Enablers that operationalize this principle are "6.x" and are presented in Section 5.6.

2.4.6 Principle 6: Respect for People

Respect the people in your program. A Lean enterprise is an organization that recognizes its people are the most important resource and is one that adopts high-performance work practices. In a Lean program, people are encouraged to identify problems and imperfections honestly and openly in real time, brainstorm root causes and corrective actions without fear, and plan effective solutions together by consensus to prevent a problem from reoccurring. When issues arise, the system is blamed and not the messengers. Experienced and knowledgeable leaders lead and mentor, but also empower frontline employees to solve problems immediately. Such an environment requires a culture of mutual respect and trust, open and honest communication, and synergistic and cooperating relationships of all stakeholders. The Lean Enablers that operationalize this principle are "1.x"and are presented as the first set of Enablers because of their importance in Section 5.1.

[20] See Morgan, J., & Liker, J. (2006). The Toyota product development system: integrating people, process and technology. Boca Raton, Fl: CRC Press (formerly Productivity Press).

3 Integrating Program Management and Systems Engineering

3.1 Management Roles in Successful Engineering Programs

In the history of exceptionally successful engineering programs, one constant theme becomes evident: successful programs are led by exceptional leaders who possess a critical skill set and maintain responsibility, authority, and accountability for success throughout the program life cycle. Examples include the U.S. nuclear submarine program led by Adm. Rickover, the early Skunk Works led by Kelly Johnson (U-2 and SR-71), the recent Apple® products led by Steve Jobs, and many Toyota and Honda automotive programs.

These leaders exhibited four critical and complementary skills:

- Deep knowledge and experience in the program domain.
- Leadership and vision skills.
- Knowledge in both systems engineering and program management.

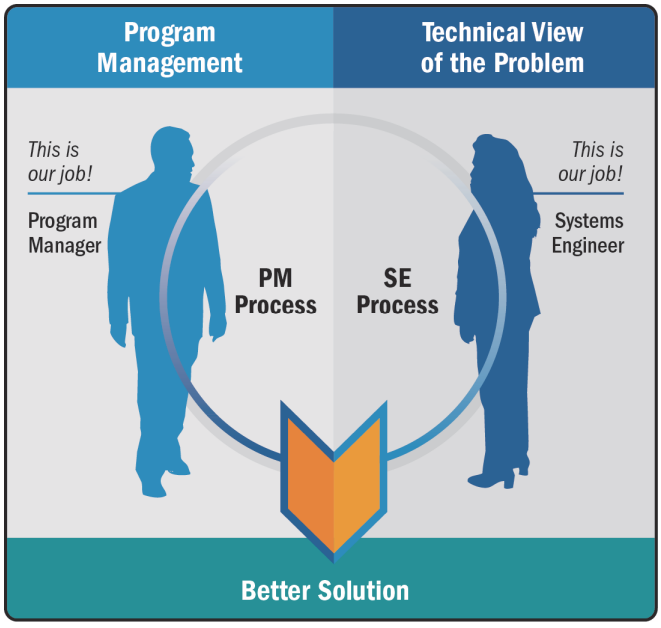

Figure 6: Better program performance through integration of program management and systems engineering.[21]

Unfortunately, in most cases, senior program leadership is trapped in a functional role mindset that often lacks the understanding (and sometimes also appreciation) of the complementary and critical skills and functions that their counterparts perform. INCOSE and PMI have published a joint statement expressing their commitment to closing this gap[21] (see Figure 6).

While the focus of the Lean Enablers presented in this document is the better integration of program management and systems engineering, we strongly recommend that the manager who, ultimately, is responsible, has authority, and is held accountable for the success of the program must have a strong understanding of both program management and systems engineering disciplines.

It is not important which path this manager followed to attain this position or what the position's title is. It is, in fact, different in programs from various companies and various industries: program leader, program manager or chief engineer, to name a few. For purposes of this guide, we will refer to the person with the ultimate responsibility, authority, and accountability (RAA) in the program as the program manager, without implying a stronger background in either program management or systems engineering.

The RAA should be supported by a team of people, from both the business as well as the technical disciplines. The leaders of business and technical operations must at least have sufficient working knowledge and appreciation for their colleagues' jobs in order to work together effectively as one unit, supporting the program. The purpose of this guide is not to prescribe any specific form of program organization, but rather to recommend the criteria that have been proven to contribute to successful programs.

[21] Langley, M., Robitaille, S. & Thomas, J. (2011). Towards a New Mindset: Bridging the Gap Between Program Management and Systems Engineering. Simultaneously published in *INCOSE Insight*, *14*(3), 4-5, and *PM Network*, *25*(9).

3.2 Overview of Program Management[22]

3.2.1 What Is a Program?

A program is a group of related projects, subprograms, and program activities managed in a coordinated way to obtain benefits not available from managing them individually. Programs comprise various components—including individual projects and work related to these component projects, such as training and operations and maintenance activities. Nonproject elements that are also part of the program include activities, such as the management effort and infrastructure needed to manage the program (e.g., program governance or program stakeholder engagement activities). Thus, programs may include elements of related work (e.g., managing the program itself) outside the scope of the discrete projects in a program.

Figure 7: The five Program Management Performance Domains.

Programs deliver benefits to organizations by generating business value, enhancing current capabilities, or developing new capabilities for the organization, customers, or stakeholders. A benefit is an outcome of actions, behaviors, products, systems, or services that provide utility to the sponsoring organization as well as to the program's intended beneficiaries or audience.

Programs are a means of achieving organizational goals and objectives, often in the context of and aligned with a strategic plan. Program benefits may be delivered incrementally throughout the duration of the program, or may be delivered all at once at the end of the program.

3.2.2 Program Management Performance Domains

Throughout its life cycle, an effective program delivers change to a variety of business processes, and does so through the actions of the program manager who works within five Program Management Performance Domains (see Figure 7). Together, these performance domains comprise the program management framework and are crucial to the success of the program:

- **Program Strategy Alignment**—Identifying opportunities and benefits that achieve the organization's strategic objectives through program implementation.
- **Program Benefits Management**—Defining, creating, maximizing, and sustaining the benefits provided by programs.
- **Program Stakeholder Engagement**—Capturing stakeholder needs and expectations, gaining and maintaining stakeholder support, and mitigating/channeling opposition.

[22] The following text reflects the description of program management contained in the review version of *The Standard for Program Management* – Third Edition (Exposure Draft Version) released in February 2012, reflecting the proposed changes to the standard for public review and comment. The final content of *The Standard for Program Management* – Third Edition, scheduled for publication in 2013, may vary from the exposure draft version of the revised standard.

- **Program Governance**—Establishing processes and procedures for maintaining proactive program management oversight and decision-making support for applicable policies and practices throughout the entire program life cycle.
- **Program Life Cycle Management**—Managing all program activities related to program definition, program benefits delivery, and program closure.

These domains are common threads that run through the life of active programs. It is within these domains that the program manager and the program team perform their tasks. The nature and the complexity of the program being implemented determines the amount of activity required in a particular domain at any particular point in time, but every program requires some activity in each of these performance domains during the active life of the program and the work within these domains is often repeated frequently.

3.2.3 Program Management Supporting Processes

Program level supporting processes enable a synergistic approach to program management for the purpose of delivering program benefits. In similar fashion to project management processes, program management supporting processes require coordination with functional groups in the organization—but in a broader context. Program management supporting processes include:

- Program Financial Management
- Program Scope Management
- Program Schedule Management
- Program Risk Management
- Program Quality Management
- Program Resource Management
- Program Communication Management
- Program Procurement Management

3.2.4 Delivering Program Benefits

Program managers focus attention on delivery of Program Benefits (see also the “value” discussion in the section on Lean thinking) and rely on the various components within the program to contribute collectively to the achievement of the program’s intended outcomes. The program manager actively engages in each of the five performance domains, applying the program management supporting processes and focusing on the outcomes of the program, assessing the contribution each of the components makes to the overall effort, and adjusting as necessary to ensure the overall program trajectory and the performance of the individual components deliver against intended benefits. Benefits Management helps ensure the benefits achieved during the conduct of the program can be sustained beyond its closure.

3.3 Overview of Systems Engineering

3.3.1 Brief History

The modern origins of systems engineering can be traced to the 1930s and the development of air defense systems. It took a more formal shape in 1954 in work by Si Ramo and Dean Woldridge on the first contract to perform systems engineering and technical assistance (SETA). Under this contract, Ramo and Wooldridge developed some of the first principles for SE and applied them to the ballistic missile program—considered one of the most successful major technology development efforts ever undertaken by the U.S. government. Systems engineering is the practical engineering realization of systems thinking—a comprehensive design process of the system that satisfies all customer stakeholder needs during an entire system life cycle.

3.3.2 Perspectives and Definitions[23]

Systems engineering has three important aspects:

- **Systems engineering is a discipline** that concentrates on the design and application of the whole (system) as distinct from the parts. It involves looking at a problem in its entirety, taking into account all the facets and all the variables and relating the social to the technical aspect.
- **Systems engineering is an iterative process** of top-down synthesis, development, and operation of a real-world system that satisfies, in a near optimal manner, the full range of requirements for the system.
- **Systems engineering is an interdisciplinary approach** and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, and then proceeding with design synthesis and system validation while considering the complete problem: operations, cost and schedule, performance, training and support, testing, manufacturing, and disposal. SE considers both the business and the technical needs of all customers with the goal of providing a quality product that meets the user needs.

The systems engineering perspective is based on **systems thinking**. Systems thinking occurs through discovery, learning, diagnosis, and dialogue that lead to sensing, modeling, and talking about the real world to better understand, define, and work with systems. Systems thinking is a unique perspective on reality—a perspective that sharpens awareness of the wholes and how the parts within those wholes interrelate. A systems thinker knows how systems fit into the larger context of day-to-day life, how they behave, and how to manage them.

Systems thinking recognizes circular causation, where a variable is both the cause and the effect of another and recognizes the primacy of interrelationships and non-linear and organic thinking—a way of thinking where the primacy of the whole is acknowledged.

The SE process has an iterative nature that supports learning and continuous improvement. As the processes unfold, systems engineers uncover the real requirements and the emergent properties of the system. Complexity can lead to unexpected and unpredictable behavior of systems; therefore, one of the objectives is to minimize undesirable consequences. This may be accomplished through the inclusion of and contributions from experts across relevant disciplines coordinated by the systems engineer.

Since SE has a horizontal orientation, including both technical and management processes, it becomes clear why an effective integration of systems engineering with program management is very important. Both processes depend upon good decision making. Decisions made early in the life cycle of a system whose consequences are not clearly understood can have enormous implications later in the life of a system. It is the task of the systems engineer to explore these issues and make critical decisions in a timely manner.

3.3.3 Systems Engineering Process Groups and Processes

Systems engineering encompasses four major process groups that are described in the INCOSE Systems Engineering Handbook and are consistent with ISO/IEC 15288:2008 (see Figure8).

[23] This and the next section are quoted and adapted from the INCOSE Systems Engineering Handbook, v. 3.2.2, October 2011, which is consistent with the ISO/IEC 15288:2008 standard.

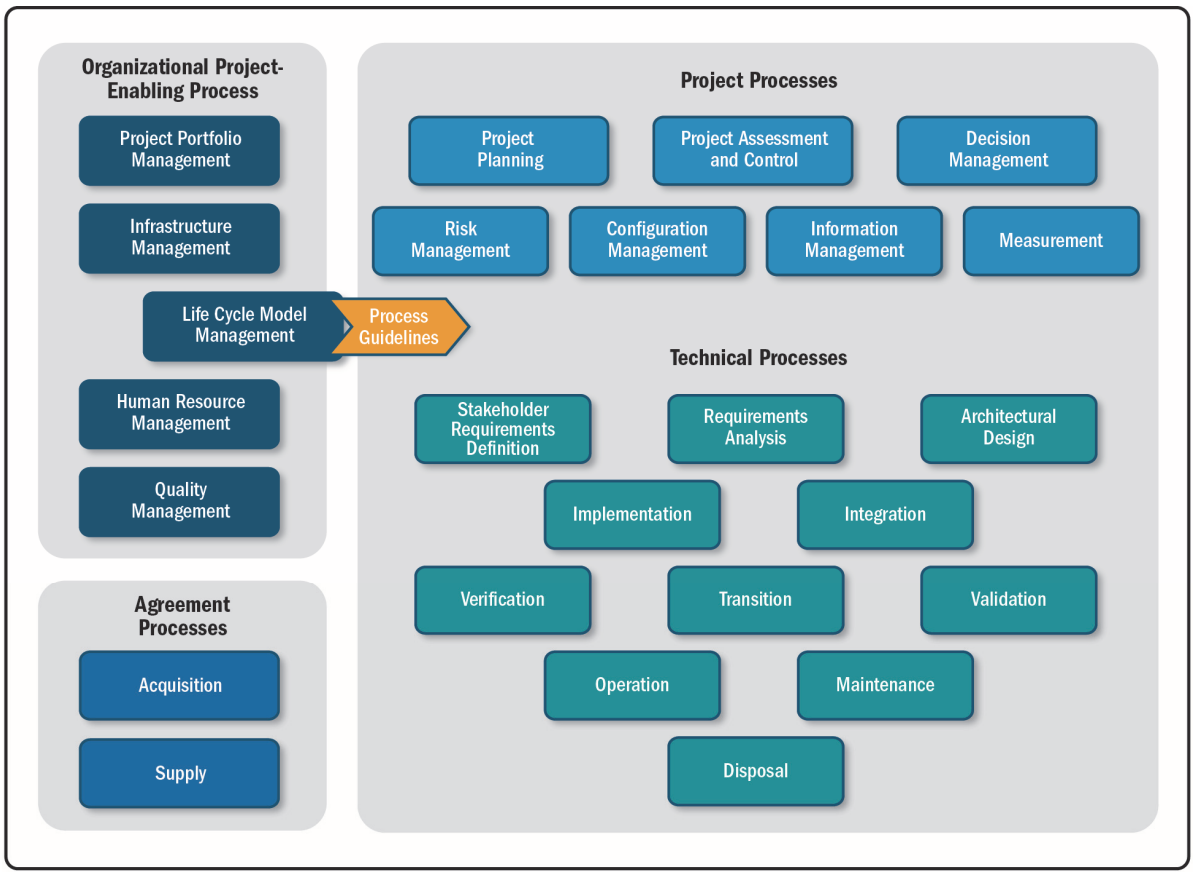

Figure 8: Overview of systems engineering process groups and processes (Source: *INCOSE SE Handbook*)

Those four process groups are briefly summarized as follows. The numbering corresponds to the numbering in the INCOSE Systems Engineering Handbook.

- **Process Group 4: Technical Processes:**

  (4.1) Stakeholder Requirements Definition Process
  (4.2) Requirements Analysis Process
  (4.3) Architectural Design Process
  (4.4) Implementation Process
  (4.5) Integration Process
  (4.6) Verification Process
  (4.7) Transition Process
  (4.8) Validation Process
  (4.9) Operation Process
  (4.10) Maintenance Process
  (4.11) Disposal Process
  (4.12) Cross-Cutting Technical Methods

- **Process Group 5: Project Processes:**

  (5.1) Project Planning Process
  (5.2) Project Assessment and Control Process
  (5.3) Decision Management Process
  (5.4) Risk Management Process

(5.5) Configuration Management Process
(5.6) Information Management Process
(5.7) Measurement Process

- **Process Group 6: Agreement Processes:**

  (6.1) Acquisition Process
  (6.2) Supply Process

- **Process Group 7: Organizational Project-Enabling Processes:**

  (7.1) Life Cycle Model Management Process
  (7.2) Infrastructure Management Process
  (7.3) Project Portfolio Management Process
  (7.4) Human Resource Management Process
  (7.5) Quality Management Process

Two additional process categories are added for the purpose of mapping the Lean Enablers to the Systems Engineering Process (see 0 for details). *All Processes (All)* lists the enablers that apply to all SE processes. *Enterprise Preparation Process (EPP)* lists the enablers that benefit all present and future programs in the enterprise or corporation and, therefore, should be implemented at the enterprise rather than at the program level, if possible.

3.4 Engineering Program Stakeholders

3.4.1 Overview and Stakeholder Groups

The Lean Enablers make frequent references to *stakeholders*. The intent of this section is to clarify how we use that term. Large-scale engineering programs are complex and so is their stakeholder base. While Lean Thinking focuses on delivering value to the customer stakeholders, there are large numbers of internal and external stakeholders who are involved in generating this value. Ultimately, the objectives and the behavior of all stakeholders must align in order for a program to be efficient and effective. This is one of the major challenges in the management of these programs. It plays a prominent role in both program management as well as systems engineering standards.

Engaging entities, organizations, and people from the initial phase of the program will directly contribute to the successful life cycle, objectives, and benefit delivery of the program. Historically, it has been imperative to identify and engage all of the respective people and organizations from the inception to the final delivery of the program.

Since stakeholder networks at the program level are much broader, and in many cases, much more complex than at the project level, architecting an effective and efficient infrastructure to communicate and collaborate with all levels of the program's interested parties is critical.

Although, there are many definitions which may vary from source to source and company to company, stakeholders are direct or indirect entities, individuals, or groups in a program who have an interest in or will be affected by the programs results. In a nutshell, program stakeholders are those entities within or outside a program and the organization that (1) sponsor the program, (2) are affected by or derive a gain from the benefits that the program delivers, or (3) have an influence on the program execution (see Table 4).

From the very start of the program, the program management team must clearly identify the stakeholders, and determine their level/span of involvement, influence, decision-making authority, activities, and roles. This also includes the stakeholder's requirements and expectations to ensure a successful program implementation and final delivery.

Table 4: Groups of program stakeholders

	Customer Stakeholders	Program Execution Stakeholders	External Stakeholders
Definition	• Sponsor the program • Are the target of the benefit from the program delivery	• Influence the program execution	• Are affected by the program without being directly targeted
Examples	• Consumer • Buyer • Evaluator • User	• Program teams and their members • Program manager • Systems engineer • Functional managers • Corporate leadership • Suppliers and contractors	• Local communities or general public • Taxpayer • Legislators • Shareholders • Natural environment

3.4.2 Aspects of Stakeholder Engagement

There are several aspects to stakeholder engagement. A few of the significant aspects are highlighted in this section. Engaging stakeholders is also a significant part of the Lean Enablers that are presented in Section 5.

- **Stakeholder Identification**: Key stakeholders should be identified from the very beginning of the program. This will include their role, decision span, requirements, expectations, and their input.
- **Stakeholder Mapping:** Relationships of the stakeholders to one another and to the program can be defined and mapped to ensure the clarity, boundary, and extent of the decision. Typical relationship maps will address the owner's organization, governmental agencies and authorities, financial and investor groups, and key external stakeholder groups.
- **Stakeholder Issue Tracking**: For each stakeholder, a clear identification of major issues of potential interest is compiled and a cross-program master issues list is constructed.
- **Stakeholder Objectives Tracking**: An initial survey of the objectives that stakeholders are trying to accomplish either by way of program or project outcome or concerns is identified initially by the program manager and refined through the stakeholder engagement process and feedback from project-level contractors.
- **Stakeholder Role Definition**: The program management team must identify the level and span of involvement of external and internal stakeholders and communicate these. The following example is the RACI structure for categorizing the level and span of involvement:
    - **R**esponsible refers to a person's span of responsibility to complete the task.
    - **A**uthority refers to the level of ownership and span of the larger decisions.
    - **A**ccountable refers to having to answer for the task completion according to expectations, including taking praise or blame for the result.
    - **C**onsulted refers to ensuring reviews of latest decisions prior to the finalization.
    - **I**nformed refers to ensuring timely communication, although no actions may be required from the person.

To plan and deliver programs successfully, program managers must maintain a comprehensive stakeholders' portfolio to manage and track all of these aspects.

3.5 Measuring Value in Engineering Programs[24]

Despite the need for accountability in publicly funded endeavors having the magnitude of engineering programs, clear definitions of *success*, *value* and *program benefits* are often neglected. It is crucial to thoroughly define the types of *value* or *benefits* which successful large-scale engineering programs provide.

The possible value propositions of programs are complex and diverse and extend beyond the classic concept of cost, schedule, and quality—the level at which projects are usually evaluated. These value propositions must also address aspects of organizational change and societal impact, which are inherent in the nature of many large-scale engineering programs.

Based on a review of academic literature on success measurement in the various disciplines represented in engineering programs, as well as a review and discussion of early frameworks within the community of practice, the following framework is proposed to describe value in engineering programs. It consists of 26 different metrics in 5 value dimensions (see Figure9). The importance of each value dimension and metric depends on the stakeholder preferences of each particular program.

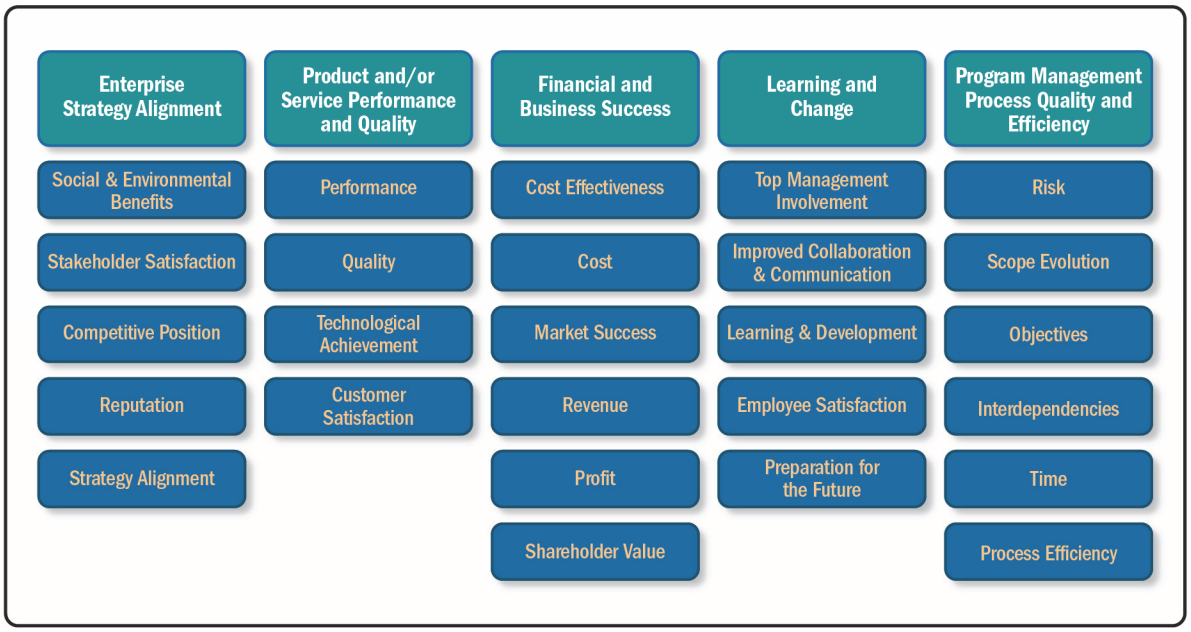

Figure 9: Value dimensions and metrics for engineering programs.

3.5.1 Enterprise Strategy Alignment

Within the dimension of Enterprise Strategy Alignment, the program is valued regarding its contribution to and alignment with the overall strategic goals of the program enterprise. These goals can vary from market-oriented goals, to image campaigns and to social and environmental benefits. They include the overall program success of benefit achievement and sustainment in terms of the design of the engineered product. The metrics associated with Enterprise Strategy Alignment are:

1. *Social and Environmental Benefits* assess the positive impact on the social and ecological environment within and around the program enterprise.

[24] This section was adapted by the original authors from: Steuber, M., & Oehmen, J. (2012). Criteria for evaluating the success of large-scale engineering programs. *Proceedings of the International Design Conference – DESIGN12*, Dubrovnik, Croatia, May 21-24, 2012.

2. *Stakeholder Satisfaction* considers the wishes and requirements of the wider set of involved persons other than the shareholders or program sponsors. It measures to what degree the different groups of stakeholders were satisfied with the result and execution of the program.
3. *Competitive Position* describes the program enterprise in its competitive environment in terms of a dominating role and the influence that the evaluated program had on improving or sustaining it, as well as any kind of competitive advantage gained through the program.
4. *Reputation* measures the influence the program had on helping to establish and maintain a specific desired image of the program enterprise to the customers but also the general public perception.
5. *Strategy Alignment* assesses the consistency of the program, its goals, and the way it is executed using the enterprise strategy.

3.5.2 Product, System and/or Service Performance and Quality

This program value dimension comprises metrics directly related to the technical (product) or delivery aspect (service) of the desired outcome and their acceptance by the customers. The metrics are:

1. *Performance* measures the technical success in terms of the compliance of the end product with the initially set performance specifications.
2. *Quality* measures the compliance of the end product with the initially set quality specifications. Furthermore, reliability and maintainability of the product in use are taken into account.
3. *Technological Achievement* assesses the inventive and innovative character of the program.
4. *Customer Satisfaction* assesses the degree to which the customers are satisfied with the end product, system and/or service developed in the program.

3.5.3 Financial and Business Success

Within the dimension of Financial and Business Success, the commercial value of the program is assessed. The following set of metrics comprises internal metrics (e.g., cost) and external metrics (e.g., market share).

1. *Cost Effectiveness* measures the profitability over time and compares it to enterprise thresholds and the initial planning.
2. *Cost* describes the total costs incurred during the program. The metric compares the actual costs against the planned costs. If applicable to the program it can be meaningful to consider costs relative to the number of units.
3. *Market Success* reflects the market acceptance of the product, system, or service. It also comprises metrics such as market share, customer loyalty, and percentage of sales by new product.
4. *Revenue* measures the total monetary sales volume of the program's end product.
5. *Profit* measures the profitability of the program as revenue in relation to costs.
6. *Shareholder Value* assesses the benefits the program achieves for the shareholders expressed through the impact the program has on the enterprise value or the stock value for market listed enterprises.

3.5.4 Learning and Change

This value dimension assesses how much the enterprise changes itself and its surrounding environment through executing the program. It investigates the individual as well as the enterprise and ultimately societal level of learning and change with the following metrics:

1. *Top Management Involvement,* as has been stated, is crucial for program success as an Enabler, but can also be seen as an indicator for success in terms of increasing the interactions, cohesion, and trust between management and lower level employees as an improved organizational asset for future programs.

2. *Improved Collaboration and Communication,* as an aspect of change within the enterprise, measures the progress that is achieved in the collaboration within and across different divisions of the program enterprise.
3. *Learning and Development* assesses the learning and skill development throughout the program enterprise. Depending on the progress, it can be measured on an individual skill level or behavior level or its impact can be measured at an organization-wide level. Learning and development also comprises the success of knowledge management activities to foster the sharing of knowledge.
4. *Employee Satisfaction* is measured through direct statement of the satisfaction level (e.g., in employee surveys) or through indirect measure such as the employee turnover rate.
5. *Preparation for the Future* measures to what extent the program contributed to make the enterprise "future-proof," by developing a crucial technology or the establishment of new improved processes that will help the enterprise in the acquisition and execution of future programs.

3.5.5 Program Management Process Quality and Efficiency

This value dimension comprises all metrics directly related to the program management process. It expresses success in terms of managing the program in a manner to ensure that the set objectives are met, while maintaining effective process efficiency and resource utilization. The five metrics in this dimension are:

1. *Risk* assesses the uncertainty of negative impacts on the objectives of the program.
2. *Scope Evolution* assesses to what extent the program objectives have changed and how well the program enterprise coped with these changes.
3. *Objectives* measure the degree to which the set objectives throughout the program management process were met.
4. *Interdependencies* assess how well interdependencies between projects within the program as well as dependencies with external programs and initiatives were managed.
5. *Time* compares the actual program length with the schedule.
6. *Process Efficiency* relates to the program management process. Efficiency measures the output related to the input, what was achieved in the program, and what amount of resources had to be utilized.

4 Top 10 Themes of Challenges in Managing Engineering Programs

The Community of Practice identified 160 program management challenges. These were prioritized based on experience from approximately 120 programs through a cross-industry survey (with emphasis on the aerospace and defense industry). The top 60 challenges are summarized in 10 major themes of challenges when managing engineering programs (see Sections 4.1 through 4.10).[25]

The list of challenges has two uses:

- These challenges served as the basis for developing the Lean Enablers—these are the problems that the Lean Enablers set out to solve. All of the Lean Enablers presented in Section 5 are mapped against one or more of the challenges. In Section A.5.1 in the Appendix, all Lean Enablers are mapped to the challenges that they address to allow for the easy identification of Enablers that help to solve a particular program management problem.
- While all challenges are described as program management issues, they can also serve as a generic risk identification checklist during the early phases of programs.

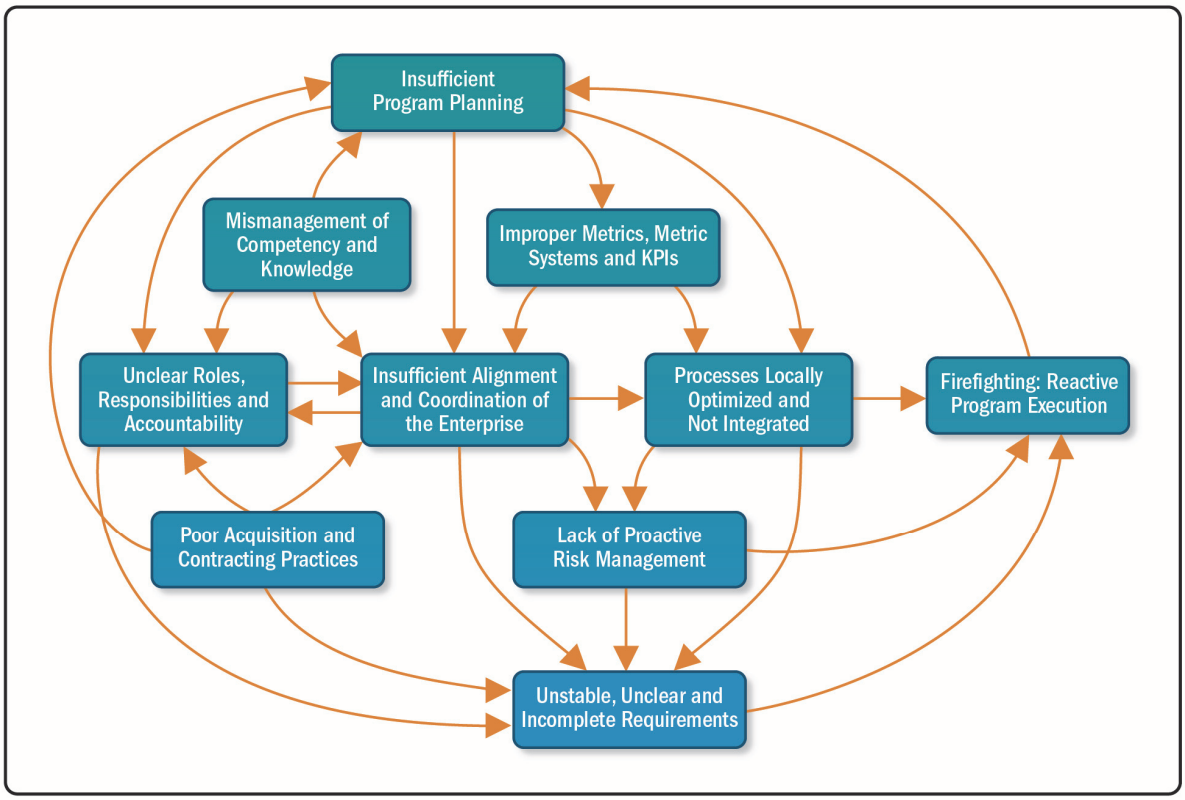

Figure10: Program management challenges influence each other in complex network.

While the group made every effort to group the challenges into well-distinguishable sets, the themes are strongly related to each other (see Figure 10). For example, the most common and significant theme—firefighting—is a significant challenge in itself, but is not the root cause itself. Directly and indirectly, all of the other challenges contribute to a program gliding off into a firefighting mode, where resources are spent fixing problems instead of eliminating their root causes (leading to more problems). Figure10 provides one example of how the challenges are related to each other. Consequently, when mapping the challenges to the Lean Enablers

[25] Some challenges are listed under more than one theme. Also, a small number of challenges were not in the top 60 list, but were included in the in the top ten list for completeness, based on discussions with the subject matter expert group.

in Section 5 and Section a.5.1, the mapping focuses on the direct link between the challenge and the enabler. Many more enablers are effective against any particular challenge when the cause-and-effect network between various challenges is considered.

The root causes of the challenges may be inside or outside of the organization. The Lean Enablers address two goals with respect to the challenges: (1) eliminating the root causes of the challenges, if they are internal to the program enterprise and can be influenced; and (2) utilizing the Lean Enablers to make the organization more responsive and effective in dealing with the symptoms and prevent cascading problems, when the root causes of the challenges are external to the program enterprise (or cannot be resolved for any other reason).

The 10 major themes of engineering program challenges and their underlying issues are presented in the following sections.

4.1 Theme 1: Firefighting—Reactive Program Execution

In this theme, the program is executed in a reactive mode toward inside and outside influences, instead of proactively managing and coordinating stakeholders, risks, and issues. This includes:

- Firefighting, where resources are focused on fixing problems instead of preventing them
- Competing resource requirements
- Unstable project priorities
- Unclear or inappropriate allocation of responsibilities and decision rights
- Insufficient management or alignment of differing priorities within collaborating organizations
- Not enough understanding of program risk
- No coherent leadership team that represents all important functions

4.2 Theme 2: Unstable, Unclear and Incomplete Requirements

Changing, unclear, and incomplete requirements from customers and other stakeholders seriously affect the efficient and effective execution of the program. Examples of the issues include:

- Incomplete understanding of stakeholder requirements
- Lack of appreciation for the complexity of the requirements; derived requirements are not identified
- Unstable program priorities
- Stakeholders are unable to clearly articulate their requirements
- Erroneous understanding of stakeholder requirements
- Insufficient propagation of changes to cost, schedule, and performance baselines throughout the program
- Requirements are not formulated properly (e.g., solution-neutral)
- Insufficient adaptation of cost, schedule, and performance baselines to the changing program environment and assumptions
- Compliance requirements (e.g., internal requirements, standards, regulations, and laws) for different stakeholders are independent of each other, not integrated, and possibly conflict with one another, which leads to increased workload, mismatch between requirements, and prevention of efficient fulfillment for similar requirements
- Unclear understanding of stakeholders' perceptions of value
- No learning from previous need definitions
- Request for proposal is issued by customer too early

4.3 Theme 3: Insufficient Alignment and Coordination of the Extended Enterprise

The complex network of organizations and departments involved in delivering the program value is not aligned to its priorities. This includes the alignment and optimization of strategic priorities and portfolios. Examples are:

- Competing resource requirements
- Insufficient management and alignment of differing priorities within collaborating organizations and with stakeholders
- Unclear priorities between immediate business goals (e.g., profitability of current program) and responsibility for other programs (e.g., capturing lessons learned, driving continuous improvement)
- Unstructured or unplanned stakeholder communication
- Differing understanding and unclear understanding of what "program enterprise" comprises
- Insufficient stakeholder integration (in particular customers and suppliers)

4.4 Theme 4: Locally Optimized Processes that are not Integrated Across the Entire Enterprise

In this theme, these processes only are locally optimized. There is a lack of visibility for the value stream, and/or barriers between organizational units to implement a seamless flow. There are insufficient trade-offs between organizations to reach an overall optimum. Example issues are:

- Lack of enterprise-wide coordination of optimization; only optimization of local processes and organization
- Lack of process standardization
- Pertaining to value stream optimization, there is a lack of understanding as to how to deal with different types of waste
- Lacks mechanism for value stream improvements

4.5 Theme 5: Unclear Roles, Responsibilities, and Accountability

The roles, responsibilities, and accountability of individuals, teams, projects, staff functions, and line functions are not clearly defined in this theme. This includes issues such as:

- Problematic allocation of responsibilities and decision rights
- Lack of alignment and integration between program management and systems engineering
- No fostering and maintaining of personal accountability for plans and outcomes
- No coherent leadership team that represents all important functions
- Roles and responsibilities between staff and line functions not defined
- Misaligned incentives for collaboration between staff, project team, suppliers, customers, or other stakeholders

4.6 Theme 6: Mismanagement of Program Culture, Team Competency, and Knowledge

In this theme, the expertise and knowledge of individuals, teams, and the organization are insufficient, not transferred properly, or not applied appropriately during the program. It is difficult to establish a productive program culture. Examples of issues are:

- Ineffective process to transfer knowledge from experienced employees and team members to new employees (in particular, this occurs in industries with aging workforce)
- Lack of feedback mechanisms to turn lessons learned into action; no implementation of new best practices in program based on lessons learned
- No adequate sharing of captured lessons learned across the enterprise
- Inadequate identification of individual skill development needs
- No documentation of lessons learned
- Inadequate team experience

- Skill level of individuals (in program management, the program team, project teams and/or staff) insufficient

4.7 Theme 7: Insufficient Program Planning

In this theme, the program planning may be inaccurate, unable to accommodate uncertainties, or both, which leads to unrealistic expectations and plans. This includes the following issues:

- Unrealistic baselines for cost, schedule, and performance
- Insufficient propagation of changes to cost, schedule, and performance baselines throughout the program
- Insufficient adaptation of cost, schedule, and performance baselines to the changing program environment and assumptions
- No realistic program schedule
- Problems with managing appropriate staff levels during project ramp-up and ramp-down
- Estimates do not reflect all aspects of the life cycle
- Insufficient probabilistic estimates
- Too few updates on estimated cost, schedule, and performance estimates during early phases of program contracting and execution

4.8 Theme 8: Improper Metrics, Metric Systems, and KPIs

The metrics and KPIs used during the program do not capture the intended performance attributes, incentivize the wrong behavior, or are lagging instead of predictive. This includes:

- Metrics are “rear-view-mirror” oriented and are not good indicators of future issues
- Metrics do not consider human behavior (gaming)
- No metrics to reflect cross-functional processes
- Diverse and distributed information technology systems and data repositories do not allow efficient acquisition and aggregation of data for metrics
- Insufficient oversight of adherence to cost/schedule/performance baselines
- Metrics have short-term focus

4.9 Theme 9: Lack of Proactive Program Risk Management

Budgetary and time constraints force limited or no risk management activity to be undertaken by the program team. The program team attempts to function without clear off-ramps and mitigation approaches. Ownership of risks is ill-defined. The issues include:

- Insufficient involvement of necessary functional and staff professionals in risk management
- Not enough understanding of program risks
- Insufficient resources and funding of risk management activities (identification, assessment, mitigation, and monitoring)
- Neglect for the human aspect of risk management, that is, culture or incentives that penalize the flagging of risks, or reporting of bad news.
- Disconnect between risk management and other program management processes
- Insufficient focus on quickly resolving identified risks

4.10 Theme 10: Poor Program Acquisition and Contracting Practices

Time constraints force inadequate quality of the request for proposal or contract bid. Improper incentives, improper management of low-TRL-technologies, insufficient leadership and interference of laws and regulations all exacerbate this challenge. Examples include:

- Request for proposal is issued by the customer too early, before customer requirements have sufficient clarity and stability
- Overriding influence of funding-related constraints
- Constraints and incentives provided by the contract are misaligned with program task and risk profile
- No adequate process to mature technologies for programs (performance and system integration properties)
- Disconnect between operational program management and contract requirements

5. The Lean Enablers for Managing Engineering Programs

This section contains the Lean Enablers for Managing Engineering Programs, sorted by the six Lean Principles. To emphasize the importance of Lean Principle 6, Treat People as Your Most Important Asset, the Enablers in this category are listed first, followed by the Enablers for the Lean Principles 1-5. Table 6 presents an overview of the 43 Enablers. The appendix (Section a.4) contains a simplified version of this section (a simple list of all Enablers and Subenablers).

Each subsection covers one of the 6 Lean Principles, for example, Section 5.1 on *1. Lean Enablers 1.x: Treat People as Your Most Important Asset (Lean Principle 6)* contains a number of Enablers (e.g., *1.1 Build a program culture based on respect for people*):

- Each Enabler is introduced by a **number of examples** that are drawn from various sources, such as documentation of highly successful programs as published by PMI, and examples from the experience of the subject matter experts and from the Lean Management literature. The examples are not meant to be complete or even representative of ways to implement the Lean Enablers, but are snapshots of what other programs have accomplished. Whenever possible, concrete company and/or program names are given, but due to confidentiality restrictions, this was not always possible. Section A.3 in the Appendix contains a detailed list of the source material and example programs.
- Additionally, each Enabler contains a number of subenablers that give concrete recommendations on how to implement the enabler (e.g., *1.1.1. Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.*).

Table 5: Example Table Used to Indicate Mapping of Lean Enablers and Subenablers in Three Categories

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

To help understand the context and applicability of each enabler and subenabler, they are mapped along three dimensions (see Table 5 for an example):

- **Program Management Performance Domain:** For each enabler and subenabler, the table indicates the domain to which the enabler has the strongest relationship. The five domains are: Program Strategy Alignment, Program Benefits Management, Program Stakeholder Engagement, Program Governance, and Program Life Cycle Management. In addition, Section A.5.2 in the Appendix contains all Lean Enablers categorized by their Program Management Performance Domain. See Section 3.2 for an overview of the performance domains.
- **Engineering Program Challenges:** Each enabler and subenabler is also mapped against one or two challenges that it addresses directly. All of the challenges are related to one other, as are the Lean Enablers. The mapping captures only the strongest, most direct links between an Enabler and the challenges. Indirectly, all Enablers help to overcome all of the challenges (also see the discussion in the introduction to Section 4). In the Appendix, the Lean Enablers are sorted by the challenges that they address (see Section A.5.1).
- **Systems Engineering Process:** The table also provides a quick overview of the high-level Systems Engineering process that is supported by this guide, followed by an exact process number. The appendix

contains the Lean Enablers, sorted by both the Systems Engineering process (Section A.5.3), as well as a complete mapping to the Lean Enablers for Systems Engineering (Section A.5.4).

The mapping at the Enabler level (i.e., the main category for all of the subenablers) is not necessarily consistent with the mapping of each subenabler. The mapping indicates the areas where most of the subenablers would fall. The Lean Principles presented in this section are listed by order of importance and not by sequential numbering, to emphasize their importance.

Table 6: Overview of Lean Enablers

5.1 Lean Enablers 1.x: Treat People as Your Most Important Asset (Lean Principle 6)

This section summarizes all of the best practices that operationalize Lean Principle 6, *Respect the people in your program*. We decided to present these Enablers not as the last section, as would be appropriate if we followed the numbering of the Lean Principles, but as the first, to emphasize its importance.

1. Lean Enablers to Treat People as Your Most Important Asset (Lean Principle 6)

1.1 Build a program culture based on respect for people.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

A major aerospace company business unit established respect for people as one of its core strategies. Program reviews and functional reviews now include reports on development, wellness, openness, and recognition. The expectation set by senior leadership has begun to affect program culture by establishing a trust-based communication environment and development plans that ensure that the employees and the programs possess the required skill set for current and future success.

The Prairie Waters program reports a culture of "what's right" and not "who's right," emphasizing the fact that everybody's ideas are heard and treated equally, regardless of their position in the organization.

In the Fernald Feed Materials Production Center Nuclear Cleanup, as well as the Rocky Flats program, the employees who were previously running the nuclear facility are now involved in its closing. In this case, respect for people was expressed in the management's empathy for the workers' situation and its support for finding new jobs.

The Mozal Smelter program based in Mozambique, faced challenges of a different kind—HIV infections. To address this challenge, the program management The Lean Principles presented in this section are listed by order of importance and not by sequential numbering, to emphasize their importance provided courses in sexual education and disease prevention.

Subenablers:

1.1.1 Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.1.2 Invest in people selection and development to address enterprise and program excellence. Ensure that hiring process matches the real needs of the program for talent and skill.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

1.1.3 Program leadership must be a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation and drive for excellence.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.1.4 Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:7.4*		

1.1.5 Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:7.4*		

1.1.6 Practice "walk around management." Do not manage from cubicle; go to the work and see for yourself.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.1.7 Build a culture of mutual trust and support (there is no shame in asking for help).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.1.8 Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:6.2*		

1.1.9 When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:5.1*		

1.1.10 When resolving issues, attack the problem, not the people.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.2 Motivate by making the higher purpose of the program and program elements transparent.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

In the Pentagon reconstruction program (Project Phoenix), extensive damage to the Pentagon that resulted from the 9/11 attack was repaired in only one year because all of the parties involved in the reconstruction effort were motivated to demonstrate America's strength and resistance to terrorism. Contracts were placed in a small fraction of the time normally required and construction productivity exceeded expectations.

The Mozal Smelter provided an entirely new dimension of industrial development to the region in Mozambique. Therefore, the higher benefit was ever present and the program management set up a project to ensure a good integration in the environment. This included agricultural development because building the plant required the resettlement of farmers from the construction site.

In the Montreal development program, Quartier International de Montreal, the sense of striving for a higher purpose was strongly present. Developing a sustainable neighborhood for future generations proved to be an effective motivator.

Other programs appealed to the individual pride of employees for being part of something exceptional. The Salt Lake City Winter Olympics recruited volunteers by presenting their involvement as a once-in-a-lifetime opportunity.

Subenablers:

1.2.1 Create a shared vision which draws out and inspires the best in people.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.2.2 Ensure everyone can see how their own contributions contribute to the success of the program vision.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.3 Support an autonomous working style.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

The U.S. Coast Guard Deepwater program provided its contractor with a great deal of freedom. The program was intended to renew the Coast Guard assets. Instead of ordering explicit numbers of each type of equipment, the Coast Guard required a set of capabilities for its future fleet. It was up to the system integrator contractor to decide what equipment was necessary to provide these capabilities.

A similar approach was used for the Fernald Feed Nuclear Cleanup program in Butler County, Ohio. The main contractor was given freedom to execute the program within the guidelines of the agreed-upon requirements.

Subenablers:

1.3.1 Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

1.3.2 Eliminate fear from the work environment. Promote conflict resolution at the lowest level.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.3.3 Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.3.4 Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto "rather ask for forgiveness than permission."

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.3.5 Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.4 Expect and support people as they strive for professional excellence and promote their careers.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

Examples:

To staff a contract designed to support a Program Management Office (PMO) at the Center for Disease Control and Prevention (CDC), a recognized government contracting organization hired a skilled project manager who had earned a PhD in epidemiology. The work in the PMO focused this manager's attention on detailed analysis and reporting and portfolio management efforts that spanned many of CDC's Centers, Institutes and Offices, but did not tap the project manager's knowledge and skill as an epidemiologist. Fearing that her background in epidemiology would go unused for an extended period, she was encouraged to speak with the leaders of the internal "university"—the education and training group within the consulting organization. From that initial contact, this project manager designed, developed, and delivered a six-week class in epidemiology that has become one of the most "in-demand" classes held within the company. The class had a standing waiting list of more than 20 for each of the six-week sessions. She has now reached a number of her colleagues who also work on CDC contracts through their participation in the class, providing insight that ultimately improves their understanding of their own work and subsequently their performance on the job. From this, she has received numerous commendations from the organization's executive leadership, has been recognized and published in the organization's internal news publication, holds a position as co-lead of an epidemiology practice area within the organization, and is now a recognized company-wide expert in epidemiology.

The Prairie Waters program reports how they fostered professional excellence regarding behavior. Not only did they clearly communicate what behavior was expected, but they asked their management to serve as role models for these behavioral characteristics.

Rockwell Collins University was created to help enhance career development opportunities at the company. Rockwell Collins University is organized into eight schools that align to core business functions. Each school has a school owner, school lead, and a school planning team to prioritize new course development and course offerings. Learning and Development supports each School within Rockwell Collins University as a learning subject matter expert. Learning and Development provides a learning infrastructure to manage and promote employee career development in their current and/or future role development associated with performance reviews. Learning and Development partners with the Rockwell

Collins University school planning teams to develop and deploy learning solutions that support and drive business goals and objectives.

The sense of striving for professional excellence at Toyota is considered fundamental for achieving high-performance processes. Toyota managers are trained to be mentors and view every engineering project and program as an opportunity for developing its engineers. New engineers are paired with a mentor. They are assigned an improvement project (freshman project), which is small but technically challenging. During the project, they learn the "Toyota way" of engineering.

The 14-X research and development program of the Brazilian Air Force, targeted at developing a new hypersonic vehicle, took a novel approach at mentoring young and new experts, engineers, and scientists in the program. They were actively supported in identifying research areas within the scope of the program that had a high personal relevance to them in the pursuit of their long-term career goals. This generated a new level of commitment throughout the technical and scientific community of the program and furthered the program goals as well as everyone's personal aspirations.

Subenablers:

1.4.1 Establish and support Communities of Practice.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

1.4.2 Invest in workforce development.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.4.3 Ensure tailored Lean training for all employees.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.4.4 Give leaders at all levels in-depth Lean training.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.4.5 Promote and honor professional meritocracy.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.4.6 Establish a highly experienced core group (grayhairs) that leads by example and institutionalizes positive behavior.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.4.7 Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.5 Promote the ability to rapidly learn and continuously improve

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

As part of its IT Service Management (ITSM) improvement program, a major financial institution established special initiatives to facilitate the effective transfer of tacit knowledge between program and operations teams so that processes previously requiring skilled employees could be automated for greater efficiency. Joint problem-solving sessions, case study based workshops and learning by observation have been used as main primary techniques for knowledge gathering.

The Haradh and Hawiyah Gas Plant programs reported that in their programs, younger employees were trained on the job through extensive mentoring by more experienced colleagues. They furthermore ensured knowledge transfer on a wider scale by continuously sharing lessons learned between project teams.

In the Trojan Reactor program, shortcomings in the skillsets of the team were initially identified, and customized training on these topics was offered.

The program management of the Quartier International de Montreal program devised a unique project execution approach. They divided the workload into smaller packages and used some of them as pilots for testing management techniques and contract awards. If proven successful, these would be rolled out on a wider scale; if not, management would adjust and test a different technique in the next pilot.

Subenablers:

1.5.1 Promote and reward continuous learning through education and experiential learning.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

1.5.2 Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.5.3 Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.5.4 Capture and share tacit knowledge to stabilize the program when team members change.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

1.5.5 Develop standards paying attention to human factors, including level of experience and perception abilities.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

1.5.6 Immediately organize quick training in any new standard to ensure buy-in and awareness.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.6 Encourage personal networks and interactions

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

The Newmont TS Power Plant program held informal dinner meetings off-site with the program management of all companies involved in the program. These meetings supported the sharing of concerns and thoughts about the program in a more comfortable environment.

The Dallas Cowboys Stadium program followed a similar approach. They occasionally organized informal gatherings for lunch or larger celebrations to motivate employees and increase team bonding.

Rockwell Collins supports networks and interactions through a Knowledge Management strategy. The KM vision is “Accelerate Knowledge. Create Value.” Goals include connecting people to people, building a global and inclusive knowledge-sharing environment, making knowledge integrated, simple, relevant, and flexible, and creating, capturing, using, and re-using knowledge.

Subenablers:

1.6.1 Prefer physical team colocation to the virtual colocation.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

1.6.2 For virtually colocated teams, invest time and money up-front to build personal relationship in face-to-face settings.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

1.6.3 Promote direct human communication to build personal relationships.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.6.4 Engage in boundary spanning activities across organizations in the enterprise (e.g. value stream mapping).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

1.6.5 Engage and sustain extensive stakeholder interactions.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.6.6 Support the development of informal and social networks within the program and to key stakeholders in the program environment.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.6.7 Encourage (and document when appropriate) open information sharing within the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

1.6.8 Program manager must have respect and personal relationship with all four main stakeholder groups: customers, superiors, program employees and key contractors/suppliers.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

5.2 Lean Enablers 2.x: Maximize Program Value (Lean Principle 1)

2. Lean Enablers to Maximize Program Value (Lean Principle 1)

2.1 Establish the value and benefit of the program to the stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	**Benefits Management**	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

Examples:

The specific research benefits that each of the major stakeholders in the U.S. Department of Energy's multi-billion dollar National Ignition Facility would receive was formally defined in a multilaboratory agreement at the program initiation. This initial agreement allowed each stakeholder to better oversee the evolving design and to more clearly define their needs prior to the start of detailed design and construction.

For the Deepwater program, it is reported that, initially, the value to the Coast Guard was defined according to three overarching goals: (1) maximize operational effectiveness, (2) minimize total cost of ownership, and (3) ensure customer satisfaction, which includes the operational commanders, aircraft pilots, cutter crews, maintenance personnel, and other users.

Similarly the Prairie Waters program defined 11 outcomes in the very early stage, defining the value of the program.

Across a dozen U.S. Department and Agency IT programs it was found that the stakeholders invariably agreed on the program overarching goal. But each stakeholder had a different detailed definition of success that was closely aligned with their organizational mission (performance for the operational user, net-ready key performance parameters for offices responsible for interoperability, maintenance for logistics centers, and policy and process compliance for acquisition authorities). Each stakeholder tried to move the program closer to its definition of success by bringing to bear their influences and resources (end-user legitimacy, funding). Successful programs viewed themselves as embedded in a supply web of conflicting forces in which they continuously managed and balanced the needs and expectations of the different stakeholders. Less successful programs saw themselves as middlemen in a one-dimensional supply chain (goods and services in one direction, compensation in the other) with the other stakeholders being distractions or impediments to the supply chain.

Subenablers:

2.1.1 Define value as the outcome of an activity that satisfies at least three conditions:

a. The external customer stakeholders are willing to pay for value.

b. Transforms information or material or reduces uncertainty.

c. Provides specified program benefits right the first time.

Performance Domain:	Governance	**Strategy Alignment**	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.1.2 Define value-added in terms of value to the customer stakeholders and their needs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.1.3 Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.1.4 Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.1.5 Explain customer stakeholder culture to Program employees, i.e. the value system, approach, attitude, expectations, and issues.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.2 Focus all program activities on the benefits that the program intends to deliver.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

The Prairie Waters program had 11 very clearly defined benefits it aimed to achieve. The core program was solely focused on these outcomes. All additional activities had to undergo review and approval. This practice ensured that the team did not get carried away with side projects that did not add value.

A project in a large semiconductor device manufacturer in the communications sector was continuously stressed regarding resources and, as a result, was one of the lower-performing projects in a wireless network processor development program. To define the project's role in obtaining the program benefit targets, the program manager clearly communicated the linkage between the project's schedule performance with its effect on program performance. The behavior of the project team towards innovative recovery of the project was renewed. The result was a significant improvement in schedule, reduction of risk, and a doubling of program revenue contribution related to that project.

Subenablers:

2.2.1 All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.2.2 Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	**Benefits Management**	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.2.3 Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	**Benefits Management**	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.3 Frequently engage the stakeholders throughout the program life cycle.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

Examples:

Having a difficult standing in the surrounding population, the Fernald Feed Nuclear Cleanup program, through extensive communication efforts, managed to calm the community. The community was not only worried about the handling of radioactive material, but also the loss of jobs due to the plant closure. The program included holding public meetings and establishing a citizen's advisory board to give locals a voice in the cleanup process.

An "Obeya room" is constantly used at Ford Motor for sharing information about the current and future state of a program during its life cycle. The information on the walls is highly visual, making it possible for anyone that walks in to understand the status of the program. The Ford CEO has stated that he prefers visiting the Obeya room more than reviewing mind-numbing slide decks and reports.

A U.S. government program delivered a collection of software components to perform sophisticated planning, execution, and assessment of operations. Because the end users had a compelling and immediate operational need, the program office saw its job as twofold: interact with the users to ensure satisfaction and diminish the effects of other stakeholders' pull on resources. The former was achieved by allocating a large fraction of program office resources to engage with end users. The latter was achieved by interacting with the other stakeholders so they understood the pressing need enough to get them vested in the end-user outcome. In this way, the success of the end-user outcome became more likely.

During the planning for a complex program that would bring together three separately developed components of what would ultimately become an integrated Management Information Systems (MIS) platform for a government agency, the program manager carefully planned stakeholder communications. As part of the stakeholder engagement plan, the program manager established information/action meetings specifically designed the meet the needs of different stakeholder groups. During program planning stages, there were weekly steering committee meetings for the program's sponsors; for executive management, monthly progress updates and demonstrations; and for executive staff, finance, and operations, bi-weekly governance meetings that ensured proper policies and practice were in place and being followed for the program. While these stakeholders were engaged and actively participating in the work, the program was seen as successful, moving forward and was hailed as an example of a properly managed program effort. When (some)

stakeholders were unable to participate regularly, although the program team's activity remained constant, program progress slowed and the perception of the quality and completeness of the work was questioned. When the absent stakeholders were re-engaged, the program was again seen in a positive light—proving to the program manager and team the importance and need for active stakeholder engagement for the initiative.

Subenablers:

2.3.1 Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

2.3.2 Establish frequent and effective interaction with internal and external stakeholders.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

2.3.3 Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

2.3.4 Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.3.5 Structure communication among stakeholders (who, how often, and what).

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.3.6 Create shared understanding of program content, goals, status, and challenges among key stakeholders.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.3.7 Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

2.3.8 Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

2.3.9 Listen to the stakeholders' comments and concerns patiently and value their views and inputs.

Performance Domain:	Governance	**Strategy Alignment**	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

2.3.10 Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.3.11 Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

2.4 Develop high-quality program requirements among customer stakeholders before bidding and execution process begins.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	**6: Agreement Processes**	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

Examples:

The Haradh Gas Plant program set ambitious schedule goals. To facilitate meeting these goals, critical equipment such as the control system was procured during the frontend engineering phase. To ensure compatibility with the suppliers' work, procurement of these parts was completed before the bidding process, and the resulting requirements regarding compatibility were included in the bidding documents.

Another program—Fernald Feed Nuclear Cleanup—was bound to federal regulations. Since the cleanup had to be done according to the acceptable level of contamination set by the U.S. Environmental Protection Agency, the end state was well known. Hence, the requirements in the contract were very concrete and tight.

Subenablers:

2.4.1 Assure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need; stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.2 Use only highly experienced people and expert institutions to write program requirements, RFPs and contracts.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.3 If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.4 Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, mindless "cut-and-paste" of requirements from previous programs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.5 Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.6 Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.7 Require personal and institutional accountability of the reviewers of requirements until the program success is demonstrated.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.8 Always clearly link requirements to specific customer stakeholder needs and trace requirements from this top level to bottom level.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.9 Peer review requirements among stakeholders to ensure consensus validity and absence of conflicts.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.10 Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.11 Clearly articulate the top-level objectives, value, program benefits and functional requirements before formal requirements or a request for proposal is issued.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.4.12 Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.5 Clarify, derive, and prioritize requirements early, often, and proactively.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

The Haradh Gas Plant program reports how early scope definition and a meticulous management of changes led to a low change order rate of less than 2% that ultimately helped controlling costs.

Several software development companies create the feature breakdown structure (FBS) to describe the product architecture. FBS serves as an instrument of communication between consumers and the development team and also identifies a "reservation" of features in which the iteration plan will be developed.

Subenablers:

2.5.1 Develop an Agile process to anticipate, accommodate, and communicate changing customer requirements.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

2.5.2 Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items, and do not allow requirements creep.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

2.5.3 Use architectural methods and modeling to create a standard program system representation (3D integrated CAE toolset, mockups, prototypes, models, simulations, and software design tools) that allow interactions with customers and other stakeholders as the best means of drawing out requirements.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

2.5.4 Listen for and capture unspoken customer requirements.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.5.5 To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

2.5.6 Actively promote the maturation of stakeholder requirements, e.g., by providing detailed trade-off studies, feasibility studies and virtual prototypes.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.5.7 Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.5.8 Create effective channels for clarification of requirements (e.g., involving customer stakeholders in program teams).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4,1*		

2.5.9 Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models, or spiral development).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

2.5.10 Employ Agile methods to manage necessary requirements change, and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable[26].

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

2.6 Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

Examples:

A major aerospace company business unit established a formal program to reduce the administrative burden on first line leaders (which also supports its "respect for people" strategy). The program includes training on workflow management for workgroups, efficient and effective e-mail management, meeting management, people development, and problem solving tools.

[26] See Section 6.1 for a detailed discussion of Agile Development and its relationship to Lean Thinking and the Lean Enablers.

The Deepwater program used a formal, fairly bureaucratic process for approvals of revisions to the program's overall baseline with decisions made on the Coast Guard Vice Commandant level. However, for lower-level decisions, this process was bypassed and decisions were made at the program level.

Subenablers:

2.6.1 Strive to minimize and streamline the burden of paperwork for external stakeholders by actively engaging them in the process and clearly articulating and aligning the benefit generated by each report.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

2.6.2 Minimize and streamline the program-internal reporting for program activities and subprojects by optimizing the internal reporting requirements. Only require reports that are clearly necessary and align reporting requirements to reduce redundant reporting.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 8.1*		

2.6.3 Ensure all review and approval steps are truly needed and value-adding in the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 8.1*		

5.3 Lean Enablers 3.x: Optimize the Value Stream (Lean Principle 2)

3. Lean Enablers to Optimize the Value Stream (Lean Principle 2)

3.1 Map the management and engineering value streams and eliminate non-value-added elements.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

A large aerospace company effectively used program startup integration events with the program team to develop high-level value stream maps of the program. These events ensured concurrence from all program leaders on the value proposition to the customer, the precedence of major value-adding tasks aligned with the customer milestones, responsibility/accountability/authority for each major task, and revelation of knowledge gaps, issues, and areas of uncertainty that needed to be resolved.

During a process called chartering, the Prairie Waters program team developed a delivery or value stream map, exploring the path to achieving the program goals. Within that system, each workflow was broken down on a process level assigning responsibilities, defining the format of the task output, and assessing the time available for completion.

Subenablers:

3.1.1 Plan to develop only what needs to be developed.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	**Benefits Management**	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.1.2 Promote reuse and sharing of program assets. Utilize standards, standard processes, modules of knowledge, technical standardization and platforms, and software libraries.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	**7: Project-Enabling Processes**	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.3*		

3.1.3 Have cross functional stakeholders and program leadership work together to build the agreed value stream.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	**Benefits Management**	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.1.4 Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	**8: Tailoring Processes**	Enterprise Preparation	All Processes	*Process: 8.1*		

3.2 Actively architect and manage the program enterprise to optimize its performance as a system.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

Examples:

The Coast Guard in the Deepwater program chose a system-of-systems acquisition strategy. Instead of replacing older equipment with new in a series of individual acquisitions, the older assets were replaced in a single program by an integrated set of modern equipment. For that purpose, the Coast Guard awarded a contract for providing capabilities—not concrete assets—to a systems integrator. The systems integrator had the freedom to translate the required capabilities to the asset level while striving for three overarching goals: (1) maximize operational effectiveness, (2) minimize total cost of ownership, and (3) ensure customer satisfaction.

An organization within a federal agency initiated a project to coordinate analysis and testing at laboratory facilities located across the United States. To improve the overall accuracy and timeliness of information reported by the laboratories, the project was focused on the standardization of coding and information management techniques used to record and analyze samples tested at all locations. The project was a success, though the organization found it difficult to sustain the improvements across the network of laboratories. Local policies and personnel turnover affected the work at each laboratory and caused the coordination of practice as well as the accuracy and timeliness of reported information to deteriorate. To address this problem, the organization looked into root causes and determined that a number of activities

related to communications among the laboratories—policy monitoring, compliance, and decision making—were contributors. To correct these issues and to focus new attention on improving and sustaining improvements for many laboratory functions, the organization repositioned the initiative within the organization and expanded its scope to become a program. This expanded program-centered approach includes project and nonproject activities, such as: (1) specialized projects targeted at activities within the laboratories, (2) communications efforts to support alignment among the laboratories, (3) a governance process that supports coordinated decision making, and (4) a benefits management plan that ensures activities are in place for monitoring benefits, managing efforts to achieve them, planning transition activities to sustain them, and a review process to refocus specific efforts based on environmental changes. The program enables the organization to view all activities affecting the laboratories as a coordinated "whole" and is viewed as a model for similar action across the organization.

Subenablers:

3.2.1 Keep activities during early program phases internal and colocated, as there is a high need for coordination.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.2.2 Set up a single, colocated organization to handle the entire systems engineering and architecting for the entire effort throughout the life cycle, in order to increase RAA.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.2.3 Ensure that systems engineering and architecting are a central part of program management and not outsourced or subcontracted, as these activities require a high level of coordination.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.2.4 Develop a clear vision and holistic view of the future state of your program enterprise, including future portfolio of products, including both the future organization as well as the future value stream. Provide guidance on a clear path forward and ensure that resources are aligned with this vision.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.3*		

3.2.5 Use a clear architectural description of the agreed solution to plan coherent program, engineering, and commercial structures.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

3.2.6 Change the program "mindset" to focus on the entire program enterprise and the value it delivers to customer stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.2.7 Lead and sustain the transformation to an integrated program management and systems engineering enterprise across customer and supplier organizations.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

3.2.8 Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:4.3*		

3.3 Pursue multiple-solution sets in parallel.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:4.3*		

Examples:

A few programs report that they pursued multiple solution sets in parallel. For example, the Prairie Waters program evaluated 50 alternative approaches in parallel, narrowing them down according to a set of criteria such as delivery schedule, cost, ability to receive approval for federal and state permits, community support, and ability to implement criteria.

The Dallas Cowboys Stadium considered various sites for the stadium before agreeing on the final location. Also, the design continuously evolved from a set of alternatives that were narrowed down stepwise according to budget and schedule impacts.

This enabler also aligns with analyses of alternatives (AoA) to identify the most promising way of satisfying its mission needs, which was started over a decade ago by the U.S. Department of Defense. Early AoA typically compared only life cycle costs, but the process was quickly expanded to include multiple measures of effectiveness and became a common element of Department of Defense's acquisition system.

Subenablers:

3.3.1 Plan to utilize cross-functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.3.2 Explore the trade space and margins fully before focusing on a point decision and too small margins.

Performance Domain:	Governance	**Strategy Alignment**	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.3.3 For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of set-based concurrent engineering.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.3.4 Explore multiple concepts, architectures, and designs early.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.3*		

3.3.5 Explore constraints and perform real trades before converging on a point design.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.4*		

3.3.6 All other things being equal, select the simplest solution.[27]

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	**4: Technical Processes**	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.4*		

3.4 Ensure up-front that capabilities exist to deliver program requirements.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	**6: Agreement Processes**	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

Examples:

In an initiative to improve the organizational project management maturity of its businesses, a U.S. division of Siemens Industry utilized Managing Successful Programmes (MSP) to define a blueprint of future-state capabilities needed to deliver the program vision and benefits. Organizational project management maturity assessments were used to help define the gaps between the current and desired future-state capabilities.

[27] Einstein said: "Any intelligent fool can make things bigger, more complex, and more violent. It takes a touch of genius—and a lot of courage—to move in the opposite direction."

Subenablers:

3.4.1 Ensure strong corporate, institutional, and personal accountability and personal penalties for "low-balling" the budget, schedule, and risk, and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.4.2 If "low-balling" is detected on a fixed price contract, insist on continuing the fixed price contract, or program termination and rebid. Do not allow switching to cost-plus.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.4.3 Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.5 Front-load and integrate the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

Early, up-front identification of potential problems allowed the management of the Haradh Gas Plant program to create workarounds and contingency plans to prevent these problems.

A member of the management team of the QIT-Fer et Titane program claimed that frontloading was crucial to a successful program execution and said, "The better you capture everything in the early stage, the better the project is defined."

Subenablers:

3.5.1 Plan early for consistent robustness and right the first time under "normal" circumstances, instead of hero-behavior in later "crisis" situations.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.2 Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.3 Establish a system and process that allows comprehensive, effective, and efficient up-front planning of program before execution begins.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	**Life Cycle Management**					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.4 The program leadership team (program manager, technical managers, lead system engineers etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	4: Process Integration	**5: Roles & Responsibilities**	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.5 Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping); identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	**4: Process Integration**	**5: Roles & Responsibilities**	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.6 Propagate front-loading of program throughout critical subprojects with similar workshops to those described in 3.5.5.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: All*		

3.5.7 Ascertain what is available to the program (resources, talent, budget, and timeline) and what is not available prior to making commitment to the customers and other stakeholders.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.8 Hold Lean Accelerated Planning sessions at the program level and for key subprojects, engaging all stakeholders in developing master schedule, value stream map, risks and opportunities, key assumptions, and action items.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	**Life Cycle Management**					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	**7: Planning**	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	**5: Project Processes**	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.9 For all critical activities, define who is responsible, approving, supporting, and informing (also known as RACI matrix), using a standardized tool, paying attention to precedence of tasks, and documenting handoffs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

3.5.10 Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.11 Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

3.5.12 Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

3.5.13 Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.5.14 Program manager must personally understand, clarify, and remove ambiguity, conflicts, and waste from key requirements and expectations at the program start.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.1*		

3.5.15 Heavily involve the key suppliers in program planning and at the early phases of program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.6 Use probabilistic estimates in program planning.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

Due to the complexity of the Deepwater program, the Coast Guard used a computer simulation model to project the operational efficiency of a variety of asset mixes in different scenarios. The model took a variety of factors into account. It was based on historical data on which probabilistic estimates are based. Before using it, the model was reviewed by different institutions known as authorities in the field of simulation modeling.

This enabler also aligns with recommendations by the United States Government Accountability Office (GAO). It encourages the use of probabilistic cost and schedule estimates in their "Cost Estimating and Assessment Guide." The goal is to use information with a realistic probability distribution, so that management can quantify the level of confidence in achieving a program within a certain funding level and can determine a defensible amount of contingency reserve to quickly mitigate risk.

Subenablers:

3.6.1 Develop probabilistic estimates for cost, schedule, and other critical planning forecasts.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.6.2 Base your planning assumptions on confidence intervals, not on point estimates.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.7 Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

Examples:

The Hawiyah Gas Plant program reported early and close collaboration with its three main contractors. Ensuring a certain standardization between the work packages of the three main contractors should mitigate the risk system integration.

In a different program—the Dallas Cowboys Stadium—the suppliers were involved in the very early cost estimation. In a bottom-up approach, the suppliers helped to develop an accurate depiction of the final costs.

The importance of supplier meetings is stressed at Ford in order to align expected outcomes between organizations. Obeya rooms may be opened for supplier visits, leading to intense and fruitful discussions. Through this process, suppliers can also be prioritized, preferred, or abandoned. Some suppliers became partners and enablers of Ford's lean transformation.

Subenablers:

3.7.1 Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.2 Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.3 Engage suppliers early in the program to identify and mitigate critical supplier-related risks.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.4 Respect your extended network of partners and suppliers by challenging them and helping them improve.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.5 Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.6 When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:*		

3.7.7 Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests, and ensure the requirements are stable.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.8 Select suppliers who are technically and culturally compatible.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.9 Strive to develop a seamless partnership between suppliers and the product development team.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.10 Include and manage the major suppliers as a part of your team.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7 11 Invite suppliers as trusted program partners to make a serious contribution to systems engineering, design, and development.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.7.12 Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items which must be handled at the top level.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

3.8 Plan leading indicators and metrics to manage the program.[28]

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.7*		

Examples:

In 2001, the United Nations introduced a results-based management system in an attempt to more closely link activity with results. Now a key element for all United Nations development program initiatives (most of them involving several international and local organizations) is program performance assessment, which is based on common metrics and consistent high-level classification. The premise is that if organizations plan in terms of the results they expect to achieve and then verify that they have achieved them, then resources will be used effectively and public support will be maintained.

The Prairie Waters program agreed on a set of critical success factors, such as budget, schedule, environmental protection, and proactive communication, that were continuously tracked and displayed in a

[28] For a detailed list of leading indicators that can be used in Systems Engineering, please see: Roedler, G., Rhodes, D., Schimmoller, H. and Jones, C. (2010). *Systems Engineering Leading Indicators Guide*, Version 2.0. Available at http://seari.mit.edu/documents/SELI-Guide-Rev2.pdf

dashboard making the current status highly visible. These top-level metrics were broken down for every bidding package to track contractors' performance.

Also in the Haradh Gas Plant, program performance was tracked. The program defined schedule, cost, quality, and safety as critical success factors. In addition, the program initiated a quality index that measures a contractor's compliance with quality requirements such as documentation, manning levels, or qualification.

Subenablers:

3.8.1 Use leading indicators to enable action before risks become issues.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.7*		

3.8.2 Focus metrics around customer stakeholder value and program benefits.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.7*		

3.8.3 Use only a few simple and easy-to-understand metrics and share them frequently throughout the enterprise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.7*		

3.8.4 Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

3.8.5 Use only those metrics that meet a stated need, objective, or program benefit.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

3.9 Develop an integrated program schedule at the level of detail for which you have dependable information.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

A master schedule was developed early in the Prairie Waters program. It contained start and completion dates for the ten major construction contracts. As the program evolved, the master schedule was completed using more detailed schedules of the milestones within the contracts.

The BAA Heathrow program utilized a rolling planning approach. In this program, the schedule was

refined as a 5-week look-ahead.

Subenablers:

3.9.1 Create a plan to appropriately integrate and align program management, systems engineering, and other high-level planning and coordination functions.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.9.2 Maximize concurrency of independent tasks and tasks that inform each other.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.9.3 Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.9.4 Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading (i.e., have appropriate contingencies and schedule buffers).[29]

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.9.5 Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.9.6 Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks with what data and when), understanding task dependencies and parent – child relationships.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

[29] Queuing theory shows that the flow approaching 100% of capacity slows down asymptotically due to the accumulation of variability, even in the absence of bottlenecks.

3.9.7 Update detailed planning regularly to reflect new information, being consistent with the long-term strategic plan. Do not force programs to execute against a detailed, outdated plan that was developed based on incomplete information.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.10 Manage technology readiness levels and protect program from Low-TRL delays and cost overruns.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

Examples:

The U.S. Department of Energy established formal policy guidance on the preferred level of technology readiness at each stage of program and project development in order to avoid schedule delays and cost overruns. Technology readiness levels are now tracked and are a major consideration in all critical decisions on a project's or program's readiness to proceed to the next phase of development, resulting in increased program performance.

The Haradh Gas Plant program relied on new technologies. To mitigate the risk of schedule overrun that was perceived with these technologies, the management team froze the process design at a certain point in time and allowed for no further changes.

Subenablers:

3.10.1 Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before starting a large-scale program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.10.2 Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

3.10.3 Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

3.10.4 Utilize program management strategies that produce the best balance between technology risk and reward in your program, such as evolutionary acquisition, incremental, or spiral development.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.10.5 Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

3.10.6 Remove show-stopping research and unproven technology from critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in risk mitigation plan. Reexamine for integration into program after significant progress has been made or defer to future systems.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.10.7 Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.10.8 Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.10.9 Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.2*		

3.10.10 Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

3.10.11 Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

3.11 Develop a communications plan.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

The Prairie Waters program not only developed internal communication protocols, having a very diverse stakeholder group, they also followed a set of communication plans for various stakeholder groups. The plans established included an overall communications plan, media relations plan, crisis communication plan, and a comprehensive community outreach plan. Furthermore, a program manual was designed covering communication flows and protocols outlining rules for information dissemination and quality.

Subenablers:

3.11.1 Develop and execute a clear communication plan that covers the entire value stream and stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

3.11.2 Plan to use visual methods wherever possible to communicate schedules, workloads, changes to customer requirements, etc.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

5.4 Lean Enablers 4.x: Create Program Flow (Lean Principle 3)

4. Lean Enablers to Create Program Flow (Lean Principle 3)

4.1 Use systems engineering to coordinate and integrate all engineering activities in the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

Examples:

The Coast Guard in the Deepwater program chose a system-of-systems acquisition strategy. Instead of replacing older equipment with new in a series of individual acquisitions, the older assets were replaced in a single program by an integrated set of modern equipment. For that purpose they awarded a contract of

providing capabilities—not concrete assets—to a single main contractor—the systems integrator. The systems integrator had the freedom of translate the required capabilities to the asset level while striving for three overarching goals: (1) maximize operational effectiveness, (2) minimize total cost of ownership, and (3) ensure customer satisfaction.

Another government program provided a single function with high technology and expensive parts to a small community of users. The government program office team assumed full responsibility for architecting and overseeing development of the system capability. The government system engineering team had sufficient knowledge and expertise and was able to save money by clarifying what the contractor was to do and what it should cost.

Subenablers:

4.1.1 Seamlessly and concurrently engage systems engineers with all engineering phases from the pre-proposal phase to the final program delivery.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.1.2 Maintain team continuity between phases to maximize experiential learning, including pre-proposal and proposal phases.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.2 Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery.[30]

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

A staffing matrix chart kept track of all responsibilities in the Dallas Cowboys Stadium program. It was used as a tool to assign responsibility based on individual skills.

In the Prairie Waters program, a program manual was developed. It served as a guidebook for individuals to outline standard procedures as well as roles and responsibilities for key tasks.

A U.S. government program to develop an information infrastructure and a product line of plug-in modules tailorable to different users set up a well-defined RACI subset of stakeholders for each decision point, product delivery, or task, even setting standards for how the different groups should work together. This was such an important ingredient to their success that it became a major task of the integration contractor to maintain it.

Subenablers:

[30] The term *program manager* is used in this and the subsequent enablers as defined in Section 3.1.

4.2.1 Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

4.2.2 Ensure continuity in the program manager position and avoid personnel rotation.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

4.2.3 Define and clearly communicate the program manager's RAA across all stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.2.4 Hold people responsible for their contributions throughout the program life cycle. Upstream activities must be held responsible for issues they cause in downstream activities.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.2.5 In the top level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation of the necessities in each other's domain.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.2.6 Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.1*		

4.3 For every program, use a program manager role to lead and integrate the program from start to finish.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

Examples:

A large aerospace company analyzed its program performance data and found a very strong correlation between program success and consistency of leadership from the proposal through the program execution

phases. Program leaders who were part of the proposal effort carried forward the knowledge and assumptions that were made during the proposal, and also represented "skin in the game" during the proposal activity, meaning they had an important stake in the outcome of the program.

In the Trojan Reactor program, the management team and the program manager were comprised of a very experienced team that was selected because of their technical competence and experience in similar programs. They were engineers by training and had additional project management training.

Subenablers:

4.3.1 Groom an exceptional program manager role with advanced skills to lead the development, the people, and assure program success.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.3.2 Ensure that the program manager possesses an appropriate background regarding: business, general management, and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.3.3 Ensure that the competency, technical knowledge, and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.3.4 Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (for example by clear traceability of requirements and effective use of change management control boards).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.4 The top level program management (e.g., program management office) overseeing the program must be highly effective.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

Examples:

The Mozal Smelter as well as the Trojan Reactor program relied heavily on experienced personnel in the program management team. In both programs, the majority of the program members were recruited from previous successful programs.

Every engineer at Toyota recognizes the engineering skill, leadership skill, and dedication it takes to become a chief engineer. This merits a high level of respect and compels every engineer to support the

chief engineer, who is mostly assigned to lead the project by focusing on technical issues and horizontal cross-functional group facilitation.

Subenablers:

4.4.1 Program management staff turnover and hiring rates must be kept low.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

4.4.2 Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

4.4.3 Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.5 Pursue collaborative and inclusive decision making that resolves the root causes of issues.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

Examples:

A large aerospace company established a standard five-step problem-solving method based on the plan-do-check-act cycle (PDCA) which helps to assure that the problem is adequately defined, root causes are identified, multiple solutions are proposed and evaluated, solutions are implemented and monitored, and the gains are sustained through performance monitoring. The root cause step includes various tools such as 5-why analysis to assure that the solutions address causes and not symptoms.

In the Prairie Waters program, a number of actions were taken to ensure efficient decision making. In a series of chartering workshops at the beginning of the program, the foundations for efficient decision making throughout the program were set. Furthermore, the organizational structure was adapted not only to foster collaboration but also to speed up decision making. Lastly, it was ensured that the right information required to make decisions is available and up to date.

Subenablers:

4.5.1 If decisions are based on assumptions that are likely to change, keep track of those assumptions and adjust the decisions when they change.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.2 Define your information needs as well as time-frame for decision making. Adjust the needed information and analysis to reflect the time you have to reach a decision.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.3 Take the time necessary to reach good decisions. Always explore a number of alternatives.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.4 Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.5 Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.6 If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.7 Define a clear, streamlined process for critical decision making, resolving conflicts of interest, and converging on consensus.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.8 Problems are corrected by those who created them, where they occur, and as soon as possible.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.9 Make decisions carefully by consensus, maintaining clear responsibility, thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.10 Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.5.11 Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision-making process.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

4.6 Integrate all program elements and functions through Program Governance

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

Examples:

After the acquisition of several independent companies in East Europe, a major utility company established a Transformation Steering Committee as a governance board for major transformation programs across all companies. The primary goal of this group was to review interim results from all critical projects, provide active direction in regards of program risk management, and overall project and program management activities.

The Deepwater and Prairie Waters programs reportedly established program oversight committees. It fell within the committee's responsibility to oversee the program planning and management as well as system integration process.

Subenablers:

4.6.1 Ensure program governance has full view, control, and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.6.2 Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk, communication, and resource management).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

4.6.3 Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

4.6.4 Use a gated process for validating planning and execution of program, and leverage functional expertise at these gates.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

4.6.5 Ensure integration between different topical domains throughout the program life cycle, e.g., architecture design, software, and hardware design.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.6.6 Align incentives across the program enterprise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.7 Use efficient and effective communication and coordination with program team.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

This example organization changed the communication of its projects with the project management office (PMO). The same improvements would apply to the communication between projects and their program. Of the 115 projects, 35 were being coordinated through the PMO which was established to provide support and centralized reporting. The projects reporting to the PMO did not use common templates or tools for managing their efforts or for reporting status, therefore the task of consolidating the information from these projects fell to the PMO. This labor-intensive consolidation process consumed 1 week of each reporting period and limited the PMO's ability to take on additional work. To simplify the process, the PMO developed a set of electronic project tools and templates within a Microsoft® SharePoint workspace and provided transition support and training to any project leader interested in automating project tracking and reporting. The SharePoint tools and templates were immediately welcomed by the project managers reporting information to the PMO. Many

acknowledged that the substantial reduction in overhead administration time. By automating and establishing a set of common tools, templates, tracking, and reporting for these projects, the project managers directly benefited. The PMO also saw a reduction in the monthly consolidation, preparation time, and effort for status reporting—ultimately reducing the total preparation interval to less than 24 hours. This enabled the PMO to take on additional projects within the organization, expanding the number reporting regularly to the PMO and improving the overall accuracy and timeliness of the organization's operational decision-support information.

The Prairie Waters program implemented a very effective communication strategy across multiple organizations in the enterprise. For each key organization, individual people were established as direct points of contact between organizational and functional counterparts, which proved to be major facilitator of direct and efficient communication and decision making.

At Ford, the program communication was streamlined. Informal meetings called "skip-level meetings" were implemented in order to allow small groups of engineers the chance to discuss relevant issues directly with leaders who were several levels above them in the hierarchy. These meetings promoted an effective way to maintain a clear line of communication between leadership and the engineers.

Subenablers:

4.7.1 Capture and absorb lessons learned from almost all programs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.7.2 Maximize coordination of effort and flow.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.7.3 Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise and with suppliers.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.7.4 Use frequent, timely, open, and honest communication.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.7.5 Promote a flat organization to simplify and speed up communication.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.7.6 Promote direct, informal, and face-to-face communication.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.8 Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

Examples:

In the QIT-Fer et Titane program, process standards were established to enable employees to work concurrently.

The Prairie Waters program manual outlined standard workflows and procedures for key tasks.

Standardized work is one of the key differentiators of the Toyota engineering process. Rigorous design standardization supports platform reusability. This allows Toyota to share critical components, subsystems, and technologies across vehicle platforms, resulting in lower product cost and higher quality. Toyota focuses on harmonizing design standardization, process standardization, and engineering skill-set standardization.

A division of Siemens utilized organizational project management maturity models to help improve project predictability and identify process improvement opportunities within a municipal transportation program. Implementation of global standard best practices at the project and organizational levels enabled more efficient and effective performance for the program.

Subenablers:

4.8.1 Standardize program management metrics and reporting system.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.8.2 Identify repeatable program management activities and standardize them.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.8.3 Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.8.4 Promote process standardization in development, management, and manufacturing.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

4.8.5 Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

4.9 Use Lean Thinking to promote smooth program flow.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: All*		

Examples:

In the Salt Lake City Winter Olympics program, various tasks were strongly interrelated and could not run in isolation. Frequent integration of these workflows helped turn the program into "a smoothly running machine."

Ford Motors recognized the opportunity to use the value-stream mapping events for enabling cross-functional and external dialogues. These meetings proved to be an excellent opportunity to identify interdependencies and understand the information flow required by each organizational unit in a program.

Subenablers:

4.9.1 Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) question everything with multiple "whys"; (b.) align process flow to decision flow; (c.) resolve all issues as they occur in frequent integrative events; and (d.) discuss tradeoffs and options.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.9.2 Be willing to challenge the customer's assumptions on technical and meritocratic grounds and to maximize program stability, relying on technical expertise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.9.3 Minimize handoffs to avoid rework.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.9.4 Optimize human resources when allocating value added (VA) and required, non-value added (RNVA) tasks: (a.) use professionals to do value-adding professional work; and(b.) when professionals are not absolutely required, use non professionals (support staff) to do required, non-value adding tasks.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.9.5 Ensure the use of consistent measurement standards across all projects and database commonality.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.9.6 Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide-communication bandwidth, standardization, work cells, and training.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

4.9.7 Use minimum number of IT tools and make common wherever possible.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.9.8 Minimize the number of software revision updates (e.g., noncritical updates) of IT tools and centrally control the update releases to prevent information churning.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.9.9 Adapt IT tools to fit the people and process.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.9.10 Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process:5.6*		

4.10 Make program progress visible to all.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

Examples:

A significant part of the integrated schedule management for the Salt Lake City Winter Olympic games was preparing and updating the large wall posters that were distributed across all major office areas. Every month, status updates and progress indicators about major projects, initiatives, and their interdependencies were updated on the posters for everyone to see.

In order to continuously track the program progress the QIT-Fer et Titane program, utilized more conventional technologies/mediums like face-to-face meetings, phone calls, and advanced technologies for web conferences were utilized.

The QIT-Fer et Titane, Prairie Waters, and Dallas Cowboys Stadium programs used an online database that was easily accessible and allowed for a quick overview of the program status.

Subenablers:

4.10.1 Make work progress visible and easy to understand to all, including external customer.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.2 Track the program's overall progress to deliver the program benefits.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.3 Utilize visual controls in public spaces for best visibility (avoid computer screens).

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.10.4 Develop a system that makes imperfections and delays visible to all.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.10.5 Use traffic light system (green, yellow, red) to report task status visually (good, warning, critical) and make certain problems are not concealed.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.10.6 Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

4.10.7 Align program metrics with intended benefits and stakeholder expectations.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.8 Establish clear line-of-sight between lower-level program and project metrics and top-level program success metrics.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.9 Develop a snapshot/summary representation of the meaningful metrics (e.g., standard deck) to measure all phases of the project and program and make it available to all.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.10 Track reduction of risk and uncertainty throughout program life cycle as KPI.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

4.10.11 Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

5.5 Lean Enablers 5.x: Create Pull in the Program (Lean Principle 4)

5. Lean Enablers to Create Pull in the Program (Lean Principle 4)

5.1 Pull tasks and outputs based on need, and reject others as waste.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 8.1*		

Examples:

In the QIT-Fer et Titan program, some significant engineering and construction activities were pulled, based on specific needs. Activities were not simply started because of preplanned schedules, but also if and when they were needed for following steps. In some cases, this also meant starting activities ahead of schedule.

"Compatibility before completion" is a practice at Ford Motors where key technical challenges drive the definition of subsystem interfaces. This is followed by a front-loaded development process that leads to a synchronized development process with just-in-time knowledge flow.

Executives at a large data services company based in the Southeast complained regularly that detailed reports designed to support decision making were failing to provide required critical decision-support information in a clear, concise, and timely manner. The reports in question were standard hardcopy financial, operations, and sales reports delivered to the executive team on a daily, weekly, monthly, and

quarterly basis. To resolve this, the senior vice president for Product Development contacted one of the business lines' PMO staff to ask for their help to improve the content and the quality of executive management reporting. The small PMO team worked directly with the executives, beginning by interviewing each executive. Two key questions were presented to identify the type and source of information that the executive team required. Those questions were: (1) "When you are out of the office and find it necessary to take action on behalf of the company, what information do you need to guide your decision making?" and (2) "When you arrive at your desk, what information do you typically access first in order to begin work?" From the answers to these questions, the PMO team designed an electronic dashboard and visualization platform that eliminated approximately 60% of the hardcopy reporting (including the time and effort required to prepare them) and presented product-based information through hourly updates highlighting key sales activities, operational performance (exceptional highs and lows), financial profile detail (with graphics), and KPI information. The near real-time information was designed to be presented online and by the use of a rolling display in each executive office. Executives would be able to access key information when they needed it, and would also have the ability to drill down into issues to obtain details. Characterizing the program to others in the organization, one executive remarked: "the outstanding achievements seen for this project can be traced directly to the interviews, where the team asked us the right questions to determine our needs. That well thought-out start contributes daily to the effort's positive outcomes."

Subenablers:

5.1.1 Let information needs pull the necessary work activities.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

5.1.2 Promote the culture in which people pull knowledge as they need it and limit the supply of information to genuine users only.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

5.1.3 Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task—use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

5.1.4 Stay connected to the customer during the task execution.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

5.1.5 Promote effective real time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure that both understand their mutual needs and expectations.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	**6: Agreement Processes**	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: ALL*		

5.1.6 Also for non-routine tasks, avoid rework by coordinating task requirements with internal customer.

Performance Domain:	Governance	Strategy Alignment	**Stakeholder Engagement**	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	**2: Requirements**	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: ALL*		

5.1.7 When pulling work, use customer stakeholder value to separate value-added from waste.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	**Life Cycle Management**					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	**All Processes**	*Process: ALL*		

5.2 Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	**4: Process Integration**	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	**6: Agreement Processes**	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

Examples:

In the Prairie Waters program, every contractor was incentivized to propose ideas to reduce costs. In cases where the ideas proved valid and were selected for realization, the savings were split evenly.

Successful U.S. government IT program offices tended to organize their teams, contracts, and funding sources/cost centers to match the layered and segmented nature of the technical enterprise. They organized personnel into disjointed teams to separately acquire applications, services, infrastructure, and data stores, etc. They aligned contracts to these separate activities and used the organization provided by the technology to also harness the complexity in the business processes. Typically, separate engineering teams were formed to deliver applications and infrastructure. These teams acted as product development units with full responsibility for cost, schedule, design, and marketing of their piece of the system within the context of the enterprise.

Subenablers:

5.2.1 Establish common contract structures throughout the program.

Performance Domain:	**Governance**	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	**3: Enterprise Alignment**	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	**10: Acquisition Practice**
INCOSE SE Process:	4: Technical Processes	5: Project Processes	**6: Agreement Processes**	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

5.2.2 Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win-win situations.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.1*		

5.2.3 Ensure that contracts support complete and open communication between the program stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

5.6 Lean Enablers 6.x: Pursue Program Perfection (Lean Principle 5)

6. Lean Enablers to Pursue Program Perfection (Lean Principle 5)

6.1 Make effective use of existing program management and organizational maturity standards.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

Examples:

The Trojan Reactor management team compiled a program manual that was based on PMI's *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* and added the team's experiences as a reference for all programs in the organization.

Ford Motors developed Technical Maturity Models and individual technical development plans to guarantee that their engineers were able to gain the appropriate level of technical excellence and maintain ongoing technical development.

Subenablers:

6.1.1 Use existing program management standards, guidelines, and applicable organizational maturity models to your program's best advantage.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

6.1.2 Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

6.1.3 Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

6.1.4 Do not implement any standard purely for achieving any sort of mandated program certification.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 8.1*		

6.1.5 Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses, goals and track progress on the process improvement journey.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.2*		

6.2 Pursue Lean for the long term.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

Examples:

With a presence in more than 42 countries and a workforce of 74,000 business technologists, Atos started a corporate Lean endeavor initially with the IT Services help desk for optimization of their consulting services for healthcare. Based on initial results and customer feedback, the company now promotes intensive Lean training and courses through the "Atos Lean Academy" both for corporate employees and external clients.

Subenablers:

6.2.1 Develop an integrated, long-term approach to implement Lean Thinking practices in product portfolio planning and the entire enterprise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

6.2.2 Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods and a Lean business case that ties Lean practices to achieving the program benefits.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

6.2.3 Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: EPP*		

6.2.4 Create incentives within the program and subprojects that foster the acceptance of Lean practices.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.2.5 Integrate the Lean activities in program management into an overall change management and process improvement approach in order to assure sustainability of the improvements and to use synergies with existing process improvement activities.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.2.6 Start small by selecting the most beneficial lean enablers for your program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.2.7 Codify lessons learned and evaluate their effectiveness.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.2.8 Look for new and innovative ways to work that add value.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.3 Strive for excellence of program management and systems engineering.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

Examples:

The management of the Quartier International de Montreal program divided the workload into smaller packages and used some of them as pilots for testing management techniques and contract awards. If proven successful, these were rolled out on a wider scale. If the pilots were not successful, management would adjust and test a different technique in the next pilot.

Improvement of organizational project management maturity at Siemens is conducted through the

utilization of multiple maturity models such as CMMI, OPM3®, and others related to the various disciplines. The structure of process maturity models drives standardization of recommended global practices, process performance evaluation, and continuous improvement in the organization.

Subenablers:

6.3.1 Implement the basics of quality.[31] Do not create, pass on, or accept defects.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.3.2 Follow basic problem solving techniques (e.g., Plan-Do-Check-Act) and adopt a culture of stopping and permanently fixing problems when they occur.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.3.3 Promote excellence under "normal" circumstances and reward pro-active management of risks, instead of rewarding "hero" behavior in crisis situations.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.3.4 Use and communicate failures as opportunities for learning—emphasizing process and not people problems.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.3.5 Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.3.6 Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, communication, and standardizing best practice.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

[31] The basics of quality include: (1) Build robust quality at each step of the process, and resolve and do not pass along problems; (2) Strive for perfection in each process step without introducing waste; (3) Do not rely on final inspection—error-proof wherever possible; (4) If final inspection is required, pursue 100 % pass rate by perfecting upstream processes; (5) Move final inspectors upstream to take role of quality mentors; (6) Apply basic plan-do-check-act method to problem solving; and (7) Promote a culture of stopping and permanently fixing problems as soon as they become apparent.

6.3.7 Promote the idea that the program should incorporate continuous improvement in the organizational culture.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.3.8 Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and over-processing waste. Ensure that the process can be executed "right the first time" from then on.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.3.9 Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

6.4 Use lessons learned to make the next program better than the last.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

Examples:

The U.S. Department of Energy established formal systems to collect and disseminate both project and program lessons learned. The degree to which these lessons learned are being incorporated and implemented is routinely checked. Lessons are now being collected from both internal and external sources.

The Mozal Smelter program was able to use practices from a preceding successful program to a large degree, replicating key functions and utilizing the same technologies. The process was facilitated by transferring approximately 70% of the management team to the new program.

In a U.S. division of Siemens Industry, lessons learned were collected, but the responsibility for reviewing and incorporating them was mostly the responsibility of the project teams. A division-level PMO was established as part of the Business Excellence Department to collect and analyze lessons learned for organizational improvements.

Subenablers:

6.4.1 Create mechanisms to capture, communicate, and apply experience.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.4.2 Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.4.3 Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.4.4 Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement the resulting change.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.4.5 Insist on standardized root cause identification and process for implementing corrective action and related training.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.4.6 Identify best practices through benchmarking and professional literature.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.4.7 Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 6.2*		

6.5 Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

Examples:

To control plan changes in the Salt Lake City Winter Olympics program, a formal change process was set up:

(1) A formal request was submitted to a centralized management and tracking group.

(2) The change was evaluated for impact and quantified by the required funding.

(3) A formal review of the change request was scheduled for the next available meeting with the

requestor, financier, and all impacted parties. At this review, the functional area director made a case for the change.

(4) Impacted functional areas approved or denied the request. If there was an impasse, the chief operating officer would make the final decision.

(5) The requestor would be notified in writing of the outcome of the review.

Subenablers:

6.5.1 Proactively align the program with changes in the environment to keep focused on achieving program benefits: Redirect, replan or stop individual program components.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 4.4*		

6.5.2 Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

6.6 Proactively manage uncertainty and risk to maximize program benefit[32].

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

Examples:

As a leading insurance organization in Canada, BCAA established a comprehensive Enterprise Risk Management Framework as an integrated and consistent approach for identifying, analyzing, responding to, and monitoring risks across all business areas and enterprise-level programs. This framework was not only the starting point to classify and manage mutually dependent risks, but also an effective way to identify new opportunities and instill a common risk language within the organization.

In the Prairie Waters program, a risk management plan was set up. It comprised risks identified by experienced program managers and mitigation strategies. The potential impact of every risk was determined to analyze the importance of the risk for the program. Based on the risk management plan, it was the managers' jobs to monitor and reevaluate the risks relevant to their area of responsibility and to take mitigation actions if necessary.

Subenablers:

6.6.1 Focus program risk management on creating and protecting value for the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

[32] For additional detail, see: Olechowski, A., Oehmen, J., Seering, W. and Ben-Daya, M.: Characteristics of successful risk management in product design. Proceedings of the International Design Conference – DESIGN 12, Dubrovnik, Croatia. May 2012

6.6.2 Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and the existing best practices to manage them.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.3 Support all critical decisions in the program with risk management results.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.4 Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.5 Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.6 Develop sufficient risk management skills in the program and provide adequate resources.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.7 Tailor the risk management process to the specific program needs and integrate it with the overall program management process.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.8 Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.9 Regularly monitor and review risks, risk mitigation actions, and the risk management system.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.6.10 Pay close attention to the opportunities and capture them along with risks.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.4*		

6.7 Strive for perfect communication, coordination, and collaboration across people and processes.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

Examples:

The management of the Dallas Cowboys Stadium program developed a rule on e-mail correspondence to avoid misunderstanding. The rule was that only one response per e-mail was allowed. Should further follow-up be required, a phone call or personal meeting would replace further e-mail correspondence.

Ford Motors developed a meeting called "reflection events" as an opportunity for program teams to learn by reflecting on performance at specific program milestones, prior to the program end. During the meeting, an A3 report is developed in order to state the problems and promote the opportunity to get critical input from the cross-functional team.

Subenablers:

6.7.1 Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

6.7.2 Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: ALL*		

6.7.3 Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management				
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.3*		

6.7.4 Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision making methods at the program beginning.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

6.7.5 Match communication competence of people with their roles when staffing the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.4*		

6.7.6 Publish instructions for e-mail distributions, instant messaging, and electronic communications.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

6.7.7 Publish instructions for artifact content and data storage: central capture versus local storage and paper versus electronic storage, balancing between excessive bureaucracy and the need for traceability.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.5*		

6.7.8 Publish a directory and organization chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.1*		

6.7.9 Ensure timely and efficient access to centralized data.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

6.7.10 Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 5.6*		

6.8 Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

Examples:

The Fluor Power plant program set up a culture in which ideas for improvement were welcome by any one. All ideas were collected and presented to the management team to assess the ideas' value and decide about required actions.

Improvement of organizational project management maturity at Siemens is conducted through the utilizing multiple maturity models such as CMMI, OPM3®, and others related to the various disciplines. The structure of process maturity models drives standardization of recommended global practices, process performance evaluation, and continuous improvement in the organization.

Subenablers:

6.8.1 Utilize and reward bottom-up suggestions for solving employee-level problems.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.8.2 Use quick response small teams comprised of program stakeholders for local problems and development of standards.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.8.3 Use formal, large improvement project teams to address program-wide issues.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6.8.4 Define a process that implements successful local improvements in other relevant parts of the program.

Performance Domain:	Governance	Strategy Alignment	Stakeholder Engagement	Benefits Management	Life Cycle Management					
Challenge Theme:	1: Firefighting	2: Requirements	3: Enterprise Alignment	4: Process Integration	5: Roles & Responsibilities	6: Competency	7: Planning	8: Metrics	9: Risk Management	10: Acquisition Practice
INCOSE SE Process:	4: Technical Processes	5: Project Processes	6: Agreement Processes	7: Project-Enabling Processes	8: Tailoring Processes	Enterprise Preparation	All Processes	*Process: 7.5*		

6 Complementary Approaches to Improve the Performance of Engineering Programs

There are a number of other approaches and recommendations used to improve the performance of engineering programs. While all have their specific objectives, strengths, and weaknesses, the Lean Enablers are compatible, complementary, and map—to a certain degree—to these approaches. In the following, we will briefly discuss three different views as examples*:*

- Agile development,
- Process maturity models, such as Capability Maturity Model Integration (CMMI) and
- Earned value management (EVM)

6.1 Agile Development

Lean Thinking and Agile development are two different but complementary concepts. There is value in recognizing the differences to ensure both concepts can work in harmony. This section focuses on Agile concepts relevant to the management of programs, which is viewed as an enterprise operational process that can very often benefit from Agile capability.

While many Agile principles are addressed and satisfied by the Lean Enablers (see Table 7), the Lean Enablers also include two specific subenablers, which call attention to Agile:

- Develop an Agile process to anticipate, accommodate, and communicate changing customer requirements. (2.5.1)
- Employ Agile methods to manage necessary requirements change and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable. (2.5.10)

6.1.1 The Basis of Agile: The Agile Manifesto[33]

The Manifesto for Agile Software Development defines the values of Agile, as well as the underlying principles. It was written for Agile Software Development and has started similar approaches in other development and engineering domains.

The four Agile Values are:

1. Individuals and interactions over processes and tools
2. Working software over comprehensive documentation
3. Customer collaboration over contract negotiation
4. Responding to change over following a plan

The twelve **Agile Principles** are:

1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage.
3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale.
4. Business people and developers must work together daily throughout the project.

[33] See: http://agilemanifesto.org/

5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation.
7. Working software is the primary measure of progress.
8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely.
9. Continuous attention to technical excellence and good design enhances agility.
10. Simplicity—the art of maximizing the amount of work not done—is essential.
11. The best architectures, requirements, and designs emerge from self-organizing teams.
12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

Table 7: A Simple Comparison of Lean and Agile

Fundamental Concept	Lean Principle	Agile Manifesto Values	Agile Manifesto Principles
Value people	6. Respect the people in your program	1. Individuals and interactions over processes and tools	5. Build projects around motivated individuals. Give them the environment and support they need, and trust them to get the job done.
Understand customer value	1. Capture the value defined by the customer stakeholders	3. Customer collaboration over contract negotiation	1. Our highest priority is to satisfy the customer through early and continuous delivery of valuable software.
Optimize and execute processes to maximize customer value	2. Map the value stream and eliminate waste 3. Flow the work through planned and streamlined value-adding steps and processes 4. Let customer stakeholders pull value 5. Pursue perfection in all processes	2. Working software over comprehensive documentation 4. Responding to change over following a plan	2. Welcome changing requirements, even late in development. Agile processes harness change for the customer's competitive advantage. 3. Deliver working software frequently, from a couple of weeks to a couple of months, with a preference for the shorter timescale. 4. Business people and developers must work together daily throughout the project. 6. The most efficient and effective method of conveying information to and within a development team is face-to-face conversation. 7. Working software is the primary measure of progress. 8. Agile processes promote sustainable development. The sponsors, developers, and users should be able to maintain a constant pace indefinitely. 9. Continuous attention to technical excellence and good design enhances agility. 10. Simplicity—the art of maximizing the amount of work not done—is essential. 11. The best architectures, requirements, and designs emerge from self-organizing teams. 12. At regular intervals, the team reflects on how to become more effective, then tunes and adjusts its behavior accordingly.

6.1.2 Comparison of Lean and Agile

Ultimately, it can be argued that both approaches strive to maximize customer value. Both approaches emphasize the importance of maximizing customer value, value the people executing the program, and optimize the program processes (see Table 7Table). Table 7 also provides a simple mapping of the Lean Enablers to the Agile Principles and their related processes in an Agile Development environment.

The most significant difference between the two approaches is that while Lean Thinking stresses a clear up-front definition of customer needs and requirements, and optimizes processes and organization to deliver that value, Agile stresses responsiveness to changing customer requirements. Lean does not forbid changing customer requirements, and Agile does not absolve an organization that does not understand customer value properly.

6.1.3 Applying Agile Development in Managing Engineering Programs[34]

Agile development can be operationalized in a program management context by doing the following:

- Use *Agile metrics* to evaluate responses to requirements uncertainty and change,
- Use an *Agile Architecture* to make the program and engineering system resilient to requirements uncertainty and change, and
- Use *Agile Design Principles* to develop a resilient program organization and a resilient engineering system

6.1.4 Agile Metrics

Agility is concerned with the ability to respond effectively under requirements uncertainty. Effective responses can be evaluated by four conditions:

- **Timely** (fast enough to deliver value),
- **Affordable** (at a cost that leaves room for an ROI),
- **Predictable** (can be counted on to meet the need), and
- **Comprehensive** (anything and everything within the mission boundary).

6.1.5 Agile Program and System Architecture

Achieving good Agile response metrics is enabled or hindered by the architecture: the program and the system being developed. A drag-and-drop, plug-and-play architecture fulfills this requirement. There are three critical elements in the architecture:

- **Catalog of Encapsulated Drag-and-Drop Modules**—Modules are self-contained units complete with interfaces that conform to the plug-and-play passive infrastructure. They can be dragged and dropped into a system of response capability with relationships to other modules connected through the passive infrastructure, and not connected directly module-to-module. Modules are encapsulated so that their interfaces conform to the passive infrastructure, but their methods of functionality are opaque to other modules. New modules can be added to module pools and new pools of modules can be added asynchronously. Module pools provide variation and diversity among modules—often with duplicate versions of modules in a pool to enable increased functional capacity of like-module deployment.
- **Catalog of Passive Infrastructure Rules and Standards**—Sometimes called middleware in IT systems, the passive infrastructure provides drag-and-drop connectivity between modules. Its value is in isolating the encapsulated modules so that unexpected side effects are minimized and operational functionality is

[34] This and the following subsections are based on: Dove, Rick: Response Ability – The Language, Structure and Culture of the Agile Enterprise. Wiley, 2001

rapid. Selecting passive infrastructure elements is a critical balance between requisite variety and parsimony —just enough in standards and rules to facilitate module connectivity but not so much to constrain the mission-required system configurations. Passive infrastructure typically evolves, but slowly, generally when migration to the next generation capability is appropriate.

- **Active Infrastructure to Sustain Agile Operation** —An Agile system is not something designed and deployed in a fixed event and then left alone. Agility is most active as responsible parties assemble new system configurations in response to new requirements—something which may happen very frequently, even daily in some cases. However, in order for new configurations to be enabled, three more responsibilities are required: (1) the collection of available modules must always be what is needed,(2) the modules that are available must always be in deployable condition, and (3) the passive infrastructure must have evolved when new configurations require new standards and rules.

6.1.6 Agile Design Principles

The 10 reusable-reconfigurable-scalable design principles add to the substance of the architecture, laying down the ground rules for designing an Agile architecture and modules:

Reusable Principles:

1. **Self-Contained Units** (Modules)—Modules are distinct, separable, loosely coupled, self-sufficient units cooperating toward a shared common purpose.
2. **Plug Compatibility** (Facilitated Interfacing)—Modules share defined interaction and interface standards, and are easily inserted or removed.
3. **Facilitated Reuse**—Modules are reusable and replicable, and responsibilities are specifically designated for inventory management, module maintenance, and upgrade of module inventory.

Reconfigurable Principles:

4. **Peer-Peer Interaction**—Modules communicate directly on a peer-to-peer relationship, and parallel rather than sequential relationships are favored.
5. **Distributed Control and Information**—Modules are directed by objective rather than method; decisions are made at point of maximum knowledge; and information is associated locally, accessible globally, and freely disseminated.
6. **Deferred Commitment**—Module relationships are transient when possible, decisions and fixed bindings are postponed until immediately necessary, and relationships are scheduled and bound in real-time.
7. **Self-Organization**—Module relationships are self-determined, and module interaction is self-adjusting or self-negotiated.

Scalable Principles:

8. **Evolving Standards**—Passive infrastructure standardizes intermodule communication and interaction; defines module compatibility; and is monitored/updated to accommodate old, current, and new modules.
9. **Redundancy and Diversity**—Duplicate modules provide right-sizing capacity options and fail-soft tolerance, and diversity among similar modules employing different methods is exploited.
10. **Elastic Capacity**—Module populations may be increased and decreased widely within the existing framework.

6.2 Capability Maturity Model Integration (CMMI)

The Lean Enablers also manifest themselves as recommendations within other global organizational best practice models. Many of the lean enablers that have been identified for engineering programs have a

supporting basis in the Capability Maturity Model Integrated (CMMI) of the Software Engineering Institute (SEI) as well as process maturity models related to organizational project management maturity such as PMI's Organizational Project Management Maturity Model (OPM3®) or the UK Cabinet Office P3M3 model. The discussion of CMMI[35] serves as one example of process maturity models (see Figure11).

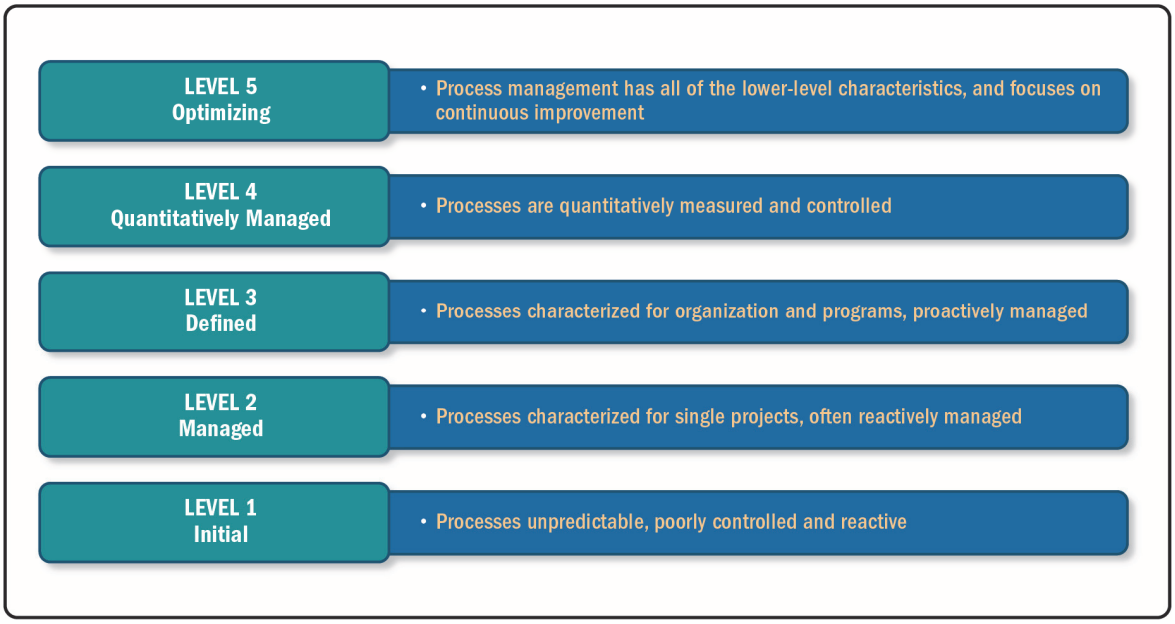

Figure 11: Characteristics of Process Maturity Levels—The Example of CMMI

Support of the engineering program enablers is expected specifically within CMMI for Development as it is a globally recognized capability maturity model for engineering-based projects. However, the focus of CMMI is at the project level initially and at the organizational level in higher levels of maturity. Although CMMI is directed principally at the project level, program specific elements such as benefits management and program level stakeholder management are supported by CMMI processes, namely Requirements Development (RD), Requirements Management (RM) and Integrated Project Management (IPM). It should be noted that for an organization to be successful at the program level, it must also exhibit sufficient capability maturity at the project level as well since they build upon and support each other's capabilities. Some examples of CMMI alignment with the lean enabler findings in this study are described in the following paragraphs.

Table 8: Mapping of Lean Enablers to CMMI Process Areas

CMMI Process Areas	Supporting Lean Enabler for Managing Engineering Programs
Causal Analysis and Resolution	4.5. Pursue collaborative and inclusive decision making that resolves the root causes of issues.
	5.1. Pull tasks and outputs based on need, and reject others as waste.
Configuration Management	4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.
	6.5. Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.

[35] Software Engineering Institute: CMMI for Development, Version 1.3, CMMI-DEV, V1.3. Technical Report, Carnegie Mellon University, 2010.

CMMI Process Areas	Supporting Lean Enabler for Managing Engineering Programs
Decision Analysis and Resolution	3.10. Manage technology readiness levels and protect program from low-TRL delays and cost overruns. 4.5. Pursue collaborative and inclusive decision making that resolves the root causes of issues.
Integrated Project Management	1.6. Encourage personal networks and interactions. 3.5. Front-load and integrate the program. 3.9. Develop an integrated program schedule at the level of detail for which you have dependable information. 3.11. Develop a communications plan. 4.2. Ensure clear responsibility, accountability and authority (RAA) throughout the program from initial requirements definition to final delivery. 4.3. For every program, use a program manager role to lead and integrate the program from start to finish. 4.6. Integrate all program elements and functions through Program Governance. 4.7. Use efficient and effective communication and coordination with the program team. 6.7. Strive for perfect communication, coordination, and collaboration across people and processes.
Measurement and Analysis	3.8. Plan leading indicators and metrics to manage the program. 4.10. Make program progress visible to all.
Organizational Process Definition	4.8. Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration. 6.7. Strive for perfect communication, coordination, and collaboration across people and processes.
Organizational Process Focus	6.1. Make effective use of existing program management and organizational maturity standards. 6.7. Strive for perfect communication, coordination, and collaboration across people and processes.
Organizational Performance Management	1.1. Build a program culture based on respect for people. 1.2. Motivate by making the higher purpose of the program and program elements transparent. 1.3. Support an autonomous working style. 1.4. Expect and support people as they strive for professional excellence and promote their careers. 1.5. Promote the ability to rapidly learn and continuously improve. 1.6. Encourage personal networks and interactions. 2.6. Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects. 3.1. Map the management and engineering value streams and eliminate non-value added elements. 3.2. Actively architect and manage the program enterprise to optimize its performance as a system. 3.6. Use probabilistic estimates in program planning. 4.9. Use Lean Thinking to promote smooth program flow. 6.2. Pursue Lean for the long term. 6.3. Strive for excellence of program management and systems engineering. 6.8. Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.

CMMI Process Areas	Supporting Lean Enabler for Managing Engineering Programs
Organizational Process Performance	1.4. Expect and support people as they strive for professional excellence and promote their careers. 1.5. Promote the ability to rapidly learn and continuously improve. 1.6. Encourage personal networks and interactions.. 2.6. Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects. 3.1. Map the management and engineering value streams and eliminate non-value added elements. 3.2. Actively architect and manage the program enterprise to optimize its performance as a system. 3.6. Use probabilistic estimates in program planning. 4.9. Use Lean Thinking to promote smooth program flow. 5.1. Pull tasks and outputs based on need, and reject others as waste. 6.2. Pursue Lean for the long term. 6.3. Strive for excellence of program management and systems engineering. 6.8. Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.
Organizational Training	1.1. Build a program culture based on respect for people. 1.4 Expect and support people as they strive for professional excellence and promote their careers.
Product Integration	3.10. Manage technology readiness levels and protect program from low-TRL delays and cost overruns. 4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.
Project Monitoring and Control	4.4. The top-level program management (e.g., program management office) overseeing the program must be highly effective.
Project Planning	3.5. Front-load and integrate the program. 3.6. Use probabilistic estimates in program planning. 3.7. Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk. 3.9. Develop an integrated program schedule at the level of detail for which you have dependable information. 3.11. Develop a communications plan.
Process and Product Quality Assurance	6.3. Strive for excellence of program management and systems engineering.
Quantitative Project Management	3.8. Plan leading indicators and metrics to manage the program. 4.5. Pursue collaborative and inclusive decision making that resolves the root causes of issues.
Requirements Development	2.1. Establish the value and benefit of the program to the stakeholders. 2.2. Focus all program activities on the benefits that the program intends to deliver. 2.3. Frequently engage the stakeholders throughout the program life cycle. 2.4. Develop high-quality program requirements among customer stakeholders before bidding and execution process begins. 2.5. Clarify, derive, and prioritize requirements early, often and proactively. 3.4. Ensure up-front that capabilities exist to deliver program requirements. 4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.

CMMI Process Areas	Supporting Lean Enabler for Managing Engineering Programs
Requirements Management	2.3. Frequently engage the stakeholders throughout the program life cycle. 2.5. Clarify, derive and prioritize requirements early, often and proactively. 4.1. Use systems engineering to coordinate and integrate all engineering activities in the program. 6.5. Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.
Risk Management	3.7. Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk. 6.6. Proactively manage uncertainty and risk to maximize program benefit.
Supplier Agreement Management	3.7. Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk. 5.2. Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
Technical Solution	3.3. Pursue multiple solution sets in parallel. 3.5. Front-load and integrate the program. 3.10. Manage technology readiness levels and protect program from low-TRL delays and cost overruns. 4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.
Validation	4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.
Verification	4.1. Use systems engineering to coordinate and integrate all engineering activities in the program.
General Practice GP2.7: Identify and involve relevant stakeholders	2.3. Frequently engage the stakeholders throughout the program life cycle. 3.7. Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.
General Practice GP2.10: Review status with higher management	4.4. The top-level program management (e.g., program management office) overseeing the program must be highly effective.
General Practice GP3.2: Collect Process-Related Experiences	6.4. Use lessons learned to make the next program better than the last.

Stakeholder management is supported by the CMMI Generic Practice, Identify and Inform Relevant Stakeholders (GP 2.7), which applies universally to all CMMI process areas in the model. The depth and extent of stakeholder engagement is determined by the organization. In this case, the same recommended practices could extend to the program as well as the project.

Systems engineering is a central theme of the CMMI for development model and is expressed as component areas of the CMMI engineering category of processes. Process areas that directly support excellence in systems engineering range throughout the development life cycle are Requirements Development (RD), Product Integration (PI), Technical Solution (TS), Validation (VAL), and Verification (VER). Program benefits should be a consideration for the entire requirements development, management, and traceability process for the component projects and may have significant impacts when part of RD and VAL. Elicitation of project requirements that are in alignment with program benefits optimization will often deliver a more effective enabling capability for the program. Control and management of the engineering product or system solution is within the scope of Requirements Management (RM) and Configuration Management (CM). The theme of technology readiness and insertion in engineering programs can be supported by Product Integration (PI), Technical Solution (TS) and by the Decision Analysis and Resolution (DAR) process areas, especially if

complemented by tools such as a technology readiness assessment and a technology maturity development process.

Optimization of program, project, and organizational performance is supported by higher maturity process areas such as Organizational Process Definition (OPD), Organizational Process Performance (OPP), Organizational Performance Management (OPM) and Causal Analysis and Resolution (CAR). Evaluation of organizational program and project performance and the evaluation and selection of improvement opportunities directly support the application of work stream improvement methodologies such as Lean or Six Sigma. However, it is recommended that good practices recommended by applicable standards for each discipline be at some level of standardized practice in the organization prior to the implementation of Lean. Improvement of standardized processes provides greater leverage in delivering lasting and significant organizational benefits. This is the structure of maturity models.

An observation is that the processes areas with numerically greater linkage to the program lean enablers (e.g., OPM, OPP, IPM, RD) are associated with higher levels of maturity in the CMMI model. It should also be noted that the weighted impact of each enabler is not defined here. However, one could postulate that an organization that is engaged in engineering-based programs would also benefit from the higher maturity levels of CMMI.

Due to the cross-functional nature and complexity of engineering programs (e.g., projects, programs, engineering, suppliers, life-cycle support and acquisition), a single maturity model or standard is often not sufficient due to their limited scope. The utilization of multiple models, such as CMMI in concert with organizational project management maturity models such as OPM3® or P3M3, will serve to complement each other. The Lean Enablers will support all of those models in an engineering program environment as an organization climbs the maturity ladder.

6.3 Earned Value Management (EVM)

6.3.1 Introduction to EVM

Earned Value Management (EVM) is a management methodology which integrates a program's technical scope, schedule, and resources with program risk in a baseline plan.[36] Against this plan, program progress is measured to provide metrics that indicate program performance trends. The methodology is often implemented with an integrated set of processes, people and tools, making up what is known as an EVM system.

The application of earned value in the early initiation and planning phases of a project increases the validity and usefulness of the cost and schedule baseline and is an excellent verification of the project scope assumptions and the scope baseline. Once established, these baselines become the best source for understanding project performance during execution. A comparison of actual performance (both cost and schedule) against this baseline provides feedback on project status and data, not only for projecting probable outcomes, but also for management to make timely and useful decisions using objective data[37].

6.3.2 The Evolution of Earned Value Management Concepts

The earned value concept was originally adapted to the management of single projects by the United States Air Force on their Minuteman Missile Program in the early 1960s. The concept was developed further for almost 40 years. In 1998, the ownership of EVM System was transferred from the US Government to NDIA as a

[36] As defined in: ANSI/EIA Standard 748-B: Earned Value Management Systems (Published June 2007).

[37]

representative of private industry. In July 1998, the Earned Value Management System became American National Standards Institute (ANSI/EIA) Standard 748.[38] NDIA created a number of documents to support the application and implementation of EVM, for example the *EVM Systems Intent Guide* and *EVM Systems Application Guide*.[39]

The subject of earned value was also adopted by PMI and described in PMI's original *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)* and in subsequent editions under the Cost Management Knowledge Area topic. In March 2005, PMI released the *The Practice Standard for Earned Value Management*—Second Edition,[40] which expands on the earned value information. The PMI standard defines earned value management as "a management methodology for integrating scope, schedule, and resources; for objectively measuring project performance and progress; and for forecasting project outcome."

6.3.3 Relationship of EVM to the Lean Enablers

The Lean Enablers work synergistically with EVM. On the one hand, EVM addresses the major challenges when managing engineering programs (see Section 4 and Table 9); on the other hand the Lean Enablers help to implement EVM more effectively (see Section 5 and Table 10Table).

Table 9: Relationship of engineering program challenges and EVM

10 Major Challenges in Engineering Programs	Impact of EVM
1: Firefighting—Reactive Program Execution	EVM provides a system for disciplined management of complex projects
2: Unstable, unclear, and incomplete requirements	EVM, through the organizing, planning, and budgeting, including revisions and data management guidelines, provides for clarification of requirements
3: Insufficient alignment and coordination of the extended enterprise	EVM provides clear metrics that span the entire program and enables a program to improve organizational alignment and overall process optimization.
4: Processes are locally optimized not integrated for the entire enterprise	See previous challenge.
5: Unclear roles, responsibilities, and accountability	EVM, through the organizing guidelines, provides for a clear structure of the organizational breakdown and assigned program scope.
6: Mismanagement of program culture, team competency, and knowledge	Not directly addressed by EVM.
7: Insufficient program planning	EVM organizing, planning, and budgeting guidelines drive a discipline-phased approach to program planning.
8: Improper metrics, metric systems, and KPIs	EVM, through the planning and budgeting and analysis and management reports guidelines, provides for clear programmatic metrics tied to performance.
9: Lack of proactive Program Risk Management	EVM's overall disciplined approach links with risk management for not only a measurement of past performance, but an understanding of what it will take to complete the program in the future, including the positive or negative uncertainties.
10: Poor program acquisition and contracting practices	EVM directly contributes to improving acquisition and contracting practices by establishing clear performance baselines.

[38] ANSI/EIA 748 is reaffirmed every five years, with the next release planned for 2012.
[39] Both guides and additional information can be found at www.ndia.org/pmsc
[40] © Project Management Institute, 2012. All rights reserved. Permission to use any material related to PMI's *Practice Standard for Earned Value Management* – Second Edition, should be requested from Project Management Institute.

One way to describe EVM practices in more detail is to break them down into five major areas (Organization; Planning and Budgeting; Accounting Considerations; Analysis and Management Reports; and Revisions and Data Maintenance) which are further broken down into 32 guidelines. EVM guidelines have a specific focus within the five areas on performance measurement, while the Lean Enablers take a broader view of program management.

Generally, all 1.x and 6.x Lean Enablers support EVM ("Lean Enablers to Treat People as Your Most Important Asset (Lean Principle 6) " and "Lean Enablers to Pursue Program Perfection (Lean Principle 5)" respectively), as they are aimed at creating a fundamentally productive organizational culture. The remaining Lean Enablers are mapped to the EVM focus areas in Table 10, where applicable.

Generally, many of the tenets outlined in the Lean Enablers would improve the effectiveness and/or efficiency within an EVM implementation. Key to EVM, as example, is the discipline required in breaking down a project's work, thus clarifying the requirements. The guidelines in EVM can be enhanced by the Lean Enablers to Maximize Program Value (Lean Principle 1). Similar, Lean Enablers to Create Program Flow (Lean Principle 3) hit key EVM disciplines, such as clear responsibility, accountability and authority, and integrate all program elements and functions through Program Governance. Finally, Lean Enablers to Pursue Program Perfection (Lean Principle 5) matches up with the EVM guideline, which promote a change management process and analysis and reporting in which lessons are learned and should be proactively applied to effect program outcomes. Lean Enablers and EVM guidelines both support the effort to execute engineering programs with excellence, which is why so many of these tenets are supportive of each other.

Table 10: Relationship of EVM and Lean Enablers

PMI Practice Standard for Earned Value Management	NDIA EVM Application Guide	Supported by Lean Enabler
Organization		
• Organize project • Assign responsibility	1. Define the authorized work elements for the program. A work breakdown structure (WBS), tailored for effective internal management control, is commonly used in this process. 2. Identify the program organizational structure including the major subcontractors responsible for accomplishing the authorized work, and define the organizational elements in which work will be planned and controlled 3. Provide for the integration of the company's planning, scheduling, budgeting, work authorization and cost accumulation processes with each other, and as appropriate, the program work breakdown structure and the program organizational structure. 4. Identify the company organization or function responsible for controlling overhead (indirect costs). 5. Provide for integration of the program work breakdown structure and the program organizational structure in a manner that permits cost and schedule performance measurement by elements of either or both structures as needed.	General: 1.x 6.x Specific: 2.x 3.x 4.x
Planning, scheduling, and budgeting		
• Schedule work • Establish budget • Determine measurement methods • Establish performance measurement baseline	6. Schedule the authorized work in a manner that describes the sequence of work and identifies significant task interdependencies required to meet the requirements of the program. 7. Identify physical products, milestones, technical performance goals, or other indicators that will be used to measure progress 8. Establish and maintain a time-phased budget baseline, at the control account level, against which program performance can be measured. Budget for long-term efforts may be held in higher-level accounts until an appropriate time for allocation at the control account level. Initial budgets established for performance measurement will be based on either internal management goals or the external customer negotiated target cost including estimates for authorized but undefinitized work. On government contracts, if an over-target baseline is used for performance measurement reporting purposes, prior	General: 1.x 6.x Specific: 3.x 4.x 5.x

PMI Practice Standard for Earned Value Management	NDIA EVM Application Guide	Supported by Lean Enabler
	notification must be provided to the customer. 9. Establish budgets for authorized work with identification of significant cost elements (labor, material, etc.) as needed for internal management and for control of subcontractors. 10. To the extent it is practical to identify the authorized work in discrete work packages, establish budgets for this work in terms of dollars, hours, or other measurable units. Where the entire control account is not subdivided into work packages, identify the far term effort in larger planning packages for budget and scheduling purposes. 11. Provide that the sum of all work package budgets plus planning package budgets within a control account equals the control account budget. 12. Identify and control the level of effort activity by time-phased budgets established for this purpose. Only that effort which is unmeasurable or which measurement is impractical may be classified as level of effort. 13. Establish overhead budgets for each significant organizational component of the company for expenses that will become indirect costs. Reflect in the program budgets, at the appropriate level, the amounts in overhead pools that are planned to be allocated to the program as indirect costs. 14. Identify management reserves and undistributed budget. 15. Provide that the program target cost goal is reconciled with the sum of all internal program budgets and management reserves.	
Accounting considerations		
• Determine measurement methods	16. Record direct costs in a manner consistent with the budgets in a formal system controlled by the general books of account. 17. When a work breakdown structure is used, summarize direct costs from control accounts in the work breakdown structure without allocation of a single control account to two or more work breakdown structure elements. 18. Summarize direct costs from the control accounts into the contractor's organizational elements without allocation of a single control account to two or more organizational elements. 19. Record all indirect costs that will be allocated to the contract. 20. Identify unit costs, equivalent unit costs, or lot costs when needed. 21. For EVMS, the material accounting system will provide for: (1) accurate cost accumulation and assignment of costs to control accounts in a manner consistent with the budgets using recognized, acceptable, costing techniques; (2) cost performance measurement at the point in time most suitable for the category of material involved, but not earlier than the time of progress payments or actual receipt of material; (3) full accountability of all material purchased for the program including the residual inventory	General: 1.x 6.x
Analysis and management reports		
• Analyze project performance	22. At least on a monthly basis, generate the following information at the control account and other levels as necessary for management control using actual cost data from, or reconcilable with, the accounting system: (1) Comparison of the amount of planned budget and the amount of budget earned for work accomplished. This comparison provides the schedule variance. (2) Comparison of the amount of the budget earned the actual (applied where appropriate) direct costs for the same work. This comparison provides the cost variance. 23. Identify, at least monthly, the significant differences between both planned and actual schedule performance and planned and actual cost performance, and provide the reasons for the variances in the detail needed by program management. 24. Identify budgeted and applied (or actual) indirect costs at the level and frequency needed by management for effective control, along with the reasons for any significant variances. 25. Summarize the data elements and associated variances through the program organization and/or work breakdown structure to support management needs	General: 1.x 6.x Specific: 4.x

PMI Practice Standard for Earned Value Management	NDIA EVM Application Guide	Supported by Lean Enabler
	and any customer reporting specified in the contract. 26. Implement managerial actions taken as the result of earned value information. 27. Develop revised estimates of cost at completion based on performance to date, commitment values for material, and estimates of future conditions. Compare this information with the performance measurement baseline to identify variances at completion important to company management and any applicable customer reporting requirements including statements of funding requirements.	
Revisions and data maintenance		
• Maintain performance measurement baseline	28. Incorporate authorized changes in a timely manner, recording the effects of such changes in budgets and schedules. In the directed effort prior to negotiation of a change, base such revisions on the amount estimated and budgeted to the program organizations. 29. Reconcile current budgets to prior budgets in terms of changes to the authorized work and internal re-planning in the detail needed by management for effective control. 30. Control retroactive changes to records pertaining to work performed that would change previously reported amounts for actual costs, earned value, or budgets. Adjustments should be made only for correction of errors, routine accounting adjustments, effects of customer or management directed changes, or to improve the baseline integrity and accuracy of performance measurement data. 31. Prevent revisions to the program budget except for authorized changes. 32. Document changes to the performance measurement baseline.	General: 1.x 6.x

7. How to Use the Lean Enablers in Your Organization—Some Suggestions

This section discusses three approaches to implement the Lean Enablers in your organization: during program formation, for strategic transformations, and during continuous improvement (or troubleshooting) of existing programs. Much of the success of all Lean deployment truly rests with the quality of the Leadership of the organization. Leaders of the organization should define what their approach is, communicate it with great repetition, visibly participate with the Lean transformation activities, and provide reward and encouragement to those who are advancing the organization's Lean journey. Given this level of leadership support, all of these differing approaches become complementary and ultimately begin to achieve a Lean culture that is continuously improving itself through the implementation of Lean in the unending pursuit of perfection. In general, every professional engaged in engineering programs should read this guide. The additional knowledge will enhance their career, increase their performance, and make them a better Lean Thinker.

7.1 Use the Lean Enablers when Starting a New Program

The Lean Enablers can make a significant contribution right from the program start when they are considered in the formative stages. One of the habits of highly effective people is to "begin with the end in mind." The Lean Enablers support this goal twofold, by stressing the need for a clear understanding of the customer stakeholder requirements and value perception, as well as proposing various effective program management practices to efficiently fulfill these requirements. Lean thinking can be ingrained in its DNA at the foundation level across all of the people from the time they begin as team members. The benefits of this are that the people within the organization evolve to think in Lean terms and pursue Lean as a means by which the company delivers value to its customers. In programs and companies of this nature, Lean simply becomes the manner in which an organization does its work, and Lean Enablers become more of an automatic response by the people doing work for their customers on a daily basis.

7.2 Guiding Strategic Program Enterprise Transformation[41]

This guide and the Lean Enablers are important "raw material" for a strategic program enterprise transformation (see Figure 12). It can be applied to the benefit of the program in all phases of the transformation.

[41] For additional detail, see: Nightingale, D. and Srinivasan, J. (2011). *Beyond the Lean Revolution: Achieving Successful and Sustainable Enterprise Transformation*. Saranac Lake, NY: AMACOM.

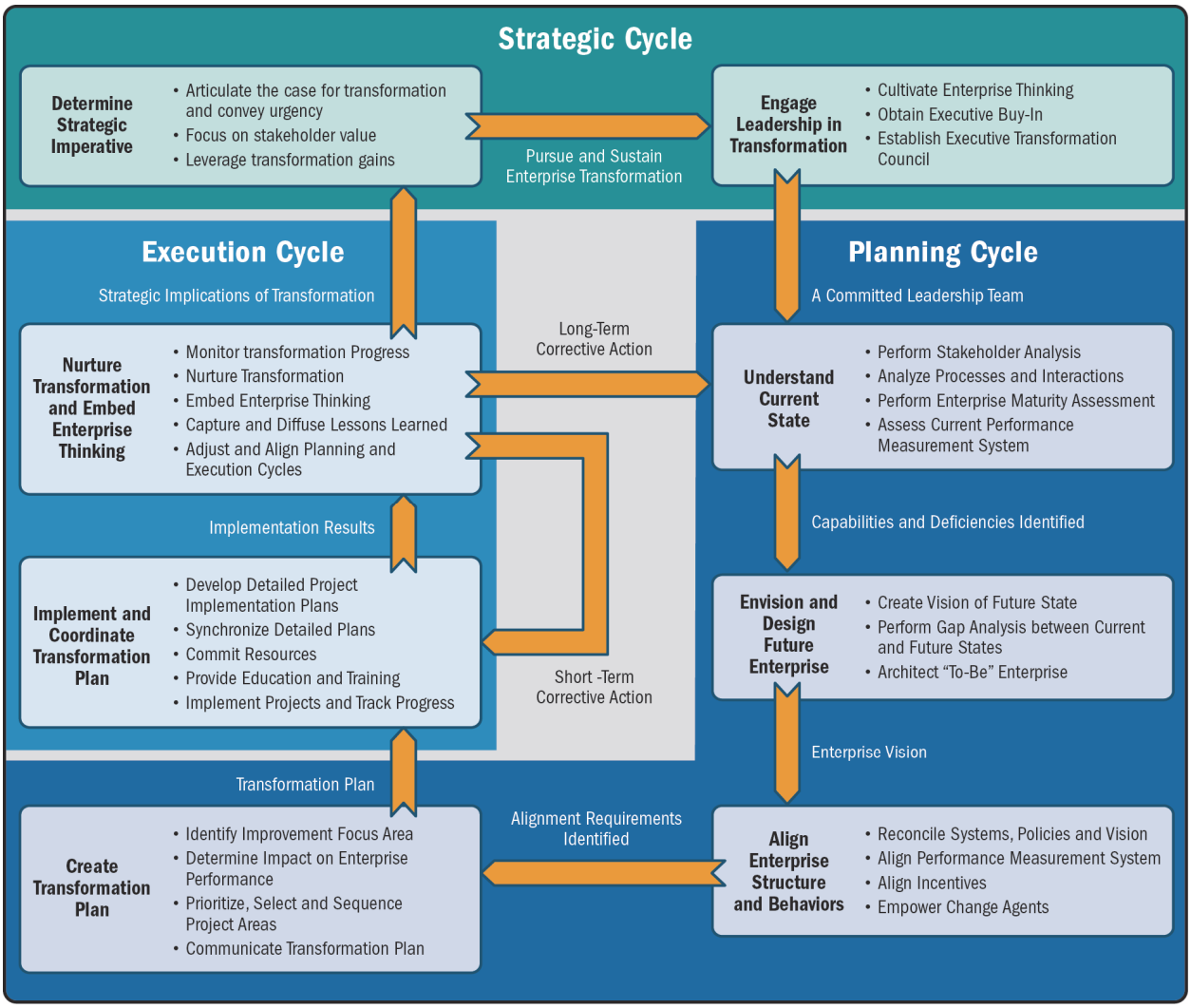

Figure 12: The MIT-LAI Enterprise Transformation Roadmap (Nightingale & Srinivasan 2011)

7.2.1 During the Strategic Cycle:

- **Determining the strategic imperatives**: A review of the program management challenges in this guide can be used to develop strategic change imperatives, as well uncover the underlying causes of top-level strategic issues (e.g., cost, quality and schedule problems).
- **Engaging leadership in transformation**: The Lean Enablers help to put together an enterprise-level transformation vision when building executive support.

7.2.2 During the Planning Cycle:

- **Understanding the current state**: Both the challenges, as well as the Lean Enablers, are ideally suited to analyze the current state of the enterprise, for example by assessing the current level of performance or alignment with the suggested Enablers.
- **Envision and design the future enterprise**: Again, the Lean Enablers can be used directly, to identify those that the future enterprise should align with, as well as defining the degree of alignment.
- **Align enterprise structures and behaviors**: The Lean Enablers contain a significant number of recommendations regarding the enterprise structure, e.g., stakeholder interactions, roles and responsibilities, and supplier integration, which are directly applicable here.

- **Create transformation plan**: The mapping of the Lean Enablers to the challenges and other management guidelines (e.g., program management performance domains, INCOSE Systems Engineering Handbook) makes it easy to identify their context and thus facilitates the creation of an overall transformation plan.

7.2.3 During the Execution Cycle:

- **Implement and coordinate the transformation plan:** All education and training material that was developed to communicate the Lean Enablers (either publicly available through the Community of Practice that developed this guide, or internally in a specific organization) can be used directly to support the transformation plan.
- **Nurture transformation and embed enterprise thinking**: All practices captured in the Lean Enablers in the section on "pursuing perfection" (Lean Principle 5) directly support the knowledge capture and continuous growth of the enterprise.

7.3 Improving Engineering Program Management

The impetus for improving existing engineering programs can come from two directions: fixing a problem or striving for excellence.

When an organization identifies some performance gap, constraint, or problem area and then needs to find a solution so that it can succeed, the Lean Enablers are a very powerful tool to do that. They enable the organization to clearly see the issue and then move the problem to an improved state. The 10 program management challenge themes discussed in Section 4 lend themselves to a top-down identification of improvement potential. As they are mapped to the Lean Enablers in Section 5 and in the Section A.5.1 of the Appendix, concrete starting points and next steps can be relatively easily defined, based on the Lean Enablers that correspond to the challenges.

The second and more proactive way is to utilize and implement the Lean Enablers is when an organization is operating without any major difficulties, but decides to find even better ways to provide greater value to their customers. Triggers can be the strategic planning of the value stream and then choosing to proactively improve some key processes that are operating well enough in the current state. Questions, such as "what are our theoretical limits of performance?" or "how can we sustainably outcompete our competitors?" or "what does true success for our customer really look like?" are asked. Great levels of success are guaranteed when an organization attains world class business performance and sets the standard for everyone else.

7.3.1 Implementation Planning

The most important aspect in communication, training, and implementation of the Lean Enablers is the answer to "what is the problem we are trying to solve?" and "what business advantage are we trying to achieve?" The organization must recognize that engineering programs have critical challenges and pitfalls, as identified in the top ten challenges. As program execution suffers and solutions are sought, using the Lean Enablers for program management becomes relevant. Leading indicators that increase visibility to the challenges and pitfalls include poor program execution related to cost, schedule, or quality; employee morale working on programs; customer requirements that are not incorporated into the product; inexperienced leadership; and the realization of the need to continually increase customer value. Faced with challenges, this should provide pull from the program management community to search for how to avoid or resolve the challenges.

This guide provides reference material. It is not intended to serve as mandatory practices, but rather it provides a vetted list of Lean Enablers that can help with managing the challenges of engineering programs.

7.3.2 Selecting the most relevant enablers

The intent of identifying the program management challenges and associated Lean Enablers is to aid the organization in managing engineering programs. Some of the identified challenges will be more relevant for your organization. After identifying which challenges/enablers will provide the most return on the investment—focus on that section. A good practice is to conduct a pilot. Select a program and ensure that the leadership of that program has read through the materials and has consciously selected Lean Enablers that will help manage their engineering program. Ensure good communication and change management plans are developed to follow the implementation and results of using these Lean Enablers.

7.3.3 Customizing and tailoring the enablers

As the most important challenges or pitfalls are identified, the Lean Enablers and their application must be tailored for the program. Further definition of the intent of the Lean Enablers is must be clearly understood by those who will use this information. Most importantly, the program leadership must understand the Lean Principles—Value, Value Stream, Flow, Pull, Perfection, and Respect for People. The maturity of an organization's Lean understanding will help determine the customizing and tailoring required for specific programs and the program management leadership.

7.3.4 Implementing the enablers and managing organizational change

There are many different approaches to implementing the Enablers. Consider providing a short overview of the materials, and assigning the program leadership pilot or community to read through the materials. This initial exposure is critically important—at this point, they may either take a keen interest and identify closely with both the challenges and the Enablers, or they may ignore it, due to lack of knowledge regarding Lean and its role in managing engineering programs. The initial exposure to the materials must also come from a trusted resource—someone who is (or has been) in their role, who represents the interests of this community, is an early adopter personality, and is a Lean advocate.

Computer-based training and instructor-led courses provide a good way to increase the awareness and knowledge of this information.

For both that initial overview and exposure to the materials, consider a systematic change management approach, such as the ADKAR®-Model.[42] This program uses a model of:

- **A—**Awareness: this is satisfied by the initial exposure to the Lean Enablers for Program Management.
- **D—**Desire: this covers the reasons of importance, for example, on a level of 1 to 5, the desire to further investigate this information?
- **K—**Knowledge: this reflects my understanding of Lean, the Lean Principals, how they apply to managing engineering programs, and what I must do to increase my knowledge of this information.
- **A—**Ability: this covers my ability to do the work, obtain sufficient training and enough reference materials and other support information I may need or training I should take, and who else should be involved so they too will be capable.
- **R—**Reinforcement: includes when results will be available, how to reward correct behavior, and how to move a program management community to awareness/desire/knowledge/ability of implementing Lean Enablers and subsequently sustain the gains?

[42] For additional detail, see: Hiatt, J. (2006).: *ADKAR: A Model for Change in Business, Government and our Community*. Loveland, CO: Prosci Research.

7.3.5 Developing Training and Communication Material

Training and communication materials will be developed separately from this guide and the mapping of the Lean Enablers to program management. Different types of training and communication materials should be considered and developed. For initial communications, executive leadership support encouraging awareness of this material would be helpful. If a body of knowledge exists in the company/enterprise, the materials should be referenced with key search words for program management practitioners. If formal instructor-led program management training is offered, this information should be incorporated—even at a high level, so the program management community will know of its existence. Information on joining this Community of Practice should also be included.

8. Potential Barriers to Implementing the Lean Enablers

A number of barriers currently exist that make it more difficult to implement the Lean Enablers. The general resistance-to-change barrier that all improvement initiatives face (and how to overcome it) was discussed briefly in the previous section. In this section, some concrete additional barriers are identified, which the subject matter experts encountered when developing, discussing and validating the enablers in three areas: government-sponsored programs, commercial programs, and academic education

8.1 Potential Barriers in Government-Sponsored Programs

- **Unstable funding environment**. Discontinuities and uncertainties in the funding of a program tend to cause instabilities with program staffing and subcontracts, and thus make efficient and effective program management more difficult.
- **Lack of rigor in exercising other known best practices**. Published government acquisition and program management guidelines and policies contain a large number of best practices that support the Lean Enablers. However, they are not always fully implemented, a fact that is regularly identified in formal program audits and evaluations.
- **Policies demanding early subcontracting**. Some government programs have a policy-driven demand to subcontract many program management activities, even in the very early phases. These policies risk subcontracting of critical coordination and integration functions, creating significant impediments to an effective program planning and execution.
- **Geographically dispersed subcontracting strategy (e.g. "made in 50 states")**. Political forces create incentives for contractors of government-sponsored programs to subdivide program activities among as many states, provinces, or other jurisdictions as possible. This could contradict those enablers that demand efficient organizational structures in the program enterprise.
- **Mismatch between contracting vehicle and risk profile**. The spectrum from fixed price to cost plus contracts creates specific incentives for behavior on the government and the contractor sides. Most importantly, it assigns the responsibilities for carrying cost risks—driven for example by technology uncertainty or production inefficiencies—between the parties. If the risk profile of a program is not aligned with the contracting vehicle and the incentives it creates, the resulting program environment will not be conducive to implementing the Lean Enablers or controlling cost.
- **Program leadership rotation**. The personnel development policy, especially in the military services, might call for a regular rotation of the government-side program manager. This is contrary to a number of Lean Enablers that demand clear and stable responsibility, accountability, and authority on both the customer and contractor sides. It also contradicts the Enablers demanding deep program-specific business and systems engineering knowledge for the top program leadership.
- **Promoting a bureaucracy of artifacts rather than engineering great systems**. Risk aversion and the demand for oversight can create a culture and environment that keeps engineers and other experts busy with documentation and administrative tasks, rather than doing what they are good at. This is opposed to the Lean Thinking philosophy that focuses on value-creating activities and minimizes (necessary and unnecessary) waste, as well as creating an environment that respects specialists and their abilities.

8.2 Potential Barriers in Commercial (and Government-Sponsored) Programs

- **No time to improve program performance.** Many programs operate under serious time constraints and pressure. Program managers prioritize activities based on their urgency, not importance. If there is no structured process to continuously improve program performance, it might be difficult to find the time to save time and money.

- **Mismatch between program execution and organizational development of capabilities**. Programs are focused on delivering benefits at a certain date and not developing the long-term capabilities of the company. If there is no balance between investing in capability development and program execution, the performance of future programs will suffer, and the interest in implementing the Lean Enablers will be diminished.
- **"We have tried Lean, it does not work here"-attitude**. Unfortunately, a significant number of companies and employees have been exposed to a "Lean" management approach where "Leaning out" was equivalent to "firing people." Others may have been part of unsuccessful attempts to implement Lean in an organization where improvement initiatives and their associated buzz words chased one another down the corridors. It is our strong opinion that the Lean principles presented in this guide are very powerful tools for improving all programs. Similarly, the Lean Enablers are excellent starting points for program-specific improvement initiatives. If you do not like "Lean," drop the term and use the Lean Enablers anyway.
- **Insufficient level of competition.** The Lean Thinking philosophy inherently demands a competitive environment where companies and employees strive for continuous improvement.

8.3 Potential Barriers in Academia and Education

- **Stove-piped education and research**. The fields of knowledge governing complex programs, such as Lean Thinking, Project Management, Systems Thinking, and Systems Engineering are inherently multidisciplinary domains. Yet, many universities and educational programs suffer from the traditional stove-piped organizations into domain departments. This results in strong bias towards specialist knowledge, only promoting and funding research and teaching on "depth" rather than "breadth." Both approaches must go hand in hand, and be supported as equally important.
- **Insufficient emphasis on global challenges and solutions**. Most modern complex engineering programs are increasingly global in scope involving global supply chain, global workforce, global economics, and global culture. Yet, many educational programs in universities do not expose students enough to these global challenges and their solutions.
- **Lack of Lean Thinking in curricula.** Although well established at many universities, there are not enough management and engineering courses that teach Lean thinking in a sufficient manner. Additional courses would enable a broader percentage of employees to drive positive and lasting changes through the application of Lean Thinking techniques.

APPENDIX

A.1 Complementary Information Sources

The following sections list additional books and studies that are relevant to managing large-scale engineering programs. As the field is vast, the list is not complete. However, we found these books and publications to be insightful and helpful in our work.

A.1.1 Lean Thinking, Lean Product Development and Lean Systems Engineering

Oppenheim, B. W. (2011). Lean for systems engineering with lean enablers for systems engineering. Hoboken, NJ: Wiley.

The INCOSE Lean Systems Engineering Working Group first published the Lean Enablers for Systems Engineering under the leadership of Bohdan Oppenheim and Deborah Secor in 2009. This book contains detailed explanations of each of the 147 enablers, with examples, value-promoted and waste-prevented implementation suggestions, lagging factors, and reading lists. These have been integrated into Lean Enablers for managing engineering programs, which are presented in this guide, however, the book offers a much more detailed discussion of the original Lean Enablers for Systems Engineering.

Reinertsen, D. G. (2009). The principles of product development flow—Second Generation Lean Product Development. Overland Park, KS: Celeritas.

This book emphasizes the idea of “flow” (Lean Principle 3, see Section 2.4.3) and presents both theory and practical advice on how to implement it in product development and engineering organizations. It contains a review of economic fundamentals of product development, gives an overview of queuing theory and its application in managing engineering programs, the reduction of variability and uncertainty in decision making, the management of “batch sizes” of engineering work and the associated work in progress, decentralized control of engineering, control under uncertainty, and the use of fast feedback to maximize value.

Murman, E., Allen, T., & Cutcher-Gershenfeld. (2002). Lean enterprise value: Insights from MIT’s Lean aerospace initiative. Basingstoke, U.K.: Palgrave Macmillan.

The key insights and findings of the 9-year Lean Aerospace Initiative (LAI) study at MIT form the basis for the principles and the value creation framework developed and explored in this book. It emphasizes the key challenge of lean at the enterprise level as balancing multi-stakeholder value creation with continuously eliminating waste. It contrasts traditional lean approaches focused on tools and localized improvements (characterized by “islands of success”) with an enterprise system approach to defining Lean and Lean improvements. A value creation framework is defined with an illustrated application of the framework at the program, corporate, and national value stream levels of analysis. Winner of the 2003 IAA Engineering Sciences Book Award.

Womack, J. & Jones, D. (2003). Lean thinking: Banish waste and create wealth in your corporation (2nd ed.). New York: Free Press.

This classic book outlines a lean framework and value-based business system based on the Toyota model. It includes case studies from the automotive, aerospace, and other manufacturing industries. The lean framework starts with businesses defining the "value" that they produce in products that best address customer needs. Business leaders then identify and clarify the "value stream" for the product. "Flow" aligns the product’s value stream across organizational boundaries. "Pull" activates the flow towards the pull of the customer's needs. The business then strives thereafter towards achieving "perfection" through continuous improvement. The model is

oriented toward change from a non-lean to a lean state, and the examples come primarily from manufacturing organizations.

Morgan, J., & Liker, J. (2006). The Toyota product development system: Integrating people, process and technology. New York: Productivity Press.

This book thoroughly examines and analyzes the product development approach of Toyota. It characterizes the Toyota Product Development System (TPDS) through 13 lean product development principles organized around process, people, and IT tools and technology subsystems. It compares and contrasts the product development process of Toyota with that of a U.S. competitor. Examples from Toyota and the U.S. competitor demonstrate value stream mapping as an extraordinarily powerful tool for continuous improvement. This book offers one of the most complete descriptions of the TPDS. It is largely descriptive of the TPDS, and does not attempt to provide extensive implementation suggestions. It is the winner of the 2007 Shingo Prize for Excellence in Manufacturing Research.

Ward, A. (2007). *Lean product and process development*. Cambridge, MA: Lean Enterprise Institute.

The author of this book is one of the pioneers in the study and practice of lean product development. This book addresses fundamentals of product development and identifies the sources of the most common problems (e.g., wastes) that plague many product development organizations. Key practices of lean product developers are described and compared with conventional product development practice. Principles of effective teamwork, engineering fundamentals, design methodology, and theories about management, cognition, and learning are brought together to describe the basic concepts of lean product development. Implications of the theories are illustrated in recommendations for implementation, although this stops short of being a workbook on the design, implementation, and operation of a lean product organization.

Oehmen, J., & Rebentisch, E. (2010). *Waste in lean product development*, MIT-LAI Whitepaper Series. Cambridge, MA: Massachusetts Institute of Technology.

This whitepaper summarizes the MIT-LAI research that applies to program management. The context of most of the research discussed in this whitepaper are pertinent to large-scale engineering programs, particularly in the aerospace and defense sector. The MIT-LAI Whitepaper Series makes a large number of MIT-LAI publications—around 120—accessible to industry practitioners by grouping by major program management activities. The goal is to provide starting points for program managers, program management staff, and system engineers to explore the knowledge accumulated by MIT-LAI and discover new thoughts and practical guidance for their everyday challenges. This whitepaper begins by introducing the challenges of programs, defining program management, and then giving an overview of existing program management frameworks. A new program management framework is introduced that is tailored towards describing the early program management phases —up to the start of production. This framework is used to summarize the relevant MIT-LAI research.

Available at: http://lean.mit.edu/products/lean-enterprise-product-development-for-practitioners

A.1.2 Systems Engineering

INCOSE. (October 2011). *The INCOSE Systems Engineering Handbook* (ver 3.2.2). San Diego, CA: author.

This handbook provides a description of the key process activities performed by systems engineers. It describes what each systems engineering process activity entails, in the context of designing for affordability and performance. This document is not intended to advocate any level of formality as necessary or appropriate in all situations. Some projects may choose which of specific activities are to be performed, while other projects may adhere to the concepts formally, with interim products under formal configuration control. It is developed for

the new systems engineer or the experienced systems engineer who needs a convenient reference. The handbook is consistent with the ISO/IEC 15288:2008 standard.

Available at http://www.incose.org/ProductsPubs/products/sehandbook.aspx

NASA. (2001). *NASA systems engineering handbook*, NASA/SP-2007-6105, Rev1. Washington, DC: author.

This handbook provides top-level guidelines for good systems engineering practices based on the collective experience of NASA from the development of aerospace systems. The handbook consists of six core chapters: (1) systems engineering fundamentals discussion, (2) the NASA program/project life cycles, (3) systems engineering processes to proceed from concept to design, (4) systems engineering processes to proceed from design to a final product,(5) crosscutting management processes in systems engineering, and (6) special topics relative to systems engineering. These core chapters are supplemented by appendices that provide outlines, examples, and further information to illustrate topics in the core chapters. The handbook makes extensive use of boxes and figures to define, refine, illustrate, and extend concepts in the core chapters.

Available at http://ntrs.nasa.gov/archive/nasa/casi.ntrs.nasa.gov/20080008301_2008008500.pdf

Office of the Deputy Under Secretary of Defense for Acquisition and Technology. (2008). *Systems engineering guide for systems of systems*, Version 1.0. Washington, DC: author.

This guide extends the methods of systems engineering to the engineering of systems of systems. It discusses the similarities and differences between systems and systems of systems, the systems engineering process to develop systems of systems, and the life cycle phases of systems of systems.

Available at: http://www.acq.osd.mil/se/docs/SE-Guide-for-SoS.pdf

Rebovich, G. Jr., & DeRosa, J. K. (2011). Patterns of success in systems engineering —Acquisition of IT-intensive government systems. MITRE Technical Paper, McLean, VA: The MITRE Corporation.

This report identifies success patterns in the systems engineering of large IT acquisition programs. It is based on an in-depth analysis of 12 highly successful programs. Two large-scale success patterns emerged and are described in detail, each with several recurring subpatterns. "Balancing the Supply Web" addresses social interdependencies among enterprise stakeholders who have different equities in the development of the capability. "Harnessing Technical Complexity" addresses the technical interdependencies among system components that together deliver an operational capability for the enterprise.

Available at http://mitre.org/work/tech_papers/2011/11_4659/

de Weck, O., Roos, D., & Magee, C. (2011). Engineering systems – Meeting human needs in a complex technological world. Cambridge, MA: MIT Press.

Today's large-scale, highly complex sociotechnical systems converge, interact, and depend on each other in ways engineers of the past could barely have imagined. As scale, scope, and complexity increase, engineers consider technical and social issues together in a highly integrated way as they design flexible, adaptable, robust systems that can be easily modified and reconfigured to satisfy changing requirements and new technological opportunities. The book offers a comprehensive examination of such systems. Through scholarly discussion, concrete examples, and history, the authors consider the engineer's changing role, new ways to model and analyze these systems, the impacts on engineering education, and the future challenges of meeting human needs through existing technologically enabled systems.

Rebovich, G., & White, B. (2010). Enterprise systems engineering: Advances in the theory and practice. Boca Raton, FL: CRC Press.

Seldom do isolated systems engineering groups work on local problems to build stove-pipe solutions; systems seldom are developed in a social, political, economic, or technical vacuum. Yet, concerted attempts to better implement systems engineering have not improved the situation. This book investigates the evolution of systems engineering, including both social change and technological change. Coverage ranges from the complex characteristics and behaviors of enterprises to the challenges they pose for engineering and technology. The book examines the emerging discipline of enterprise systems engineering and the impacts of enterprise processes and leading-edge technologies on the evolution of an enterprise.

A.1.3 Program Management

Project Management Institute (2012). *The Standard for Program Management* – Third edition (exposure draft version). Newtown Square, PA: author.[43]

The Standard for Program Management identifies practices for managing multiple projects and programs successfully and describes key underlying concepts such as the five Program Management Performance Domains and the Program Management Supporting Processes that are fundamental to the delivery of successful programs. Section 1 provides a Project Management Framework as a basis for understanding program management. Section 2 defines program management and its component parts and discusses program management in the context of the organization. The remaining sections describe the Program Management Performance Domains in detail, explain how the program manager works within these domains during the life of a program, and explains the foundational concepts of benefits management and benefits sustainment. Focus on these concepts helps to ensure that program managers lead programs in a manner that facilitates improved performance and achievement of benefits that are derived from the program.

UK Cabinet Office. (2011) *Managing successful programmes*. London, England, UK: author.

Managing Successful Programmes comprises a set of principles and processes for use when managing a program. It is not prescriptive, but is flexible and designed to be adapted to meet the needs of local circumstances. The Managing Successful Programmes (MSP) framework was built upon the experiences numerous programs. MSP defines the roles and responsibilities of all who need to form part of the leadership of a program. Effective leadership of a program is achieved through informed decision-making and flexible management. The MSP framework is based on three core concepts: MSP Principles, which are derived from positive and negative lessons learned from program experiences; MSP Governance Themes that define an organization's approach to program management; and MSP Transformational Flow, which provides a route through the life cycle of a program from its conception through to the delivery of new capabilities, outcomes, benefits realization, and business transformation.

Partington, D., Pellegrinelli, S., & Young, M. (2005). Attributes and levels of programme management competence: An interpretive study. *International Journal of Project Management, 23*(2), 87–95.

Abstract: Growth in the use of programs as a vehicle for implementing strategy has been accompanied by a need to understand the competence of effective program managers. Corporate leaders know that promoting

[43] PMI released a review version of the third edition of *The Standard for Program Management* in February 2012, reflecting proposed changes to the standard for public review and comment. The final content of *The Standard for Program Management* – Third Edition, scheduled for publication in January 2013, may vary from the exposure draft version of the revised standard discussed here and used in this document.

proven project managers into program manager roles is unreliable, yet little rigorous research has been done into the distinctiveness of program management competence. Using the interpretive approach known as phenomenography, we studied the management of 15 strategic programs spread over seven industry sectors. We present our findings in the form of a framework of 17 key attributes of program management work, each conceived at four levels in a hierarchy of competence.

Pellegrinelli, S. (2011). What's in a name: Project or programme? *International Journal of Project Management,* v*29*(2), 232–240.

Abstract: The common conception of program management as an extension or variant of project management, and therefore endowed with the same rationalist, instrumental underpinnings, is reviewed and questioned. In particular, the implications of labeling are highlighted, and the limitations for practice of conflated or poorly differentiated conceptions or models of project management and program management are discussed. The central argument of this paper is that a distinct program management model, grounded in a view of social reality as continually constructed through the actions and interactions of individuals—a becoming or related social constructionist ontology—provides an alternative way of shaping and undertaking change initiatives. Such a program management model, when practiced by reflective, context sensitive, and value/ethically aware practitioners, can coexist with and complement traditional project management approaches within an organization.

Thiry, M. (2010). Program management (Fundamentals of project management). Surrey, England, UK: Gower.

This book is based on practical applications of program management in different countries, as well as leading standards. It goes beyond multiple-project management to connect program management with business strategy and value realization. Sections cover the program's context, elements, actors, and life cycle. It emphasizes the need for program specific processes, based on an iterative life cycle and the management of multiple stakeholders and their expected benefits. The book is grounded in a theoretical framework, complemented by a number of case studies. It analyzes organizational structures for program management and provides tools and techniques to deal with complex, unplanned change in a structured manner. "Program Management" was awarded the 2010 Canadian Project Management Book Award of Merit by the Project Management Association of Canada.

U.S. Department of Defense. (2008). *Operation of the Defense Acquisition Systems* (Instruction Number 5000.02 and related documents). Washington, DC: author.

This instruction sets the management framework for large-scale engineering programs funded by the U.S. Department of Defense. It is one example of the program management practices employed and prescribed by government customers. It covers (among other elements) the program life cycle with its stage gates and general life cycle phase requirements; categories of programs; IT aspects; testing and evaluation guidelines; guidelines for cost estimation; program management guidelines; and systems engineering requirements. The Defense Acquisition University developed a number of guides to operationalize these requirements, for example the *Joint Program Management Handbook*, as well as the *Defense Acquisition Guidebook.*

- DoDi 5000.02: http://www.dtic.mil/whs/directives/corres/pdf/500002p.pdf
- DAU Joint Program Management Handbook: http://www.dau.mil/pubscats/PubsCats/Joint%20PM%20Handbook%2010_2004.pdf
- DAU Defense Acquisition Guidebook: https://acc.dau.mil/CommunityBrowser.aspx?id=350719

A.2 Complete List of Engineering Program Challenges

Table 11 contains a complete list of all program management challenges that were identified by the subject matter experts. The challenges that received a high priority in the assessment survey were consolidated to the 10 major engineering program challenges in Section 4. The following list follows the original structure in which the challenges were collected.

Table A1: Complete List of Identified Engineering Program Challenges

Challenge #	Engineering Program Challenge
1.	Program Execution
1.1.	**High-level program issues**
1.1.1.	Unstable funding
1.1.2.	Overriding influence of funding-related constraints
1.1.3.	No activity based costing and management
1.1.4.	No realistic program schedule
1.1.5.	Resources focused on fixing problems instead of preventing them
1.1.6.	Insufficient program management resources at contractor
1.1.7.	Insufficient program management/oversight resources at customer
1.2.	**Program leadership**
1.2.1.	Lack of leadership commitment
1.2.2.	Problematic allocation of responsibility and decision rights
1.2.3.	Insufficient program manager qualification
1.2.4.	Lack of alignment and integration between program management and systems engineering
1.2.5.	No coherent leadership team that represents all important functions (e.g., program management and systems engineering)
1.2.6.	Program management task broken down between too many individuals and/or organizations
1.3.	**Multi-project coordination**
1.3.1.	Competing resource requirements (e.g., allocation and choice of resources)
1.3.2.	Unstable project priorities
1.3.3.	Problems with managing staff levels during project ramp-up and ramp-down
1.3.4.	Troubled projects are not canceled early
1.3.5.	No buffer scheduled between projects
1.3.6.	Insufficient management of sub projects
1.4.	**Baseline planning, control and adaptation**
1.4.1.	No clear planning of cost/schedule/performance baselines
1.4.2.	Unrealistic cost/schedule/performance baselines
1.4.3.	Insufficient oversight of adherence to cost/schedule/performance baselines (also see challenges regarding metrics)
1.4.4.	Insufficient adaptation of cost/schedule/performance baselines to changing program environment/assumptions
1.4.5.	Insufficient propagation of changes to cost/schedule/performance baselines through the program
1.5.	**Configuration management**
1.5.1.	Insufficient configuration management of key program information assets
1.5.2.	Insufficient transparency regarding schedule, scope, cost, quality and performance status
1.5.3.	Insufficient coordination and communication of out-of-position work
1.5.4.	Oversimplification of configuration management by high-level planning
1.5.5.	Working on outdated data wastes resources

Challenge #	Engineering Program Challenge
1.6.	**Program Controlling and metrics system**
1.6.1.	Metrics are rear-view-mirror oriented and are not good indicators for future issues
1.6.2.	Metrics are outdated at the time of reporting
1.6.3.	Metrics do not allow drill down to understand root causes of poor metrics
1.6.4.	Diverse and distributed IT systems and data repositories do not allow efficient acquisition and aggregation of data for metrics
1.6.5.	Metrics have short-term focus
1.6.6.	Metrics do not consider human behavior ("gaming")
1.6.7.	Metrics are too high level and cannot be used for operational decision making
1.6.8.	Metrics are too detailed and cause excessive workload to track
1.6.9.	Frequency of monitoring of metrics is not aligned with timely decision making process (too frequent or too infrequent)
1.6.10.	No metrics to reflect cross-functional processes
1.6.11.	No metrics to track project performance or project progress (e.g., EVM)
1.7.	**Program risk management**
1.7.1.	No defined risk management process
1.7.2.	Not enough understanding of program risks
1.7.3.	No involvement of all staff into risk management
1.7.4.	Disconnect between risk management and other program management processes
1.7.5.	Insufficient resources and funding for risk management activities (identification, assessment, mitigation, monitoring)
1.7.6.	Insufficient focus on quickly resolving identified risks
1.7.7.	Neglect of the human aspect of risk management, that is, culture or incentives that penalize the flagging of risks or reporting of bad news
1.8.	**HR Development, staffing, expertise**
1.8.1.	Skill level of individuals (in program management, the program team, project teams and/or staff) not sufficient
1.8.2.	Inadequate team experience
1.8.3.	Ineffective process to transfer knowledge from experienced employees/team members to new(er) employees (in particular in industries with aging workforce)
1.8.4.	Inadequate identification of individual skill development needs
1.8.5.	Unsupportive environment for individual learning (e.g., through training opportunities or also making mistakes)
1.8.6.	Program needs regarding intellectual capital are unclear
1.8.7.	No specialist career path
1.8.8.	Insufficient resource planning (understaffing or no identification of possible understaffing)
1.8.9.	Rotation of key personnel on contractor side leads to instabilities in program
1.8.10.	Rotation of key personnel on customer side leads to instabilities in program
2.	Enterprise Stakeholder Management
2.1.	**Program Stakeholder Management**
2.1.1.	Unclear definition of "stakeholders"
2.1.2.	Unclear understanding of stakeholder value perception
2.1.3.	Unstructured/unplanned stakeholder communication
2.1.4.	Insufficient stakeholder integration (in particular customers and suppliers)
2.1.5.	Insufficient management/alignment of differing priorities within collaborating organizations and with stakeholders
2.1.6.	No process to (re)integrate and manage constantly changing stakeholders or stakeholder representatives

Challenge #	Engineering Program Challenge
2.1.7.	Compliance requirements of different stakeholders are independent of each other and not integrated (leading to increased workload, mismatch between requirements, prevents efficient fulfillment of similar requirements)
2.2.	**Coordination within the enterprise**
2.2.1.	Differing understanding and unclear understanding of what "program enterprise" comprises
2.2.2.	Lack of enterprise-wide coordination of optimization: only local process and organization optimization
2.2.3.	Insufficient management of IP issues
2.2.4.	Insufficient communication and information flow within the program (distance, time zones, cultures, etc.)
2.2.5.	Lack of process standardization
2.2.6.	Unclear priorities between immediate business goals (e.g., profitability of own program) and responsibility for other programs (e.g., capturing lessons learned, driving continuous improvement)
2.3.	**Task allocation and responsibility within the enterprise**
2.3.1.	Outsourcing of tasks without retaining sufficient in-house capabilities to supervise, appraise, and manage outsourced tasks
2.3.2.	Creating dependence by losing critical capabilities through outsourcing
2.3.3.	No fostering and maintaining of personal accountability of plans and outcomes
2.3.4.	Insufficient coordination and integration between line and staff functions
2.3.5.	Roles and responsibilities between staff and line functions not defined
2.3.6.	Value of staff organization and/or needs of line organization unclear
2.3.7.	No clear definition of hand-offs within and between staff and line
2.3.8.	Unclear team leadership (when is line, when staff organization responsible for an issue?)
2.3.9.	No single point of accountability for major program objectives (time, cost, performance)
2.4.	**Change management**
2.4.1.	Insufficient use of benchmarking and assessment tools for evaluation of enterprise structure
2.4.2.	No enterprise-wide integrated continuous improvement process
2.4.3.	Insufficient use of benchmarking and assessment tools to identify improvement potentials
2.4.4.	No enterprise-wide organizational learning and change management process
2.5.	**Value delivery, benefits realization and management**
2.5.1.	No explicit, favorable business case for all stakeholders
2.5.2.	Uncoordinated business cases for different companies/stakeholders
2.5.3.	Unclear/not quantified value from program
2.5.4.	No metrics to measure value/benefits for different stakeholders
2.5.5.	Program value to stakeholders is not documented and tracked continuously
2.5.6.	Value realization is not aligned with change management
2.5.7.	No clear, coordinated process and strategy for value realization
2.5.8.	No integrated, life-cycle view of program value and benefits
2.5.9.	Program value not sustained and transitioned over specific program phases (or subprojects)
2.6.	**Knowledge management**
2.6.1.	No open information sharing
2.6.2.	No documentation of lessons learned
2.6.3.	Insufficient or nonstandardized usage of information technology
2.6.4.	No adequate sharing of captured lessons learned across the enterprise
2.6.5.	Lack of feedback mechanisms to turn lessons learned into action; no implementation of lessons learned as new best practices throughout the program
2.7.	**Incentive alignment**

Challenge #	Engineering Program Challenge
2.7.1.	Lack of incentives
2.7.2.	Lack of incentive transparency
2.7.3.	Mismatch of incentive with desired outcome
2.7.4.	Misaligned incentives for cost/schedule / quality priorities
2.7.5.	Misaligned incentives for collaboration between staff, project team, suppliers, customers, or other stakeholders
2.7.6.	Constraints and incentives provided by the contract are misaligned with program task and risk profile
3.	Scoping, Planning and Contracting
3.1.	**Definition of stakeholder needs and requirements**
3.1.1.	Stakeholders do not clearly articulate their requirements (e.g., implicit requirements or unaware of requirements)
3.1.2.	Incomplete understanding of stakeholder requirements
3.1.3.	Erroneous understanding of stakeholder requirements
3.1.4.	Lack of appreciation of requirements complexity; derived requirements are not identified
3.1.5.	No learning from previous need definitions
3.1.6.	Requirements are not formulated properly (e.g., solution-neutral)
3.1.7.	Request for proposal (RFP) is issued by customer too early, before customer requirements reached sufficient clarity and stability
3.2.	**Managing trade-offs**
3.2.1.	Insufficient multi-attribute trade-offs/tradespace exploration
3.2.2.	No effective/quantitative trade-off studies between cost, schedule, and performance
3.3.	**Life-cycle estimation of cost, schedule, performance**
3.3.1.	Lack of life cycle documentation
3.3.2.	Insufficient probabilistic estimates
3.3.3.	Too little updates on estimated value during early phases
3.3.4.	Estimates does not reflect all aspects of the life cycle
3.4.	**Contract negotiation and management**
3.4.1.	Contract fails to establish clear operational, real-life expectations regarding program management (e.g., communication, financial, and legal aspects)
3.4.2.	Disconnect between operational program management and contract requirements
3.4.3.	Imprecise or unclear contract terms and conditions
3.4.4.	Ill-designed contract scope
3.4.5.	Unclear award criteria and process
3.4.6.	Program managers do not read contract; do not use it as a valuable resource
3.4.7.	Contracts fail to keep up with dynamic development of program
3.4.8.	Contract abused as *club* or *fence* by different parties
3.4.9.	Contract fails to establish win-win situation
3.4.10.	Contract regulations are not based on best practices and cause additional burden, or do not encourage the use of best practices (e.g., contracting designed on past “bad experiences,” not structured to provide efficient program management environment)
3.4.11.	Contract hinders information flow within the program (e.g., restraining confidentiality requirements)
3.4.12.	No standard structure for (sub)contracts
3.4.13.	Type of contract does not reflect operational requirements or best practices (e.g., cost-plus contract for program with high level of technology readiness, or fixed-cost contract for program with low level of technology readiness)
4.	Technology development and integration
4.1.	**Technology maturation monitoring**

Challenge #	Engineering Program Challenge
4.1.1.	No process implemented to assess technology maturation
4.1.2.	No adequate process to mature technologies for programs (performance and system integration properties)
4.2.	**Technology transition management**
4.2.1.	No established technology insertion process
4.2.2.	No person/team in charge to manage and monitor technology transition
4.2.3.	No formal reviews and communication plans for technology transition
4.2.4.	No overall system optimization that takes full advantage of new technologies (instead, new technologies are adapted to existing systems)
4.2.5.	Different types of new technology integration not addressed appropriately (hardware-hardware, hardware-software, software-software etc.)
4.2.6.	Limited engineering expertise regarding new technologies
4.2.7.	Intellectual property issues and confidentiality regulations between government, contractor, and suppliers hinder effective technology development and integration
5.	Engineering, product design and development
5.1.	**Engineering team organization**
5.1.1.	Insufficient integrated product team structure
5.1.2.	No clear team leadership structure
5.1.3.	Teams work package/priorities not aligned with overall program goals
5.1.4.	Lack of skill and functional diversity within the teams
5.1.5.	Inefficient communication flow to and within IPTs
5.1.6.	No balance between teams and functions (only applies to programs with matrix organizations)
5.1.7.	System architecture does not support product development process or IPTs (complex organizations often instigate overcomplicated system designs)
5.1.8.	No diverse learning strategies
5.2.	**Product architecting**
5.2.1.	Insufficient integration of program management requirements into the SE process
5.2.2.	Insufficient exploration of alternative solutions
5.2.3.	Mismatch between program characteristics and chosen development process
5.2.4.	Program management exerts pressure against use of SE best practices (e.g., pressure to pursue point design, neglecting of –ilities)
5.3.	**Value stream optimization**
5.3.1.	Lack of understanding what waste is
5.3.2.	Lack of understanding as to how to deal with different types of waste
5.3.3.	No understanding of current vs. preferred value stream
5.3.4.	No mechanism for value stream improvements
5.4.	**Testing and prototyping**
5.4.1.	Testing setup or prototype does not match type of information that team wants to gather
5.4.2.	No balance regarding amount of testing (too much or too little)
5.4.3.	Testing team unaware of critical properties of new technology (e.g., vibration sensitivity is an issue in new technology, in addition to thermal sensitivity)
5.4.4.	Testing processes and equipment unfit to test new technologies (e.g., unable to measure new critical properties or not sensitive enough)

A.3 Overview of Programs Used in Validation and as Examples

While no program is perfect, a number of programs stand out as best-in-class examples. Those examples were used in this guide in two ways. First, to validate the recommended Lean Enablers by checking to what extent the Lean Enablers were used in successful programs. The results of the content analysis of documentation on these programs are discussed in Section 1.4. Secondly, the programs were used to generate some examples of the application of the Lean Enablers for Section 5. While some programs were used for both applications, some programs were used solely to generate examples in Section 5.

A.3.1 Programs Used for Both Content Analysis and as Examples

All but the Coast Guard Deepwater programs are winners and finalists of PMI's Project of the Year Award from 2001 through 2011. The PMI Project of the Year Award recognizes the accomplishments of a project and project team for superior performance and exemplary execution of project management using processes and approaches that are consistent with *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. Projects from around the world are invited to participate, regardless of size, industry type, or location.

Coast Guard Deepwater

The Coast Guard Deepwater program was set up to renew the U.S. Coast Guard fleet by replacing or upgrading current assets. For that purpose, the Coast Guard specified a set of mission requirements. In a system-of-systems acquisition approach, the main contractor provided an integrated system of assets meeting these mission requirements rather than replace single classes of ships or aircrafts in individual acquisitions.

Source: GAO. (2006, April). GAO-06-546 Coast Guard. Reports to Congressional Requesters. Washington, DC: author, 1-51.

Prairie Waters

A massive drought from 2002 to 2003 depleted the water supply in the city of Aurora, CO, USA to an all-time low, falling to just 26 % of its total capacity. The city was left with a 9-month supply of water for its citizens—far less than the 3 to 5-year supply it prefers to keep. Officials decided to implement a project that would prevent future drought-related shortages. In August 2005, the Aurora City Council launched the Prairie Waters project, which called for the construction of nearly 34 miles (55 km) of 60-in. (1.5-m) pipeline, 4 pump stations, a natural purification area and one of the world's most technically advanced water-treatment facilities, handling 50 million gallons (189 million liters) per day.

Source: PMI (2011). Application documents submitted by Aurora Water for the Prairie Waters Project to PMI for the PMI Project of the Year Award. Reviewed with permission by the authors.

Dallas Cowboys Stadium

To provide the Dallas Cowboys football team with a new stadium that would showcase their games in a way that matches their larger-than-life reputation, and offer the City of Dallas a flexible venue for hosting a diverse variety of events ranging from rock concerts to rodeos and basketball games to NFL's Super Bowl, which the stadium housed in February 2011, the stadium's owners worked closely with the builders to create a structure that offers first-class amenities and flexible functionality. The 8-year process to construct the new US$1 billion Dallas Cowboys Stadium (Arlington, TX, USA) involved work performed by more than 100 subcontractors and 2,200 personnel, using materials from vendors in 10 U.S. states and 12 countries to realize a building design that was revised 300 times.

Source: PMI (2010). Application documents submitted by Manhattan Construction Company for the Dallas Cowboys Stadium Project to PMI for the PMI Project of the Year Award. Reviewed with permission by the authors.

Fluor – Newmont TS Power Plant

After winning the US$533 million bid to build a coal-fired power plant for Newmont Nevada Energy Investment Ltd., Fluor Corporation was just about ready to kick off the project. Material and labor costs had been steadily rising, and the Irving, TX, USA-based company thought it had researched and prepared for every conceivable problem the project might face. Then Hurricane Katrina hit and even though the storm landed more than 1,500 miles (2,414 kilometers) away from the plant project site in rural Nevada, USA—it altered everything. Laborers across the country flocked to the ravaged Gulf Coast, leaving the project scrambling to fill jobs at the project's remote desert site. Newmont had launched the project to offset soaring energy costs at its gold mine—25 & of the total operation costs went to paying the power bill. Once completed, the 242-megawatt coal plant would take the mine off the local energy grid, reducing Newmont's power costs by US$60 million to US$70 million per year and creating an additional revenue stream from power sold back to the grid.

Source: Gale, S. F. (2009, November). Power Players. *PM Network*, *23*(11),32–39.

BAA Heathrow Airport Terminal 1 Overhaul

Terminal 1 at London's Heathrow Airport accommodates nearly 20 million international travelers annually. Although the cramped 40-year-old structure had been altered to comply with more stringent post-9/11 security regulations and the needs of long-haul traffic, it was in need of a major overhaul to remove asbestos and offer services appropriate for 21st-century travelers. The project needed to be completed within a very tight and nonnegotiable timeframe.

Source: Wheatley, M. (2009, December). Terminal velocity. *PM Network*. *23*(12), 40–45.

Hatch Ltd.—QIT-Fer et Titane

One of the great challenges in implementing upgrade projects is keeping the organization's general operations running without interruption. Hatch Ltd., based in Ontario, Canada, implemented an upgrade project for the metallurgy company QIT-Fer et Titane (Quebec, Canada) that enabled QIT to increase its output without disrupting its plant's performance.

Source: Jones, T. (2009, January). The invisible hand. *PM Network, 23*(1), 32–39.

Fernald Feeds Materials Production Center Nuclear Cleanup

The closure of a cold-war nuclear facility close to Cincinnati, Ohio, USA, presented one of the largest environmental cleanup operations in U.S. history. By the time the program kicked off, the area had suffered significant contamination that raised public awareness. Managing these external stakeholders proved to be a major political challenge throughout the program.

Source: Hildebrand, C. (2009, January). The Cleanup Act. *PM Network, 23*(1), pp. 32–39.

Rocky Flats Plant

For nearly 37 years, the Rocky Flats Plant in Golden, CO, USA, served as a top-secret, high-security nuclear weapons facility. In 1989, it abruptly stopped making weapons, leaving behind contaminated facilities, soil, and groundwater. Five years later, the U.S. Department of Energy (DOE) labeled the site one of the country's most significant nuclear vulnerabilities. That same year, Kaiser-Hill Co. LLC, in Broomfield, Colo., USA, picked up the

contract to begin cleanup and stabilization of the plant. In 2000, the company won a second contract to finish the closure and cleanup of the entire 6,245-acre site, including the 385-acre industrial area. The company was given only six years and a $3.96 billion budget—a task that most thought impossible. In fact, the DOE estimated that the project would take 70 years and cost $36 billion. With the help of innovative initiatives such as pay-for-performance incentives, the company closed the plant 14 months ahead of schedule and was more than $553 million underbudget. Despite the high-risk environment the team was working in, there were no major injuries during the course of the project.

Source: Hunsberger, K. (2007, January). Finding closure. *PM Network, 21*(1), 28–37.

Quartier International de Montreal

In 2001, no one wanted to live in the 66-acre Quartier International de Montréal. An expressway acted as a trench, turning the city's international district into a dysfunctional gap between the historic district, Old Montréal, and the business district. Today, because of a massive urban revitalization project, the area is a thriving destination for both locals and tourists. Housing is booming, also. There are more than 1,000 new units completed or under construction. Rrecently, a condominium sold for $2.5 million and, overall, the project generated $770 million in related construction. The aim of the $90 million, 5-year Quartier international de Montréal (QIM) project was twofold: increase access to the area and build out the space with quality design and quality materials.

Source: Ellis, L. (2006, January). Urban inspiration. *PM Network, 20*(1),28–34.

Haradh Gas Plant

A massive construction project, built in one of the most remote places on earth, delivered 6 months ahead of schedule and 27 % underbudget—the Haradh Gas Plant results speak for themselves. The Haradh Gas Plant, located on the edge of the Rub'al-Khali desert, the largest area of continuous sand in the world, was fully online in June 2003. It was the result of a 4-year project that required 51 million construction man-hours, including 49 million hours without a lost workday incident. Saudi Aramco achieved these outstanding results by applying recognized project management processes and methodologies. The second in a series of major Saudi Aramco projects designed to expand the processing capabilities of the region's plants and meet increasing demand for natural gas, the Haradh Gas Plant has a feed rate of 1.6 billion standard cubic feet per day and a 1.5 billion cubic feet per day sales capacity—the most of any existing Saudi Aramco plant. Like the Hawiyah Gas Plant, Haradh is part of a new generation of gas processing plants that receive a sweeter, nonassociated gas mixture that produces more hydrocarbon condensate than processing plants dealing with only sour associated gas streams.

Source: Haynes, M. (2005, January). The winning drill. *PM Network, 19*(1), 28–33.

Salt Lake City, Utah Winter Olympics

It was 5 years in the making and the $1.9 billion 2002 Olympic Winter and Paralympic Games were a massive undertaking, encompassing 78 Olympic and 15 Paralympic events. While athletes were the star performers, project managers seamlessly delivered world-class games. After the award of the Paralympic Games to Utah in 1997, the Salt Lake Organizing Committee (SLOC) began coordinating with federal and state agencies to plan the needed infrastructure, including an I-15 highway expansion, the Utah Department of Transportation's Traffic Operations Center, and key highway interchange improvements. At the start, most Olympic managing directors viewed project management and quality assurance as directly applicable only to large construction-related projects, technical development programs, and other finite and easily quantified activities. Project management contributed to turning a $400 million deficit into a $100 million surplus.

Source: Foti, R. (2009, January). The best Winter Olympics, period. *PM Network, 18*(1). 22–28.

Hawiyah Gas Plant

In 1996, the Hawiyah Gas Program was launched 36 mi (60 km) south of Udhailiyah in Saudi Arabia's eastern province. The new plant was to receive sweet (low-sulfur) gas from the Jauf reservoir and sour Khuff gas from wells in the Hawiyah fields. This program was designed to speed development of Saudi Aramco's nonassociated gas resources (produced directly from gas reservoirs and not as a secondary product of oil production) and to liberate major quantities of oil for export. With increased natural gas capacity, a number of local industries, including the Kingdom's national electric company, would be able to transition to natural gas. This monumental task involved global suppliers, more than 10,000 workers of 50 different nationalities, and government supervision and support. Despite the challenges of working on a project of this magnitude, the Saudi Aramco project management organization delivered the plant more than $200 million under budget and 4 months ahead of schedule.

Source: Foti, R. (2003, January). PMI 2002 Project of the Year: Saudi Aramco's Hawiyah gas plant. *PM Network, 17*(1), 20–27.

Mozal Smelter

The Mozal Project included the construction of a 250,000-ton-per-annum primary aluminum smelter located 10.5 mi (17 km) west of the Maputo city center in Mozambique, one of about 30 countries that produces aluminum. With a budget at more than US$1.3 billion, the project reportedly represents the largest single foreign direct investment in Mozambique. Confronted with intimidating technical and logistical challenges, with poorly developed industrial infrastructure and civil engineering capacity—and despite swarms of mosquitoes and the worst floods imaginable—the Mozal Smelter Project delivered a productive aluminum smelter ahead of schedule and under budget.

Source: Williams, E. (2002, January). The Mozal smelter project, river of aluminum. *PM Network*. Vol. 16, no. 1 (Jan. 2002), p. 20-26

Trojan Reactor Vessel

It was an ambitious project from the start: to remove, transport, and dispose of a full-sized commercial nuclear reactor, complete with its internal structures and laden with radioactivity from 19 years in service, and packaged in one piece for shipment, which weighed more than two million pounds. This approach offered many advantages over the conventional method of segmenting the reactor and its internal structures for up to 88 separate shipments for disposal. Removing the reactor vessel as a whole would expose workers and the public to a fraction of the potential radiation. It would result in less than half the radioactive waste—and all of that at a low level of radioactivity. It would realize some $15 million in savings. There was one major obstacle facing the Trojan Reactor Vessel and Internals Removal (RVAIR) Project team—it had never been done before. Many doubted that it could be done. Not only was the project successfully accomplished, the costs were US$15 million less than originally projected and US$19 million less than conventional on-site reactor-removal methods.

Source: Holtzman, J. (2001, January). The Trojan reactor vessel and internals removal project. *PM Network, 15*(1), 28–32.

A.3.2 Programs used Solely as Examples

A number of programs were used as examples throughout Section 5. While several examples rely on the experience reported by the subject matter experts during the work of the group, additional information and resources available for some of the reported programs are included here.

MITRE-Identified Best in Class Programs

Researchers at MITRE published a report that identifies success patterns in the systems engineering of large IT acquisition programs. It is based on an in-depth analysis of 12 highly successful programs. Four of these programs are used as examples in this document:

1. *A Product Line Tailored to Users:* This program was set up to build a family of products to serve multiple users performing a similar function in various unique ways. It delivered an information infrastructure and a product line of plug-in modules.
2. *Cutting Edge Technology Development:* This U.S. government provided a single function with high technology, expensive, piece parts to a small community of users. The government's system engineering work force consisted of 150 individuals from several government and quasi-government organizations.
3. *Integrating Disparate Elements:* This U.S. government program was an attempt to build a seamless network of cooperating users, linking their systems though a new service-oriented architecture. These systems were expensive, and the users were not accustomed to sharing information. The integration effort provided a tremendous cost savings—orders of magnitude less than each of the disparate system programs. Thus the challenges were as much social as technical.
4. *Sophisticated Worldwide Planning:* This U.S. government IT program delivered a collection of software components to perform sophisticated planning, execution, and assessment of operations. It operated with hundreds of users in about one dozen locations around the world.

Source: Rebovich, G.,& DeRosa, J. (2011). Patterns of success in systems engineering —Acquisition of IT-intensive government systems. *MITRE Technical Paper.*McLean, VA: MITRE Corp.

Siemens Examples

A number of examples related to best program management practices have been identified and implemented at Siemens in the past years. These findings are documented in the following two sources.

Source: Sopko, J.A., Yellayi, S. and Clark, S (2012). An Organization's Journey to Achieve Business Excellence Through OPM Maturity. 2012 PMI Global Congress Proceedings, Marseille, France

Source: Sopko, J. A., & Strausser, G. (2010). The value of organizational project management (OPM) maturity—Understanding, measuring, and delivering benefits. 2010 PMI Global Congress Proceedings, Washington, DC.

Toyota Examples

The Toyota examples were drawn from the following publication:

Source: Morgan, J., & Liker, J. K. (2006). The Toyota product development system: Integrating people, process, and technology., New York, NY: Productivity Press.

Ford Examples

The Ford examples were taken from the following publication:

Source: Liker, J. K., & Morgan, J. (2011). Lean product development as a system: A case study of body and stamping development at Ford. *Engineering Management Journal, 23*(1), 16–28.

A.4 Reference List of Lean Enablers for Managing Engineering Programs

Table A2 is a simplified summary list of all Lean Enablers presented in Section 5.

Table A2: Reference List of Lean Enablers for Managing Engineering Programs

#	Enabler and Subenabler	Page
1.	**Lean Enablers to Treat People as Your Most Important Asset (Lean Principle 6)**	**35**
1.1.	**Build a program culture based on respect for people.**	
1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.	
1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that the hiring process matches the real needs of the program for talent and skill.	
1.1.3.	Program leadership must act as a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation and drive for excellence.	
1.1.4.	Hire people based on passion, "sparkle in the eye," and broad professional knowledge—not based solely on very specific skill needs (i.e., hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.	
1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.	
1.1.6.	Practice “walk-around management." Do not manage from a cubicle; go to the work and see for yourself.	
1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).	
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."	
1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.	
1.1.10.	When resolving issues, attack the problem—not the people.	
1.2.	**Motivate by making the higher purpose of the program and program elements transparent.**	
1.2.1.	Create a shared vision which draws out and inspires the best in people.	
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.	
1.3.	**Support an autonomous working style.**	
1.3.1.	Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.	
1.3.2.	Eliminate fear from the work environment. Promote conflict resolution at the lowest level.	
1.3.3.	Allow a certain amount of "failure" in a controlled environment at lower levels, so that people can take risk and grow by experience.	
1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto “rather ask for forgiveness than permission.”	
1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.	
1.4.	**Expect and support people as they strive for professional excellence and promote their careers.**	
1.4.1.	Establish and support communities of practice.	
1.4.2.	Invest in workforce development.	
1.4.3.	Ensure tailored Lean training for all employees.	
1.4.4.	Give leaders at all levels in-depth Lean training.	
1.4.5.	Promote and honor professional meritocracy.	
1.4.6.	Establish a highly experienced core group (grayhairs) that leads by example and institutionalizes positive behavior.	

#	Enabler and Subenabler	Page
2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.	
2.3.5.	Structure communication among stakeholders (who, how often, and what).	
2.3.6.	Create shared understanding of program content, goals, status and challenges among key stakeholders.	
2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.	
2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.	
2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.	
2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.	
2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.	
2.4.	**Develop high-quality program requirements among customer stakeholders before bidding and execution process begins.**	
2.4.1.	Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need: stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.	
2.4.2.	Use only highly experienced people and expert institutions to write program requirements, RFPs, and contracts.	
2.4.3.	If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.	
2.4.4.	Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, for example mindless "cut-and-paste" of requirements from previous programs.	
2.4.5.	Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.	
2.4.6.	Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.	
2.4.7.	Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated.	
2.4.8.	Always clearly link requirements to specific customer stakeholder needs and trace requirements from top level to bottom level.	
2.4.9.	Use peer-review requirements among stakeholders to ensure consensus validity and absence of conflicts.	
2.4.10.	Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.	
2.4.11.	Clearly articulate the top-level objectives, value, program benefits and functional requirements before formal requirements or a request for proposal is issued.	
2.4.12.	Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.	
2.5.	**Clarify, derive, and prioritize requirements early, often and proactively.**	
2.5.1.	Develop an Agile process to anticipate, accommodate, and communicate changing customer requirements.	
2.5.2.	Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items and do not allow requirements creep.	

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3.2.8.	Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors.	
3.3.	**Pursue multiple solution sets in parallel**	
3.3.1.	Plan to utilize cross-functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.	
3.3.2.	Explore the tradespace and margins fully before focusing on a point decision and too small margins.	
3.3.3.	For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of Set-Based Concurrent Engineering.	
3.3.4.	Explore multiple concepts, architectures, and designs early.	
3.3.5.	Explore constraints and perform real trades before converging on a point design.	
3.3.6.	All other things being equal, select the simplest solution.	
3.4.	**Ensure up-front that capabilities exist to deliver program requirements.**	
3.4.1.	Ensure strong corporate, institutional, and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.	
3.4.2.	If "low-balling" is detected on a fixed-price contract, insist on continuing the fixed-price contract, or program termination and rebid. Do not allow switching a to cost-plus contract.	
3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.	
3.5.	**Front-load and integrate the program.**	
3.5.1.	Plan early for consistent robustness and right-the-first-time under "normal" circumstances, instead of hero-behavior in later "crisis" situations.	
3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.	
3.5.3.	Establish a system and process that allows comprehensive, effective, and efficient up-front planning of the program before execution begins.	
3.5.4.	The program leadership team (program manager, technical managers, and lead system engineers, etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.	
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.	
3.5.6.	Propagate front-loading of the program throughout critical subprojects with similar workshops to those described in 3.5.5..	
3.5.7.	Ascertain what is available to the program (e.g., resources, talent, budget, and timeline) and what is not available prior to making a commitment to the customers and other stakeholders.	
3.5.8.	Hold Lean accelerated planning sessions at the program level and for key subprojects, engaging all stakeholders in developing a master schedule, value stream map, risks and opportunities, key assumptions, and action items.	
3.5.9.	For all critical activities, define who is responsible for approving, supporting, and informing (also known as RACI matrix), using a standardized tool and paying attention to the precedence of tasks and documenting handoffs.	
3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.	
3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.	
3.5.12.	Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.	

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3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.	
3.5.14.	The program manager must personally understand, clarify, and remove ambiguity, conflicts, and waste from key requirements and expectations at the program start.	
3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.	
3.6.	**Use probabilistic estimates in program planning.**	
3.6.1.	Develop probabilistic estimates for cost, schedule and other critical planning forecasts.	
3.6.2.	Base planning assumptions on confidence intervals, not on point estimates.	
3.7.	**Work with suppliers to proactively avoid conflict, and anticipate and mitigate program risk.**	
3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.	
3.7.2.	Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.	
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.	
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.	
3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.	
3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.	
3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests; and ensure the requirements are stable.	
3.7.8.	Select suppliers who are technically and culturally compatible.	
3.7.9.	Strive to develop a seamless partnership between suppliers and the product development team.	
3.7.10.	Include and manage the major suppliers as a part of your team.	
3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.	
3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items, which must be handled at the top level.	
3.8.	**Plan leading indicators and metrics to manage the program.**	
3.8.1.	Use leading indicators to enable action before risks become issues.	
3.8.2.	Focus metrics around customer stakeholder value and program benefits.	
3.8.3.	Use only few simple and easy to understand metrics and share them frequently throughout the enterprise.	
3.8.4.	Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.	
3.8.5.	Use only those metrics that meet a stated need, objective, or program benefit.	
3.9.	**Develop an integrated program schedule at the level of detail for which you have dependable information.**	
3.9.1.	Create a plan to appropriately integrate and align program management, systems engineering, and other high-level planning and coordination functions.	
3.9.2.	Maximize concurrency of independent tasks and tasks that inform each other.	
3.9.3.	Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.	
3.9.4.	Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading, that is, have appropriate contingencies and schedule buffers.	
3.9.5.	Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.	
3.9.6.	Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks and with what data and when), understanding task dependencies and parent – child relationships.	

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4.2.5.	In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation for the necessities in each other's domain.	
4.2.6.	Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.	
4.3.	**For every program, use a program manager role to lead and integrate the program from start to finish.**	
4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.	
4.3.2.	Ensure that the program manager possesses an appropriate background regarding business, general management, and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.	
4.3.3.	Ensure that the competency, technical knowledge and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.	
4.3.4.	Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (for example by clear traceability of requirements and effective use of change management control boards).	
4.4.	**The top-level program management (e.g., program management office) overseeing the program must be highly effective.**	
4.4.1.	Program management staff turnover and hiring rates must be kept low.	
4.4.2.	Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.	
4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.	
4.5.	**Pursue collaborative and inclusive decision making that resolves the root causes of issues.**	
4.5.1.	If decisions are based on assumptions that are likely to change, keep track of those assumptions and adjust the decisions when they change.	
4.5.2.	Define information needs as well as the time frame for decision making. Adjust the needed information and analysis to reflect the allotted time for reaching a decision.	
4.5.3.	Take the time necessary to reach good decisions. Always explore a number of alternatives.	
4.5.4.	Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.	
4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.	
4.5.6.	If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.	
4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest, and converging on consensus.	
4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.	
4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.	
4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.	
4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision-making process.	
4.6.	**Integrate all Program Elements and Functions through Program Governance**	

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4.6.1.	Ensure program governance has full view, control and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.	
4.6.2.	Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk-, communication, and resource management)	
4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.	
4.6.4.	Use a gated process for validating, planning, and execution of the program and leverage functional expertise at these gates.	
4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, software, and hardware design.	
4.6.6.	Align incentives across the program enterprise.	
4.7.	**Use efficient and effective communication and coordination with program team.**	
4.7.1.	Capture and absorb lessons learned from almost all programs.	
4.7.2.	Maximize coordination of effort and flow.	
4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise and with suppliers.	
4.7.4.	Use frequent, timely, open, and honest communication.	
4.7.5.	Promote flat organization to simplify and speed up communication.	
4.7.6.	Promote direct, informal, and face-to-face communication.	
4.8.	**Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.**	
4.8.1.	Standardize the program management metrics and reporting system.	
4.8.2.	Identify repeatable program management activities and standardize them.	
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.	
4.8.4.	Promote process standardization in development, management, and manufacturing.	
4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.	
4.9.	**Use Lean Thinking to promote smooth program flow.**	
4.9.1.	Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) Question everything with multiple "whys"; (b.) Align process flow to decision flow; (c.) Resolve all issues as they occur in frequent integrative events; and (d.) Discuss tradeoffs and options.	
4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds and to maximize program stability, relying on technical expertise.	
4.9.3.	Minimize handoffs to avoid rework.	
4.9.4.	Optimize human resources when allocating value added (VA) and required, non-value added (RNVA) tasks:. (a.) Use professionals to do value-adding professional work; (b.) When professionals are not absolutely required, use nonprofessionals (support staff) to do required, non-value added tasks.	
4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.	
4.9.6.	Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide communication bandwidth, standardization, work cells, and training.	
4.9.7.	Use minimum number of IT tools and make common wherever possible.	
4.9.8.	Minimize the number of the software revision updates (e.g., noncritical updates) of IT tools and centrally control the update releases to prevent information churning.	
4.9.9.	Adapt the IT tools to fit the people and process.	
4.9.10.	Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.	

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6.2.	**Pursue Lean for the long term.**	
6.2.1.	Develop an integrated, long-term approach to implement Lean Thinking practices in product portfolio planning and the entire enterprise.	
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods and a Lean business case that ties Lean practices to achieving the program benefits.	
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.	
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.	
6.2.5.	Integrate the Lean activities in program management into an overall change management and process improvement approach in order to assure sustainability of the improvements, as well as use synergies with existing process improvement activities.	
6.2.6.	Start small by selecting the most beneficial lean enablers for the program.	
6.2.7.	Codify lessons learned and evaluate their effectiveness.	
6.2.8.	Look for new and innovative ways to work that add value.	
6.3.	**Strive for excellence of program management and systems engineering.**	
6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects.	
6.3.2.	Follow basic problem-solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.	
6.3.3.	Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.	
6.3.4.	Use and communicate failures as opportunities for learning, emphasizing process and not people problems.	
6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.	
6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.	
6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.	
6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.	
6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.	
6.4.	**Use lessons learned to make the next program better than the last.**	
6.4.1.	Create mechanisms to capture, communicate, and apply experience.	
6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.	
6.4.3.	Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.	
6.4.4.	Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement resulting change.	
6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.	
6.4.6.	Identify best practices through benchmarking and professional literature.	
6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.	
6.5.	**Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.**	

#	Enabler and Subenabler	Page
6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits: Redirect, replan or stop individual program components.	
6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.	
6.6.	**Proactively manage uncertainty and risk to maximize program benefit.**	
6.6.1.	Focus program risk management on creating and protecting value for the program.	
6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.	
6.6.3.	Support all critical decisions in the program with risk management results.	
6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.	
6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.	
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.	
6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.	
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.	
6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.	
6.6.10.	Pay close attention to the opportunities and capture them along with risks.	
6.7.	**Strive for perfect communication, coordination, and collaboration across people and processes.**	
6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.	
6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.	
6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.	
6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.	
6.7.5.	Match the communication competence of people with their roles when staffing the program.	
6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.	
6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.	
6.7.8.	Publish a directory and organizational chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.	
6.7.9.	Ensure timely and efficient access to centralized data.	
6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.	
6.8.	**Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.**	
6.8.1.	Utilize and reward bottom-up suggestions for solving employee-level problems.	
6.8.2.	Use quick response small teams comprised of program stakeholders for local problems and development of standards.	
6.8.3.	Use formal, large improvement project teams to address program-wide issues.	
6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.	

A.5 Mapping of Lean Enablers

All of the following mappings (other than the mapping to Lean Enablers for Systems Engineering) can also be found in Section 5 in the "summary tables" next to each Lean Enabler. The following mapping and tables are provided to allow cross-referencing as well as identifying particular for specific challenges, performance domains, systems engineering processes, as well as provide to provide the mapping to the Lean Enablers for Systems Engineering.

A.5.1 Mapping to Program Management Challenges

Table A3 contains the Lean Enablers, sorted by program management challenges. As discussed in Section 4, all program management challenges are related to each other. So if we considered indirect influence of the Lean Enablers on the challenges using 1 or 2 "cause and effect hops," all Enablers would affect all challenges. In this table, we only map the strongest influences. We strongly suggest consulting the complete list of Lean Enablers to identify the most effective improvement opportunity for any program management challenge.

The program management challenges that are directly addressed by the most Lean Enablers are Challenge 1 (firefighting and reactive program execution), Challenge 3 (Insufficient alignment of the program enterprise), Challenge 4 (Insufficient process integration) and Challenge 6 (Mismanagement of program culture, team competency, and knowledge). (See Tables A3–A12.)

Table A3: Lean Enablers Directly Addressing Firefighting and Reactive Program Execution

LE #	Lean Enablers Addressing Challenge 1: Reactive Program Execution (Firefighting)
1.1.	Build a program culture based on respect for people
1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.
1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that hiring process matches the real needs of the program for talent and skill.
1.1.3.	Program leadership must be a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation, and drive for excellence.
1.1.4.	Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
1.1.6.	Practice "walk-around management." Do not manage from the cubicle; go to the work and see for yourself.
1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."
1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.
1.1.10.	When resolving issues, attack the problem—not the people.
1.2.	Motivate by making the higher purpose of the program and program elements transparent
1.2.1.	Create a shared vision which draws out and inspires the best in people
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision
1.3.	Support an autonomous working style
1.3.1.	Use and communicate flow down of responsibility, authority, and accountability (RAA) to make decisions at lowest appropriate level.
1.3.2.	Eliminate fear from the work environment. Promote conflict resolution at the lowest level.

LE #	Lean Enablers Addressing Challenge 1: Reactive Program Execution (Firefighting)
1.3.3.	Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.
1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto “rather ask for forgiveness than permission.”
1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement, human creativity, and entrepreneurship.
1.4.	Expect and support people as they strive for professional excellence and promote their careers.
1.4.1.	Establish and support communities of practice.
1.4.2.	Invest in workforce development.
1.4.3.	Ensure tailored Lean training for all employees.
1.4.4.	Give leaders at all levels in-depth Lean training.
1.4.5.	Promote and honor professional meritocracy.
1.4.6.	Establish a highly experienced core group ("grayhairs") that leads by example and institutionalizes positive behavior.
1.4.7.	Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.
1.5.	Promote the ability to rapidly learn and continuously improve.
1.5.1.	Promote and reward continuous learning through education and experiential learning.
1.5.2.	Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."
1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
1.5.4.	Capture and share tacit knowledge to stabilize the program when team members change.
1.5.5.	Develop standards paying attention to human factors, including level of experience and perception abilities.
1.6.	Encourage personal networks and interactions.
1.6.1.	Prefer physical team colocation to the virtual colocation.
1.6.2.	For virtually colocated teams, invest time and money up-front to build personal relationship in face-to-face settings.
1.6.3.	Promote direct human communication to build personal relationships.
1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
1.6.5.	Engage and sustain extensive stakeholder interactions.
1.6.6.	Support the development of informal and social networks within the program and to key stakeholders in the program environment.
1.6.7.	Encourage (and document when appropriate) open information sharing within the program.
1.6.8.	Program manager must have respect and personal relationship with all four main stakeholder groups: customers, superiors, program employees, and key contractors/suppliers.
2.3.1.	Everyone involved in the program must have a customer—first spirit, focusing on the clearly defined program value and requirements.
3.5.3.	Establish a system and process that allows comprehensive, effective, and efficient up-front planning of program before execution begins.
3.5.7.	Ascertain what is available to the program (resources, talent, budget, and timeline) and what is not available prior to making commitment to the customers and other stakeholders.
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.
3.7.10.	Include and manage the major suppliers as a part of your team.
3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items which must be handled at the top level.
4.4.	The top-level program management (e.g., program management office) overseeing the program must be highly effective.

LE #	Lean Enablers Addressing Challenge 1: Reactive Program Execution (Firefighting)
4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.1.	Use existing program management standards, guidelines, and applicable organizational maturity models to the program's best advantage.
6.1.2.	Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.
6.1.3.	Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
6.1.4.	Do not implement any standard purely for achieving any sort of mandated program certification.
6.1.5.	Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses, identify goals, and track progress on the process improvement journey.
6.2.	Pursue Lean for the long term.
6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods, and a Lean business case that ties Lean practices to achieving the program benefits.
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
6.2.5.	Integrate the Lean activities in program management into your overall change management and process improvement approach in order to assure sustainability of the improvements, as well as use synergies with existing process improvement activities.
6.2.6.	Start small by selecting the most beneficial Lean enablers for your program.
6.2.7.	Codify lessons learned and evaluate their effectiveness.
6.2.8.	Look for new and innovative ways to work that add value.
6.3.	Strive for excellence of program management and systems engineering.
6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects.
6.3.2.	Follow basic problem solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.
6.3.3.	Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.
6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.
6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.
6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.
6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.
6.4.	Use lessons learned to make the next program better than the last.
6.4.1.	Create mechanisms to capture, communicate, and apply experience.
6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.
6.4.3.	Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.

LE #	Lean Enablers Addressing Challenge 1: Reactive Program Execution (Firefighting)
6.4.4.	Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement the resulting change.
6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
6.4.6.	Identify best practices through benchmarking and professional literature.
6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.
6.5.	Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.
6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits; redirect, replan, or stop individual program components.
6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.
6.6.	Proactively manage uncertainty and risk to maximize program benefit.
6.6.1.	Focus program risk management on creating and protecting value for the program.
6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.
6.6.3.	Support all critical decisions in the program with risk management results.
6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.
6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.
6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.
6.6.10.	Pay close attention to the opportunities and capture them along with risks.
6.7.	Strive for perfect communication, coordination, and collaboration across people and processes.
6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.
6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose, unstructured memos. Keep underlying data as backup in case it is requested by the receiver.
6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.
6.7.5.	Match the communication competence of people with their roles when staffing the program.
6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.
6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.
6.7.8.	Publish a directory and organizational chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.
6.7.9.	Ensure timely and efficient access to centralized data.
6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.
6.8.	Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.
6.8.1.	Utilize and reward bottom-up suggestions for solving employee-level problems.

LE #	Lean Enablers Addressing Challenge 1: Reactive Program Execution (Firefighting)
6.8.2.	Use quick response small teams comprised of program stakeholders for local problems and development of standards.
6.8.3.	Use formal, large improvement project teams to address program-wide issues.
6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.

Table A4: Lean Enablers Directly Addressing Unstable, Unclear and Incomplete Requirements

LE #	Lean Enablers Addressing Challenge 2: Unclear Requirements
2.1.	Establish the value and benefit of the program to the stakeholders.
2.1.1.	Define value as the outcome of an activity that satisfies at least three conditions: (a.) The external customer stakeholders are willing to pay for value; (b.) Transforms information or material or reduces uncertainty; And (c). Provides specified program benefits right the first time.
2.1.2.	Define value-added in terms of value to the customer stakeholders and their needs.
2.1.3.	Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.
2.1.4.	Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.
2.1.5.	Explain customer stakeholder culture to program employees, that is, the value system, approach, attitude, expectations, and issues.
2.2.	Focus all program activities on the benefits that the program intends to deliver.
2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.
2.2.3.	Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability).
2.3.	Frequently engage the stakeholders throughout the program life cycle.
2.3.1.	Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.
2.3.2.	Establish frequent and effective interaction with internal and external stakeholders.
2.3.3.	Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.
2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
2.3.5.	Structure communication among stakeholders (who, how often, and what).
2.3.6.	Create shared understanding of program content, goals, status, and challenges among key stakeholders.
2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.
2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.
2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.
2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.
2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.
2.4.	Develop high-quality program requirements among customer stakeholders before the bidding and execution process begins.
2.4.1.	Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need, stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.
2.4.2.	Use only highly experienced people and expert institutions to write program requirements, RFPs, and contracts.

LE #	Lean Enablers Addressing Challenge 2: Unclear Requirements
2.4.3.	If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.
2.4.4.	Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, mindless "cut-and-paste" of requirements from previous programs.
2.4.5.	Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.
2.4.6.	Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.
2.4.7.	Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated.
2.4.8.	Always clearly link requirements to specific customer stakeholder needs and trace requirements from this top level to bottom level.
2.4.9.	Use peer-review requirements among stakeholders to ensure consensus validity and absence of conflicts.
2.4.10.	Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.
2.4.11.	Clearly articulate the top-level objectives, value, program benefits, and functional requirements before formal requirements or a request for proposal is issued.
2.4.12.	Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, and the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.
2.5.	Clarify, derive, and prioritize requirements early, often and proactively.
2.5.1.	Develop an agile process to anticipate, accommodate, and communicate changing customer requirements.
2.5.2.	Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items, and do not allow requirements creep.
2.5.3.	Use architectural methods and modeling to create a standard program system representation (3D integrated CAE toolset, mockups, prototypes, models, simulations, and software design tools) that allow interactions with customers and other stakeholders as the best means of drawing out requirements.
2.5.4.	Listen for and capture unspoken customer requirements.
2.5.5.	To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.
2.5.6.	Actively promote the maturation of stakeholder requirements, e.g., by providing detailed trade-off studies, feasibility studies, and virtual prototypes.
2.5.7.	Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.
2.5.8.	Create effective channels for clarification of requirements (e.g., involving customer stakeholders in program teams).
2.5.9.	Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models or spiral development).
2.5.10.	Employ agile methods to manage necessary requirements change and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable.
3.5.14.	The program manager must personally understand, clarify, and remove ambiguity, conflicts, and waste from key requirements and expectations at the program start.
3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.

LE #	Lean Enablers Addressing Challenge 2: Unclear Requirements
3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests, and ensure the requirements are stable.
3.10.8.	Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").
3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.
4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds, and to maximize program stability, relying on technical expertise.
4.10.7.	Align program metrics with intended benefits and stakeholder expectations.
5.1.6.	For nonroutine tasks, avoid rework by coordinating task requirements with internal customer.
6.1.	Make effective use of existing program management and organizational maturity standards.

Table A5: Lean Enablers Directly Addressing Insufficient Alignment and Coordination of the Extended Enterprise

LE #	Lean Enablers Addressing Challenge 3: Insufficient Enterprise Alignment
1.1.6.	Practice "walk-around management." Do not manage from the cubicle; go to the work and see for yourself.
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."
1.2.	Motivate by making the higher purpose of the program and program elements transparent.
1.2.1.	Create a shared vision which draws out and inspires the best in people.
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.
1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
1.6.5.	Engage and sustain extensive stakeholder interactions.
2.1.	Establish the value and benefit of the program to the stakeholders.
2.1.4.	Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.
2.1.5.	Explain customer stakeholder culture to program employees, that is, the value system, approach, attitude, expectations, and issues.
2.2.	Focus all program activities on the benefits that the program intends to deliver.
2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.
2.2.2.	Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program.
2.2.3.	Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability).
2.3.	Frequently engage the stakeholders throughout the program life cycle.
2.3.1.	Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.
2.3.2.	Establish frequent and effective interaction with internal and external stakeholders.
2.3.3.	Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.
2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
2.3.5.	Structure communication among stakeholders (who, how often, and what).
2.3.6.	Create shared understanding of program content, goals, status, and challenges among key stakeholders.
2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.
2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.
2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.

LE #	Lean Enablers Addressing Challenge 3: Insufficient Enterprise Alignment
2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.
2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.
2.5.5.	To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.
2.5.7.	Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.
2.6.	Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects.
2.6.1.	Strive to minimize and streamline the burden of paperwork for external stakeholders by actively engaging them in the process and clearly articulating and aligning the benefit generated by each report.
2.6.2.	Minimize and streamline the program-internal reporting for program activities and subprojects by optimizing the internal reporting requirements. Only require reports that are clearly necessary and align reporting requirements to reduce redundant reporting.
2.6.3.	Ensure all review and approval steps are truly needed and value-adding in the program.
3.1.3.	Have cross-functional stakeholders and program leadership work together to build the agreed value stream.
3.4.	Ensure up-front that capabilities exist to deliver program requirements.
3.4.1.	Ensure strong corporate, institutional and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.
3.4.2.	If "low-balling" is detected on a fixed-price contract, insist on continuing the fixed-price contract, or terminate the program and rebid. Do not allow switching to a cost-plus contract.
3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.
3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.
3.5.4.	The program leadership team (program manager, technical managers, lead system engineers, etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits, the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.
3.7.	Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.
3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
3.7.2.	Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests, and ensure the requirements are stable.
3.7.8.	Select suppliers who are technically and culturally compatible.
3.7.9.	Strive to develop a seamless partnership between suppliers and the product development team.
3.7.10.	Include and manage the major suppliers as a part of your team.
3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items that must be handled at the top level.
3.10.10.	Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.

LE #	Lean Enablers Addressing Challenge 3: Insufficient Enterprise Alignment
3.10.11.	Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
3.11.	Develop a communications plan.
3.11.1.	Develop and execute a clear communications plan that covers the entire value stream and stakeholders.
3.11.2.	Plan to use visual methods wherever possible to communicate schedules, workloads, changes to customer requirements, etc.
4.1.	Use systems engineering to coordinate and integrate all engineering activities in the program.
4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the preproposal phase to the final program delivery.
4.1.2.	Maintain team continuity between phases to maximize experiential learning, including preproposal and proposal phases.
4.3.4.	Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (e.g., by clear traceability of requirements and effective use of change management control boards).
4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.
4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest and converging on consensus.
4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.
4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss over them.
4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision making process.
4.6.	Integrate all program elements and functions through program governance.
4.6.1.	Ensure program governance has full view, control, and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.
4.6.2.	Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk-, communication, and resource management).
4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.
4.6.4.	Use a gated process for validating, planning, and execution of the program and leverage functional expertise at these gates.
4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, software, and hardware design.
4.6.6.	Align incentives across the program enterprise.
4.7.4.	Use frequent, timely, open, and honest communication.
4.7.5.	Promote flat organization to simplify and speed up communication.
4.7.6.	Promote direct, informal, and face-to-face communication.
4.8.	Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.
4.8.4.	Promote process standardization in development, management, and manufacturing.
4.9.7.	Use minimum number of IT tools and make common wherever possible.
4.10.	Make program progress visible to all.
4.10.1.	Make work progress visible and easy to understand to all, including external customer.
4.10.6.	Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.
4.10.7.	Align program metrics with intended benefits and stakeholder expectations.

LE #	Lean Enablers Addressing Challenge 3: Insufficient Enterprise Alignment
4.10.11.	Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.
5.1.4.	Stay connected to the customer during the task execution.
5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
5.2.1.	Establish common contract structures throughout the program.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win–win situations.
5.2.3.	Ensure that contracts support complete and open communication between the program stakeholders.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.1.	Use existing program management standards, guidelines, and applicable organizational maturity models to the program's best advantage.
6.1.2.	Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.
6.1.3.	Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
6.2.6.	Start small by selecting the most beneficial Lean enablers for your program.
6.3.	Strive for excellence of program management and systems engineering.
6.3.1.	Implement the basics of quality. Do not create, pass on or accept defects.
6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.
6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.
6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.
6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organizations.
6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits: redirect, replan, or stop individual program components.
6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.
6.7.	Strive for perfect communication, coordination, and collaboration across people and processes.
6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.
6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.
6.7.5.	Match the communication competence of people with their roles when staffing the program.
6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.

Table A6: Lean Enablers Directly Addressing Locally Optimized Processes that are Not Integrated for the Entire Enterprise

LE #	Lean Enablers Addressing Challenge 4: Process Integration
1.1.10.	When resolving issues, attack the problem, not the people.
1.5.	Promote the ability to rapidly learn and continuously improve.

LE #	Lean Enablers Addressing Challenge 4: Process Integration
1.5.6.	Immediately organize quick training in any new standard to ensure buy-in and awareness.
2.1.3.	Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.
3.1.	Map the management and engineering value streams and eliminate non-value added elements.
3.1.1.	Plan to develop only what needs to be developed.
3.1.2.	Promote reuse and sharing of program assets. Utilize standards, standard processes, modules of knowledge, technical standardization and platforms, and software libraries.
3.1.3.	Have cross-functional stakeholders and program leadership work together to build the agreed value stream.
3.1.4.	Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks.
3.2.	Actively architect and manage the program enterprise to optimize its performance as a system.
3.2.1.	Keep activities during early program phases internal and colocated, as there is a high need for coordination.
3.2.2.	Set up a single, colocated organization to handle the entire systems engineering and architecting for the entire effort throughout the life cycle, in order to increase RAA.
3.2.3.	Ensure that systems engineering and architecting are a central part of program management and not outsourced or subcontracted, as these activities require a high level of coordination.
3.2.4.	Develop a clear vision and holistic view of the future state of your program enterprise, including future portfolio of products, including both the future organization as well as the future value stream. Provide guidance on a clear path forward and ensure that resources are aligned with this vision.
3.2.5.	Use a clear architectural description of the agreed solution to plan a coherent program, engineering, and commercial structures.
3.2.6.	Change the program “mindset” to focus on the entire program enterprise and the value it delivers to customer stakeholders.
3.2.7.	Lead and sustain the transformation to an integrated program management and systems engineering enterprise across customer and supplier organizations.
3.2.8.	Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors.
3.3.	Pursue multiple solution sets in parallel.
3.3.1.	Plan to utilize cross - functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.
3.3.2.	Explore the trade space and margins fully before focusing on a point decision and too small margins.
3.3.3.	For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of Set-Based Concurrent Engineering.
3.3.4.	Explore multiple concepts, architectures, and designs early.
3.3.5.	Explore constraints and perform real trades before converging on a point design.
3.3.6.	All other things being equal, select the simplest solution.
3.4.	Ensure up-front that capabilities exist to deliver program requirements.
3.4.1.	Ensure strong corporate, institutional and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.
3.4.2.	If "low-balling" is detected on a fixed-price contract, insist on continuing the fixed-price contract, or terminate the program, and rebid. Do not allow switching to cost-plus contracts.
3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits, the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.

LE #	Lean Enablers Addressing Challenge 4: Process Integration
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.
3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.
3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests, and ensure the requirements are stable.
3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items which must be handled at the top level.
4.1.	Use systems engineering to coordinate and integrate all engineering activities in the program.
4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the preproposal phase to the final program delivery.
4.1.2.	Maintain team continuity between phases to maximize experiential learning, including preproposal and proposal phases.
4.5.	Pursue collaborative and inclusive decision making that resolves the root causes of issues.
4.5.1.	If decisions are based on assumptions that are likely to change, keep track of those assumptions and adjust the decisions when they change.
4.5.2.	Define the information needs as well as time frame for decision making. Adjust the needed information and analysis to reflect the allotted time for reaching a decision.
4.5.3.	Take the time necessary to reach good decisions. Always explore a number of alternatives.
4.5.4.	Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.
4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.
4.5.6.	If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.
4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest and converging on consensus.
4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.
4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.
4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision making process.
4.6.	Integrate all program elements and functions through Program Governance.
4.6.1.	Ensure program governance has full view, control and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.
4.6.2.	Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk, communication, and resource management).
4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.
4.6.4.	Use a gated process for validating, planning, and execution of the program, and leverage functional expertise at these gates.
4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, software, and hardware design.
4.6.6.	Align incentives across the program enterprise.
4.7.	Use efficient and effective communication and coordination with program team.
4.7.1.	Capture and absorb lessons learned from almost all programs.
4.7.2.	Maximize coordination of effort and flow.

LE #	Lean Enablers Addressing Challenge 4: Process Integration
4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise, and with suppliers.
4.7.4.	Use frequent, timely, open, and honest communication.
4.7.5.	Promote flat organization to simplify and speed up communication.
4.7.6.	Promote direct, informal and face-to-face communication.
4.8.1.	Standardize program management metrics and reporting system.
4.8.2.	Identify repeatable program management activities and standardize them.
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
4.8.4.	Promote process standardization in development, management, and manufacturing.
4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.
4.9.	Use Lean Thinking to promote smooth program flow.
4.9.1.	Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) Question everything with multiple “whys”’ (b.) Align process flow to decision flow;(c). Resolve all issues as they occur in frequent integrative events; and (d.) Discuss tradeoffs and options.
4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds, and to maximize program stability, relying on technical expertise.
4.9.3.	Minimize handoffs to avoid rework.
4.9.4.	Optimize human resources when allocating value-added (VA) and required, non-value-added (RNVA) tasks: (a.) Use professionals to do value-adding professional work; and (b.) When professionals are not absolutely required, use nonprofessionals (support staff) to do required, non-value adding tasks.
4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.
4.9.6.	Use Lean tools to promote the flow of information and minimize handoffs. Implement small batchs size of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide communication bandwidth, standardization, work cells, and training.
4.9.7.	Use minimum number of IT tools and make common wherever possible.
4.9.8.	Minimize the number of the software revision updates (e.g., noncritical updates) of IT tools and centrally control the update releases to prevent information churning.
4.9.9.	Adapt the IT tools to fit the people and process.
4.9.10.	Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.
5.1.	Pull tasks and outputs based on need, and reject others as waste.
5.1.1.	Let information needs pull the necessary work activities.
5.1.2.	Promote the culture in which people pull knowledge as they need it and limit the supply of information to genuine users only.
5.1.3.	Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task; use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.
5.1.4.	Stay connected to the customer during the task execution.
5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
5.1.6.	For nonroutine tasks, avoid rework by coordinating task requirements with internal customer.
5.1.7.	When pulling work, use customer stakeholder value to separate value added from waste.
5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.1.	Use existing program management standards, guidelines, and applicable organizational maturity models to the program’s best advantage.

LE #	Lean Enablers Addressing Challenge 4: Process Integration
6.1.2.	Focus on achieving the program benefits when selecting, customizing and implementing program management standards, guidelines, and maturity models.
6.1.3.	Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
6.1.4.	Do not implement any standard purely for achieving any sort of mandated program certification.
6.1.5.	Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses, goals, and track progress on the process improvement journey.
6.2.	Pursue Lean for the long term.
6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods, and a Lean business case that ties Lean practices to achieving the program benefits.
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
6.2.5.	Integrate the Lean activities in program management into the overall change management and process improvement approach in order to assure sustainability of the improvements, and use synergies with existing process improvement activities.
6.2.6.	Start small by selecting the most beneficial Lean enablers for your program.
6.3.	Strive for excellence of program management and systems engineering.
6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects.
6.3.2.	Follow basic problem solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.
6.3.3.	Promote excellence under "normal" circumstances and reward pro-active management of risks, instead of rewarding "hero" behavior in crisis situations.
6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.
6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.
6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
6.4.6.	Identify best practices through benchmarking and professional literature.
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.
6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
6.8.	Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.
6.8.1.	Utilize and reward bottom-up suggestions for solving employee-level problems.
6.8.2.	Use quick response small teams comprised of program stakeholders for local problems and development of standards.
6.8.3.	Use formal, large improvement project teams to address program-wide issues.
6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.

Table A7: Lean Enablers Directly Addressing Unclear Roles, Responsibilities, and Accountability

LE #	Lean Enablers Addressing Challenge 5: Unclear Roles and Responsibility
1.3.1.	Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.
3.5.4.	The program leadership team (program manager, technical managers, lead system engineers etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits, the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.5.9.	For all critical activities, define who is responsible for approving, supporting, and informing (also known as the RACI matrix), using a standardized tool, paying attention to precedence of tasks, and documenting handoffs.
3.7.10.	Include and manage the major suppliers as a part of your team.
4.2.	Ensure clear responsibility, accountability and authority (RAA) throughout the program from initial requirements definition to final delivery.
4.2.1.	Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical).
4.2.2.	Ensure continuity in the program manager position and avoid personnel rotation.
4.2.3.	Define and clearly communicate the program manager's RAA across all stakeholders.
4.2.4.	Hold people responsible for their contributions throughout the program life cycle. Upstream activities must be held responsible for issues they cause in downstream activities.
4.2.5.	In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation of the necessities in each other's domain.
4.2.6.	Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.
4.3.	For every program, use a program manager role to lead and integrate the program from start to finish.
4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.
4.3.2.	Ensure that the program manager possesses an appropriate background regarding: business, general management, and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.
4.3.3.	Ensure that the competency, technical knowledge, and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.
4.5.	Pursue collaborative and inclusive decision making that resolves the root causes of issues.
4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.
4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.
4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise, and with suppliers.
5.1.3.	Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task - use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.3.2.	Follow basic problem solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.

Table A8: Lean Enablers Directly Addressing Mismanagement of Program Culture, Team Competency and Knowledge

LE #	Lean Enablers Addressing Challenge 6: Culture, Competency & Skills
1.1.	Build a program culture based on respect for people.

LE #	Lean Enablers Addressing Challenge 6: Culture, Competency & Skills
1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.
1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that hiring process matches the real needs of the program for talent and skill.
1.1.3.	Program leadership must be a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation, and drive for excellence.
1.1.4.	Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
1.1.5.	Reward based upon team performance, and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
1.1.6.	Practice "walk-around management." Do not manage from cubicle; go to the work and see for yourself.
1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."
1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.
1.2.1.	Create a shared vision which draws out and inspires the best in people.
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.
1.3.	Support an autonomous working style.
1.3.1.	Use and communicate flow down of responsibility, authority, and accountability (RAA) to make decisions at lowest appropriate level.
1.3.2.	Eliminate fear from the work environment: promote conflict resolution at the lowest level.
1.3.3.	Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.
1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto “rather ask for forgiveness than permission.”
1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.
1.4.	Expect and support people as they strive for professional excellence and promote their careers.
1.4.1.	Establish and support communities of practice.
1.4.2.	Invest in workforce development.
1.4.3.	Ensure tailored Lean training for all employees.
1.4.4.	Give leaders at all levels in-depth Lean training.
1.4.5.	Promote and honor professional meritocracy.
1.4.6.	Establish a highly experienced core group ("grayhairs") that leads by example and institutionalizes positive behavior.
1.4.7.	Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.
1.5.	Promote the ability to rapidly learn and continuously improve.
1.5.1.	Promote and reward continuous learning through education and experiential learning.
1.5.2.	Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."
1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
1.5.4.	Capture and share tacit knowledge to stabilize the program when team members change.
1.5.5.	Develop standards paying attention to human factors, including level of experience and perception abilities.
1.5.6.	Immediately organize quick training in any new standard to ensure buy-in and awareness.
1.6.	Encourage personal networks and interactions.

LE #	Lean Enablers Addressing Challenge 6: Culture, Competency & Skills
1.6.1.	Prefer physical team colocation to the virtual colocation.
1.6.2.	For virtually colocated teams, invest time and money up-front to build personal relationship in face-to-face settings.
1.6.3.	Promote direct human communication to build personal relationships.
1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
1.6.6.	Support the development of informal and social networks within the program and to key stakeholders in the program environment.
1.6.7.	Encourage (and document when appropriate) open information sharing within the program.
1.6.8.	Program manager must have respect and personal relationship with all four main stakeholder groups: customers, superiors, program employees and key contractors/suppliers.
3.3.1.	Plan to utilize cross - functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
3.7.8.	Select suppliers who are technically and culturally compatible.
3.7.10.	Include and manage the major suppliers as a part of your team.
3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
4.1.2.	Maintain team continuity between phases to maximize experiential learning, including pre-proposal and proposal phases.
4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.
4.3.2.	Ensure that the program manager possesses an appropriate background regarding: business, general management, and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.
4.3.3.	Ensure that the competency, technical knowledge and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.
4.3.4.	Ensure that the program manager has clarity over the impact of technical requirements and scope changes (e.g., by clear traceability of requirements and effective use of change management control boards).
4.4.	The top level program management (e.g., program management office) overseeing the program must be highly effective.
4.4.1.	Program management staff turnover and hiring rates must be kept low.
4.4.2.	Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.
4.7.1.	Capture and absorb lessons learned from almost all programs.
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.
4.9.4.	Optimize human resources when allocating value-added (VA) and required, non-value-added (RNVA) tasks: (a.) Use professionals to do value-adding professional work; and (b.) When professionals are not absolutely required, use nonprofessionals (support staff) to do required, non-value adding tasks.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods and a Lean business case that ties Lean practices to achieving the program benefits.
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.
6.2.7.	Codify lessons learned and evaluate their effectiveness.
6.2.8.	Look for new and innovative ways to work that add value.
6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.

LE #	Lean Enablers Addressing Challenge 6: Culture, Competency & Skills
6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
6.4.	Use lessons learned to make the next program better than the last.
6.4.1.	Create mechanisms to capture, communicate, and apply experience.
6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.
6.4.3.	Create a process to regularly review, evaluate and standardize lessons learned and prepare them for implementation.
6.4.4.	Assign responsibility and accountability for reviewing, evaluating, standardizing lessons learned, and implement resulting change.
6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
6.4.6.	Identify best practices through benchmarking and professional literature.
6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.
6.5.	Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.
6.6.	Proactively manage uncertainty and risk to maximize program benefit.
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.
6.7.	Strive for perfect communication, coordination and collaboration across people and processes.
6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.
6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.
6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision- making methods at the program beginning.
6.7.5.	Match the communication competence of people with their roles when staffing the program
6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.
6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.
6.7.8.	Publish a directory and organization chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.
6.7.9.	Ensure timely and efficient access to centralized data.
6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.

Table A9: Lean Enablers Directly Addressing Insufficient Program Planning

LE #	Lean Enablers Addressing Challenge 7: Insufficient Planning
2.2.2.	Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program.
2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
3.1.1.	Plan to develop only what needs to be developed.
3.5.	Front-load and integrate the program.
3.5.1.	Plan early for consistent robustness and right the first time under "normal" circumstances, instead of hero-behavior in later "crisis" situations.

LE #	Lean Enablers Addressing Challenge 7: Insufficient Planning
3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.
3.5.3.	Establish a system and process that allows comprehensive, effective and efficient up-front planning of program before execution begins.
3.5.4.	The program leadership team (program manager, technical managers, lead system engineers, etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.5.6.	Propagate front-loading of program throughout critical subprojects with similar workshops to those described in 3.5.5.
3.5.7.	Ascertain what is available to the program (resources, talent, budget, and timeline) and what not available prior to making commitment to the customers and other stakeholders.
3.5.8.	Hold Lean Accelerated Planning sessions at the program level and for key subprojects, engaging all stakeholders in developing master schedule, value stream map, risks and opportunities, key assumptions, and action items.
3.5.9.	For all critical activities, define who is responsible, approving, supporting, and informing (also known as RACI matrix), using a standardized tool, paying attention to precedence of tasks and documenting handoffs.
3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.
3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.
3.5.12.	Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.
3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.
3.5.14.	Program manager must personally understand, clarify and remove ambiguity, conflicts, and waste from key requirements and expectations at the program start.
3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.
3.6.	Use probabilistic estimates in program planning.
3.6.1.	Develop probabilistic estimates for cost, schedule, and other critical planning forecasts.
3.6.2.	Base planning assumptions on confidence intervals—not on point estimates.
3.9.	Develop an integrated program schedule at the level of detail for which you have dependable information.
3.9.1.	Create a plan to appropriately integrate and align program management, systems engineering, and other high-level planning and coordination functions.
3.9.2.	Maximize concurrency of independent tasks and tasks that inform each other.
3.9.3.	Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.
3.9.4.	Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading, that is, have appropriate contingencies and schedule buffers.
3.9.5.	Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.
3.9.6.	Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks with what data and when), understanding task dependencies, and parent –child relationships.
3.9.7.	Update detailed planning regularly to reflect new information, being consistent with the long-term strategic plan. Do not force programs to execute against a detailed, outdated plan that was developed based on incomplete information.
3.11.2.	Plan to use visual methods wherever possible to communicate schedules, workloads, and changes to customer requirements, etc.
4.8.	Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.

LE #	Lean Enablers Addressing Challenge 7: Insufficient Planning
4.8.2.	Identify repeatable program management activities and standardize them.
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
4.8.4.	Promote process standardization in development, management, and manufacturing.
6.1.	Make effective use of existing program management and organizational maturity standards

Table A10: Lean Enablers Directly Addressing Improper Metrics, Metric Systems and KPIs

LE #	Lean Enablers Addressing Challenge 8: Improper Metrics
1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.
3.8.	Plan leading indicators and metrics to manage the program.
3.8.1.	Use leading indicators to enable action before risks become issues.
3.8.2.	Focus metrics around customer stakeholder value and program benefits.
3.8.3.	Use only few simple and easy to understand metrics and share them frequently throughout the enterprise.
3.8.4.	Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.
3.8.5.	Use only those metrics that meet a stated need, objective, or program benefit.
4.6.6.	Align incentives across the program enterprise.
4.8.1.	Standardize program management metrics and reporting system.
4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.
4.10.	Make program progress visible to all.
4.10.1.	Make work progress visible and easy to understand to all, including external customer.
4.10.2.	Track the program's overall progress to deliver the program benefits.
4.10.3.	Utilize visual controls in public spaces for best visibility (avoid computer screens).
4.10.4.	Develop a system that makes imperfections and delays visible to all.
4.10.5.	Use traffic light system (green, yellow, red) to report task status visually (good, warning, critical) and make certain problems are not concealed.
4.10.6.	Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.
4.10.7.	Align program metrics with intended benefits and stakeholder expectations.
4.10.8.	Establish clear line-of-sight between lower-level program and project metrics and top-level program success metrics.
4.10.9.	Develop a snapshot/summary representation of the meaningful metrics (e.g., standard deck) to measure all phases of the project and program and make it available to all.
4.10.10.	Track reduction of risk and uncertainty throughout program life cycle as KPI.
4.10.11.	Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win–win situations.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
6.3.3.	Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.

LE #	Lean Enablers Addressing Challenge 8: Improper Metrics
6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.

Table A11: Lean Enablers Directly Addressing Lack of Proactive Program Risk Management

LE #	Lean Enablers Addressing Challenge 9: Lack of Risk Management
3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.
3.5.12.	Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.
3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
3.8.1.	Use leading indicators to enable action before risks become issues.
3.10.	Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
3.10.1.	Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before starting a large-scale program.
3.10.2.	Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).
3.10.3.	Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.
3.10.4.	Utilize program management strategies that produce the best balance between technology risk and reward in your program, such as evolutionary acquisition and incremental or spiral development.
3.10.5.	Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.
3.10.6.	Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in the risk mitigation plan. Reexamine for integration into program after significant progress has been made or defer to future systems.
3.10.7.	Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.
3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.
3.10.11.	Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
4.10.10.	Track reduction of risk and uncertainty throughout program life cycle as KPI.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win–win situations.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.6.	Proactively manage uncertainty and risk to maximize program benefit.
6.6.1.	Focus program risk management on creating and protecting value for the program.
6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.
6.6.3.	Support all critical decisions in the program with risk management results.
6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.
6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.

LE #	Lean Enablers Addressing Challenge 9: Lack of Risk Management
6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.
6.6.10.	Pay close attention to the opportunities and capture them along with risks.

Table A12: Lean Enablers Directly Addressing Challenge 10: Poor Program Acquisition and Contracting Practices

LE #	Lean Enablers Addressing Challenge 10: Poor Contracting and Acquisition
3.4.2.	If a "low-balling" is detected on a fixed price contract, insist on continuing the fixed price contract, or program termination and rebid. Do not allow switching to cost-plus.
3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
3.7.8.	Select suppliers who are technically and culturally compatible.
3.10.	Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
3.10.1.	Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before starting a large-scale program.
3.10.2.	Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).
3.10.3.	Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.
3.10.4.	Utilize program management strategies that produce the best balance between technology risk and reward in the program, such as evolutionary acquisition and incremental or spiral development.
3.10.5.	Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.
3.10.6.	Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in the risk mitigation plan. Reexamine for integration into program after significant progress has been made or defer to future systems.
3.10.7.	Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.
3.10.8.	Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").
3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.
3.10.10.	Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.
3.10.11.	Utilize Independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
5.2.1.	Establish common contract structures throughout the program.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win–win situations.
5.2.3.	Ensure that contracts support complete and open communication between the program stakeholders.
6.1.	Make effective use of existing program management and organizational maturity standards.

A.5.2 Mapping to Program Management Performance Domains

Tables A13 through A 17 contain the Lean Enablers, sorted by Program Management Performance Domain.

Table A13: Lean Enablers Related to Program Governance

#	Enablers and Subenablers Related to Program Governance
1.3.	Support an autonomous working style.
1.3.1.	Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.
1.3.2.	Eliminate fear from the work environment. Promote conflict resolution at the lowest level.
1.3.3.	Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.
1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto “rather ask for forgiveness than permission.”
1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.
1.4.	Expect and support people as they strive for professional excellence and promote their careers.
1.4.1.	Establish and support communities of practice.
1.4.2.	Invest in workforce development.
1.4.3.	Ensure tailored Lean training for all employees.
1.4.4.	Give leaders at all levels in-depth Lean training.
1.4.5.	Promote and honor professional meritocracy.
1.4.6.	Establish a highly experienced core group ("grayhairs") that leads by example and institutionalizes positive behavior.
1.4.7.	Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.
1.5.	Promote the ability to rapidly learn and continuously improve.
1.5.1.	Promote and reward continuous learning through education and experiential learning.
1.5.2.	Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."
1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
1.5.5.	Develop standards paying attention to human factors, including level of experience and perception abilities.
1.5.6.	Immediately organize quick training in any new standard to ensure buy-in and awareness.
1.6.	Encourage personal networks and interactions.
1.6.1.	Prefer physical team colocation to the virtual colocation.
1.6.2.	For virtually colocated teams, invest time and money up-front to build personal relationship in face-to-face settings.
1.6.3.	Promote direct human communication to build personal relationships.
2.1.5.	Explain customer stakeholder culture to program employees, that is, the value system, approach, attitude, expectations, and issues.
2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.
2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.
2.3.3.	Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.
2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
2.4.1.	Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need, stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.

#	Enablers and Subenablers Related to Program Governance
2.4.10.	Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.
2.4.11.	Clearly articulate the top-level objectives, value, program benefits and functional requirements before formal requirements or a request for proposal is issued.
2.4.12.	Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.
2.4.2.	Use only highly experienced people and expert institutions to write program requirements, RFPs and contracts.
2.4.3.	If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.
2.4.4.	Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, mindless "cut-and-paste" of requirements from previous programs.
2.4.5.	Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.
2.4.6.	Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.
2.4.7.	Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated.
2.5.	Clarify, derive, and prioritize requirements early, often, and proactively.
2.5.1.	Develop an agile process to anticipate, accommodate, and communicate changing customer requirements.
2.5.10.	Employ agile methods to manage necessary requirements change, and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable.
2.5.2.	Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items, and do not allow requirements creep.
2.5.3.	Use architectural methods and modeling to create a standard program system representation (3D integrated CAE toolset, mockups, prototypes, models, simulations, and software design tools) that allow interactions with customers and other stakeholders as the best means of drawing out requirements.
2.5.6.	Actively promote the maturation of stakeholder requirements, for example, by providing detailed trade-off studies, feasibility studies, and virtual prototypes.
2.5.8.	Create effective channels for clarification of requirements (e.g., involving customer stakeholders in program teams).
2.5.9.	Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models, or spiral development).
2.6.	Actively minimize the bureaucratic, regulatory. and compliance burden on the program and subprojects.
2.6.2.	Minimize and streamline the program-internal reporting for program activities and subprojects by optimizing the internal reporting requirements. Only require reports that are clearly necessary, and align reporting requirements to reduce redundant reporting.
2.6.3.	Ensure all review and approval steps are truly needed and value-adding in the program.
3.1.2.	Promote reuse and sharing of program assets. Utilize standards, standard processes, modules of knowledge, technical standardization and platforms, and software libraries.
3.1.4.	Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks.
3.10.6.	Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in the risk mitigation plan. Reexamine for integration into program after significant progress has been made or defer to future systems.

#	Enablers and Subenablers Related to Program Governance
3.10.7.	Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.
3.10.8.	Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").
3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.
3.2.	Actively architect and manage the program enterprise to optimize its performance as a system.
3.2.1.	Keep activities during early program phases internal and colocated, as there is a high need for coordination.
3.2.2.	Set up a single, colocated organization to handle the entire systems engineering and architecting for the entire effort throughout the life cycle, in order to increase RAA.
3.2.3.	Ensure that systems engineering and architecting are a central part of program management and not outsourced or subcontracted, as these activities require a high level of coordination.
3.2.5.	Use a clear architectural description of the agreed solution to plan coherent programs, engineering, and commercial structures.
3.2.8.	Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors.
3.3.	Pursue multiple solution sets in parallel.
3.3.1.	Plan to utilize cross-functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.
3.3.3.	For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of Set-Based Concurrent Engineering.
3.3.4.	Explore multiple concepts, architectures, and designs early.
3.3.5.	Explore constraints and perform real trades before converging on a point design.
3.3.6.	All other things being equal, select the simplest solution.
3.4.	Ensure up-front that capabilities exist to deliver program requirements.
3.4.1.	Ensure strong corporate, institutional and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.
3.4.2.	If low-balling is detected on a fixed-price contract, insist on continuing the fixed-price contract, or terminate the program, and rebid. Do not allow switching to cost-plus contracts.
3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.
3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.
3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.
3.5.6.	Propagate front-loading of program throughout critical subprojects with similar workshops to those described previously.
3.5.7.	Ascertain what is available to the program (resources, talent, budget and timeline) and what not available prior to making commitment to the customers and other stakeholders.
3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
3.7.10.	Include and manage the major suppliers as a part of your team.
3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
3.7.2.	Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.
3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.

#	Enablers and Subenablers Related to Program Governance
3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.
3.7.8.	Select suppliers who are technically and culturally compatible.
3.7.9.	Strive to develop a seamless partnership between suppliers and the product development team.
3.8.	Plan leading indicators and metrics to manage the program.
3.8.1.	Use leading indicators to enable action before risks become issues.
3.8.2.	Focus metrics around customer stakeholder value and program benefits.
3.8.3.	Use only few simple and easy to understand metrics and share them frequently throughout the enterprise.
3.8.4.	Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.
3.8.5.	Use only those metrics that meet a stated need, objective, or program benefit.
4.1.	Use systems engineering to coordinate and integrate all engineering activities in the program.
4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the preproposal phase to the final program delivery.
4.1.2.	Maintain team continuity between phases to maximize experiential learning, including preproposal and proposal phases.
4.10.7.	Align program metrics with intended benefits and stakeholder expectations.
4.10.8.	Establish clear line-of-sight between lower-level program and project metrics and top-level program success metrics.
4.10.9.	Develop a snapshot/summary representation of the meaningful metrics (e.g., standard deck) to measure all phases of the project and program and make it available to all.
4.2.	Ensure clear responsibility, accountability. and authority (RAA) throughout the program from initial requirements definition to final delivery.
4.2.1.	Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical).
4.2.2.	Ensure continuity in the program manager position and avoid personnel rotation.
4.2.3.	Define and clearly communicate the program manager's RAA across all stakeholders.
4.2.5.	In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation of the necessities in each other's domain.
4.2.6.	Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.
4.3.	For every program, use a program manager role to lead and integrate the program from start to finish.
4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.
4.3.2.	Ensure that the program manager possesses an appropriate background regarding business, general management and engineering experience, leadership and people skills, and experience working on highly technical engineering programs.
4.3.3.	Ensure that the competency, technical knowledge and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.
4.3.4.	Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (for example by clear traceability of requirements and effective use of change management control boards).
4.4.	The top-level program management (e.g., program management office) overseeing the program must be highly effective.
4.4.1.	Program management staff turnover and hiring rates must be kept low.
4.4.2.	Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.
4.5.6.	If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.

#	Enablers and Subenablers Related to Program Governance
4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest, and converging on consensus.
4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.
4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility, and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.
4.6.	Integrate all program elements and functions through Program Governance.
4.6.1.	Ensure program governance has full view, control and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.
4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage nonadvocates in review process.
4.6.4.	Use a gated process for validating, planning, and execution of the program and leverage functional expertise at these gates.
4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, design, and hardware design.
4.6.6.	Align incentives across the program enterprise.
4.7.	Use efficient and effective communication and coordination with program team.
4.7.5.	Promote flat organization to simplify and speed up communication.
4.7.6.	Promote direct, informal, and face-to-face communication.
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
4.8.4.	Promote process standardization in development, management, and manufacturing.
4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.
4.9.	Use Lean Thinking to promote smooth program flow.
4.9.1.	Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) Question everything with multiple “whys”; (b.) Align process flow to decision flow; (c.) Resolve all issues as they occur in frequent integrative events; and (d.) Discuss tradeoffs and options.
4.9.10.	Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.
5.1.3.	Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task—use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.
5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
5.2.1.	Establish common contract structures throughout the program.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win—win situations.
5.2.3.	Ensure that contracts support complete and open communication between the program stakeholders.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.1.	Use existing program management standards, guidelines and applicable organizational maturity models to your program’s best advantage.
6.1.4.	Do not implement any standard purely for achieving any sort of mandated program certification.
6.1.5.	Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses or goals and track progress on the process improvement journey.
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods and a Lean business case that ties Lean practices to achieving the program benefits.
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.

#	Enablers and Subenablers Related to Program Governance
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
6.2.6.	Start small by selecting the most beneficial Lean enablers for the program.
6.2.7.	Codify lessons learned and evaluate their effectiveness.
6.2.8.	Look for new and innovative ways to work that add value.
6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects
6.4.	Use lessons learned to make the next program better than the last.
6.4.1.	Create mechanisms to capture, communicate, and apply experience.
6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.
6.4.3.	Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.
6.4.4.	Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement resulting change.
6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
6.4.6.	Identify best practices through benchmarking and professional literature.
6.5.	Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.
6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits: Redirect, replan or stop individual program components.
6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.
6.6.	Proactively manage uncertainty and risk to maximize program benefit.
6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.
6.6.3.	Support all critical decisions in the program with risk management results.
6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.
6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.

Table A14: Lean Enablers Related to Program Strategy Alignment

#	Enablers and Subenablers related to Program Strategy Alignment
2.1.1.	Define value as the outcome of an activity that satisfies at least three conditions: (a.) The external customer stakeholders are willing to pay for value; (b.) Transforms information or material or reduces uncertainty; and (c.) Provides specified program benefits right the first time.
2.1.2.	Define value-added in terms of value to the customer stakeholders and their needs.
2.1.3.	Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.
2.4.8.	Always clearly link requirements to specific customer stakeholder needs and trace requirements from this top level to bottom level.
3.2.6.	Change the program "mindset" to focus on the entire program enterprise and the value it delivers to customer stakeholders.
3.2.7.	Lead and sustain the transformation to an integrated program management and systems engineering enterprise across customer and supplier organizations.
3.3.2.	Explore the trade space and margins fully before focusing on a point decision and too small margins.
3.9.1.	Create a plan to appropriately integrate and align program management, systems engineering, and other high-level planning and coordination functions.

#	Enablers and Subenablers related to Program Strategy Alignment
4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision-making process.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.3.	Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
6.2.	Pursue Lean for the long term.
6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
6.2.5.	Integrate the Lean activities in program management into an overall change management and process improvement approach in order to assure sustainability of the improvements, as well as use synergies with existing process improvement activities.
6.3.	Strive for excellence of program management and systems engineering.
6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.
6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.

Table A15: Lean Enablers Related to Program Stakeholder Engagement

#	Enablers and Subenablers Related to Program Stakeholder Engagement
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."
1.6.5.	Engage and sustain extensive stakeholder interactions.
1.6.6.	Support the development of informal and social networks within the program and to key stakeholders in the program environment.
1.6.7.	Encourage (and document when appropriate) open information sharing within the program.
2.1.4.	Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.
2.3.	Frequently engage the stakeholders throughout the program life cycle.
2.3.1.	Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.
2.3.2.	Establish frequent and effective interaction with internal and external stakeholders.
2.3.5.	Structure communication among stakeholders (who, how often, and what).
2.3.6.	Create shared understanding of program content, goals, status, and challenges among key stakeholders.
2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.
2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.
2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.
2.4.	Develop high-quality program requirements among customer stakeholders before bidding and execution process begins.
2.4.9.	Use peer-review requirements among stakeholders to ensure consensus validity and absence of conflicts.
2.5.4.	Listen for and capture unspoken customer requirements
2.5.5.	To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.
2.5.7.	Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.
2.6.1.	Strive to minimize and streamline the burden of paperwork for external stakeholders by actively engaging them in the process and clearly articulating and aligning the benefit generated by each report.

#	Enablers and Subenablers Related to Program Stakeholder Engagement
3.11.	Develop a communications plan.
3.11.1.	Develop and execute a clear communications plan that covers the entire value stream and stakeholders.
3.11.2.	Plan to use visual methods wherever possible to communicate schedules, workloads, and changes to customer requirements, etc.
3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.7.	Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests; and ensure the requirements are stable.
4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.
5.1.4.	Stay connected to the customer during the task execution.
5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
5.1.6.	For nonroutine tasks, avoid rework by coordinating task requirements with internal customers.
6.1.	Make effective use of existing program management and organizational maturity standards.

Table A16: Lean Enablers Related to Program Benefits Management

#	Enablers and Subenablers Related to Program Benefits Management
1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
2.1.	Establish the value and benefit of the program to the stakeholders.
2.2.	Focus all program activities on the benefits that the program intends to deliver.
2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.
2.2.2.	Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program.
2.2.3.	Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability).
3.1.	Map the management and engineering value streams and eliminate non-value-added elements.
3.1.1.	Plan to develop only what needs to be developed.
3.1.3.	Have cross-functional stakeholders and program leadership work together to build the agreed value stream.
3.2.4.	Develop a clear vision and holistic view of the future state of the program enterprise, including the future portfolio of products, the future organization, and the future value stream. Provide guidance on a clear path forward and ensure that resources are aligned with this vision.
3.5.14.	Program manager must personally understand, clarify and remove ambiguity, conflicts and waste from key requirements and expectations at the program start.
4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds and to maximize program stability, relying on technical expertise.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.2.	Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.

Table A17: Lean Enablers Related to Program Life-cycle Management

#	Enablers and Subenablers Related to Program Life-cycle Management
1.1.	Build a program culture based on respect for people.
1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.
1.1.10.	When resolving issues, attack the problem, not the people.
1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that the hiring process matches the real needs of the program for talent and skill.
1.1.3.	Program leadership must act as a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation, and drive for excellence.
1.1.4.	Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
1.1.6.	Practice “walk-around management." Do not manage from a cubicle; go to the work and see for yourself.
1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).
1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.
1.2.	Motivate by making the higher purpose of the program and program elements transparent.
1.2.1.	Create a shared vision which draws out and inspires the best in people.
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.
1.3.	Support an autonomous working style.
1.5.4.	Capture and share tacit knowledge to stabilize the program when team members change.
3.10.	Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
3.10.1.	Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before starting a large-scale program.
3.10.10.	Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.
3.10.11.	Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
3.10.2.	Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).
3.10.3.	Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.
3.10.4.	Utilize program management strategies that produce the best balance between technology risk and reward in your program, such as evolutionary acquisition and incremental or spiral development.
3.10.5.	Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.
3.5.	Front-load and integrate the program.
3.5.1.	Plan early for consistent robustness and right the first time under "normal" circumstances, instead of hero-behavior in later "crisis" situations.
3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.
3.5.12.	Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.
3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.

#	Enablers and Subenablers Related to Program Life-cycle Management
3.5.3.	Establish a system and process that allows comprehensive, effective and efficient up-front planning of program before execution begins.
3.5.8.	Hold Lean accelerated planning sessions at the program level and for key subprojects, engaging all stakeholders in developing master schedule, value stream map, risks and opportunities, key assumptions, and action items.
3.5.9.	For all critical activities, define who is responsible, approving, supporting, and informing (also known as RACI matrix), using a standardized tool, paying attention to precedence of tasks and documenting handoffs.
3.6.	Use probabilistic estimates in program planning.
3.6.1.	Develop probabilistic estimates for cost, schedule, and other critical planning forecasts.
3.6.2.	Base planning assumptions on confidence intervals, not on point estimates.
3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items, which must be handled at the top level.
3.9.	Develop an integrated program schedule at the level of detail for which you have dependable information.
3.9.2.	Maximize concurrency of independent tasks and tasks that inform each other.
3.9.3.	Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.
3.9.4.	Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading, that is, have appropriate contingencies and schedule buffers.
3.9.5.	Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.
3.9.6.	Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks with what data and when), understanding task dependencies and parent – child relationships.
3.9.7.	Update detailed planning regularly to reflect new information, being consistent with the long-term strategic plan. Do not force programs to execute against a detailed, outdated plan that was developed based on incomplete information.
4.10.	Make program progress visible to all.
4.10.1.	Make work progress visible and easy to understand to all, including external customer.
4.10.10.	Track reduction of risk and uncertainty throughout program life cycle as KPI.
4.10.11.	Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.
4.10.2.	Track the program's overall progress to deliver the program benefits.
4.10.3.	Utilize visual controls in public spaces for best visibility (avoid computer screens).
4.10.4.	Develop a system that makes imperfections and delays visible to all.
4.10.5.	Use traffic light system (green, yellow, red) to report task status visually (good, warning, critical) and make certain problems are not concealed.
4.10.6.	Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.
4.2.4.	Hold people responsible for their contributions throughout the program life cycle. Upstream activities must be held responsible for issues they cause in downstream activities.
4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.
4.5.	Pursue collaborative and inclusive decision making that resolves the root causes of issues
4.5.1.	If decisions are based on assumptions that are likely to change, keep track of those assumptions and adjust the decisions when they change.
4.5.2.	Define the information needs as well as time frame for decision making. Adjust the needed information and analysis to reflect the allotted time for reaching a decision.
4.5.3.	Take the time necessary to reach good decisions. Always explore a number of alternatives.
4.5.4.	Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.

#	Enablers and Subenablers Related to Program Life-cycle Management
4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.
4.6.2.	Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk-, communication- and resource management).
4.7.1.	Capture and absorb lessons learned from almost all programs.
4.7.2.	Maximize coordination of effort and flow
4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise, and with suppliers.
4.7.4.	Use frequent, timely, open and honest communication.
4.8.	Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration
4.8.1.	Standardize program management metrics and reporting system
4.8.2.	Identify repeatable program management activities and standardize them.
4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
4.9.3.	Minimize handoffs to avoid rework.
4.9.4.	Optimize human resources when allocating value added (VA) and required, non-value added (RNVA) tasks. a. Use professionals to do value-adding professional work. b. When professionals are not absolutely required, use non - professionals (support staff) to do required, non-value adding tasks
4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.
4.9.6.	Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide communication bandwidth, standardization, work cells, and training.
4.9.7.	Use minimum number of IT tools and make common wherever possible.
4.9.8.	Minimize the number of the software revision updates (e.g., non critical updates) of IT tools and centrally control the update releases to prevent information churning.
4.9.9.	Adapt the IT tools to fit the people and process.
5.1.	Pull tasks and outputs based on need, and reject others as waste
5.1.1.	Let information needs pull the necessary work activities.
5.1.2.	Promote the culture in which people pull knowledge as they need it and limit the supply of information to genuine users only.
5.1.7.	When pulling work, use customer stakeholder value to separate value added from waste.
6.1.	Make effective use of existing program management and organizational maturity standards
6.3.2.	Follow basic problem solving techniques (e.g., Plan-Do-Check-Act) and adopt a culture of stopping and permanently fixing problems when they occur
6.3.3.	Promote excellence under "normal" circumstances and reward pro-active management of risks, instead of rewarding "hero" behavior in crisis situations.
6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.
6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.
6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.
6.6.1.	Focus program risk management on creating and protecting value for the program.

#	Enablers and Subenablers Related to Program Life-cycle Management
6.6.10.	Pay close attention to the opportunities and capture them along with Risks.
6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree
6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources
6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.
6.7.	Strive for perfect communication, coordination and collaboration across people and processes
6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, shared by team, and knowledge management strategy to enable the sharing of data and information within the enterprise.
6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.
6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
6.7.5.	Match the communication competence of people with their roles when staffing the program.
6.7.6.	Publish instructions for e-mail distributions, instant messaging and electronic communications.
6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.
6.7.8.	Publish a directory and organization chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.
6.7.9.	Ensure timely and efficient access to centralized data.
6.8.	Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders
6.8.1.	Utilize and reward bottom - up suggestions for solving employee - level problems.
6.8.2.	Use quick response small teams comprised of program stakeholders for local problems and development of standards.
6.8.3.	Use formal, large improvement project teams to address program-wide issues.
6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.

A.5.3 Mapping to INCOSE Systems Engineering Processes

The INCOSE Systems Engineering Handbook partitions Systems Engineering into 26 processes, consistent with the ISO/IEC 15288:2008 standard. (For an explanation of the INCOSE Systems Engineering Processes, please refer to Section 3.3.) The following table maps the 329 Lean Enablers for Managing Engineering Programs onto those 26 processes.

Table A18: Key to the Systems Engineering Processes

SE Process Number	Process name
4	Technical Processes
4.1	Stakeholder Requirements Definition Process
4.2	Requirements Analysis Process
4.3	Architectural Design Process
4.4	Implementation Process
4.5	Integration Process

SE Process Number	Process name
4.6	Verification Process
4.7	Transition Process
4.8	Validation Process
4.9	Operation Process
4.10	Maintenance Process
4.11	Disposal Process
5	Project Processes
5.1	Project Planning Process
5.2	Project Assessment and Control Process
5.3	Decision Management Process
5.4	Risk Management Process
5.5	Configuration Management Process
5.6	Information Management Process
5.7	Measurement Process
6	Agreement Processes
6.1	Acquisition Process
6.2	Supply Process
7	Organizational Project-Enabling Processes
7.1	Life Cycle Model Management Process
7.2	Infrastructure Management Process
7.3	Project Portfolio Management Process
7.4	Human Resource Management Process
7.5	Quality Management Process
8	Tailoring Processes
8.1	Tailoring Process
	Additional Process Categories
ALL	Lean Enablers that refer to all Systems Engineering processes
EPP	Enterprise planning and preparation processes (see below)

The Systems Engineering Handbook illustrates each process with a context diagram, i.e. five boxes titled: Inputs, Activities, Outputs, Controls, and General Enablers. The boxes labeled General Enablers in different diagrams include various combinations of the following bullets:

- Organizational/Enterprise Policies, Procedures, and Standards
- Organizational/Enterprise Infrastructure
- Project Infrastructure
- Implementation Enabling System

These General Enablers should not be confused with Lean Enablers presented in the present document. The INCOSE General Enablers are not focused on Lean, and are defined at much higher level than the Lean Enablers.

The mapping of 329 Lean Enablers and sub-enablers onto the 26 INCOSE processes was performed to some extent by “trial and error”. The decision was self-evident in most cases, but not all. When in doubt, the given enabler has been placed in only one process which was judged the most appropriate from an implementation point of view.

The results of the mapping are:

- The largest group of 81 enablers was judged to apply to all INCOSE processes, and those are listed below under a special heading "**All Processes**". These enablers address the critical aspects of SE which are often ignored in traditional programs and in SE handbooks, and which flow naturally from Lean Thinking, for example excellent coordination and communication, alignment for customer value, teamwork, better interactions between stakeholders, emphasis on performing the right work right the first time, excellent interpersonal relations and human habits.
- The next in size is the **Project Planning Process** with 58 enablers. This is consistent with a strong focus of Lean Enablers on improving front - end activities of programs: better preparations, better planning for value capture, better planning of program, planning for best communication and coordination means, better frontloading, stronger integration of SE and PD, and better human relations among stakeholders.
- Following the approach of mapping the Lean Enablers for Systems Engineering (see Section 1.6), we decided to define a new process, termed **Enterprise Preparation Process (EPP)**. It lists those 17 Lean enablers which benefit all present and future programs in the Enterprise (corporation), and therefore should be implemented at the Enterprise rather than a program level, if possible.
- **Eight SE Processes indicate zero dedicated Lean enablers**: Integration, Verification, Transition, Validation, Operations, Maintenance, Disposal, and Infrastructure Management. This is not an indication that these eight processes need no Lean wisdom. Instead, the way to improve these processes is indirect, by applying Lean wisdom to the front - end processes where most of the critical decisions are made (enterprise and program preparations, program planning, value capture, design frontloading, best engineering practices, implementation, quality, and management). In particular, the 81 Lean enablers listed under “All Processes” will improve the eight processes profoundly.

Table A19: Lean Enablers, Sorted by Systems Engineering Process Number

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
4		**Systems Engineering: Technical Processes**
4.1		**Stakeholder Requirements Definition Process**
4.1	2.1.	Establish the value and benefit of the program to the stakeholders
4.1	2.1.1.	Define value as the outcome of an activity that satisfies at least three conditions. a. The external customer stakeholders are willing to pay for value. b. Transforms information or material or reduces uncertainty. c. Provides specified program benefits right the first time.
4.1	2.1.2.	Define value - added in terms of value to the customer stakeholders and their needs
4.1	2.1.3.	Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.
4.1	2.1.4.	Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.
4.1	2.1.5.	Explain customer stakeholder culture to Program employees, i.e. the value system, approach, attitude, expectations, and issues.
4.1	2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits
4.1	2.5.	Clarify, derive and prioritize requirements early, often and proactively
4.1	2.5.10.	Employ agile methods to manage necessary requirements change and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable.
4.1	2.5.4.	Listen for and capture unspoken customer requirements
4.1	2.5.6.	Actively promote the maturation of stakeholder requirements, e.g., by providing detailed trade-off studies, feasibility studies and virtual prototypes

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
4.1	2.5.7.	Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.
4.1	2.5.8.	Create effective channels for clarification of requirements (e.g., involving customer stakeholders in program teams)
4.1	3.5.14.	Program manager must personally understand, clarify and remove ambiguity, conflicts and waste from key requirements and expectations at the program start
4.2		**Requirements Analysis Process**
4.2	3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels
4.3		**Architectural Design Process**
4.3	2.3.3.	Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.
4.3	2.5.3.	Use architectural methods and modeling to create a standard program system representation (3D integrated CAE toolset, mockups, prototypes, models, simulations, and software design tools) that allow interactions with customers and other stakeholders as the best means of drawing out requirements.
4.3	2.5.9.	Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models or spiral development)
4.3	3.2.	Actively Architect and manage the Program Enterprise to optimize its performance as a system
4.3	3.2.1.	Keep activities during early program phases internal and co-located, as there is a high need for coordination.
4.3	3.2.2.	Set up a single, co-located organization to handle the entire Systems Engineering and Architecting for the entire effort throughout the life cycle, in order to increase RAA.
4.3	3.2.3.	Ensure that Systems Engineering and Architecting are a central part of program management and not outsourced or subcontracted, as these activities require a high level of coordination.
4.3	3.2.5.	Use a clear architectural description of the agreed solution to plan a coherent program, engineering and commercial structures.
4.3	3.2.8.	Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors
4.3	3.3.	Pursue multiple solution sets in parallel
4.3	3.3.2.	Explore the trade space and margins fully before focusing on a point decision and too small margins.
4.3	3.3.3.	For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of Set-based Concurrent Engineering
4.3	3.3.4.	Explore multiple concepts, architectures and designs early.
4.4		**Implementation Process**
4.4	3.3.5.	Explore constraints and perform real trades before converging on a point design.
4.4	3.3.6.	All other things being equal, select the simplest solution.
4.4	6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits: Redirect, re-plan or stop individual program components
5.		**Systems Engineering: Project Processes**
5.1		**Project Planning Process**
5.1	1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that hiring process matches the real needs of the program for talent and skill.
5.1	1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively-minded individuals over perfect-looking credentials on paper.
5.1	1.5.4.	Capture and share tacit knowledge to stabilize the program when team members change
5.1	1.6.1.	Prefer physical team co - location to the virtual co - location.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
5.1	1.6.2.	For virtually co-located teams, invest time and money up-front to build personal relationship in face-to-face settings
5.1	1.6.8.	Program manager must have respect and personal relationship with all four main stakeholder groups: customers, superiors, program employees and key contractors/suppliers.
5.1	2.2.	Focus all program activities on the benefits that the program intends to deliver
5.1	2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.
5.1	2.2.2.	Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program
5.1	2.2.3.	Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability)
5.1	2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery
5.1	2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
5.1	2.3.5.	Structure communication among stakeholders (who, how often, and what)
5.1	2.3.6.	Create shared understanding of program content, goals, status and challenges among key stakeholders
5.1	2.5.1.	Develop an agile process to anticipate, accommodate, and communicate changing customer requirements
5.1	3.1.	Map the management and engineering value streams and eliminate non-value added elements
5.1	3.1.1.	Plan to develop only what needs to be developed
5.1	3.1.3.	Have cross functional stakeholders and program leadership work together to build the agreed value stream.
5.1	3.11.	Develop a communications plan
5.1	3.11.1.	Develop and execute a clear communications plan that covers the entire value stream and stakeholders.
5.1	3.11.2.	Plan to use visual methods wherever possible to communicate schedules, workloads, changes to customer requirements, etc.
5.1	3.2.6.	Change the program "mindset" to focus on the entire program enterprise and the value it delivers to customer stakeholders
5.1	3.3.1.	Plan to utilize cross - functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.
5.1	3.5.	Front-load and integrate the program
5.1	3.5.1.	Plan early for consistent robustness and right the first time under "normal" circumstances, instead of hero-behavior in later "crisis" situations
5.1	3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops
5.1	3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.
5.1	3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.
5.1	3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.
5.1	3.5.3.	Establish a system and process that allows comprehensive, effective and efficient up-front planning of program before execution begins.
5.1	3.5.4.	The program leadership team (program manager, technical managers, lead system engineers etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
5.1	3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones. and establish an action plan.
5.1	3.5.7.	Ascertain what is available to the program (resources, talent, budget and timeline) and what not available prior to making commitment to the customers and other stakeholders.
5.1	3.5.8.	Hold Lean Accelerated Planning sessions at the program level and for key sub-projects, engaging all stakeholders in developing master schedule, value stream map, risks and opportunities, key assumptions and action items.
5.1	3.6.	Use probabilistic estimates in program planning.
5.1	3.6.1.	Develop probabilistic estimates for cost, schedule and other critical planning forecasts.
5.1	3.6.2.	Base planning assumptions on confidence intervals, not on point estimates.
5.1	3.9.	Develop an Integrated Program Schedule at the level of detail for which you have dependable information.
5.1	3.9.1.	Create a plan to appropriately integrate and align program management, systems engineering and other high-level planning and coordination functions.
5.1	3.9.2.	Maximize concurrency of independent tasks and tasks that inform each other.
5.1	3.9.3.	Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.
5.1	3.9.4.	Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading, i.e., have appropriate contingencies and schedule buffers.
5.1	3.9.5.	Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.
5.1	3.9.6.	Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks with what data and when), understanding task dependencies and parent – child relationships.
5.1	3.9.7.	Update detailed planning regularly to reflect new information, being consistent with the long-term strategic plan. Do not force programs to execute against a detailed, outdated plan that was developed based on incomplete information.
5.1	4.1.	Use systems engineering to coordinate and integrate all engineering activities in the program.
5.1	4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the pre-proposal phase to the final program delivery.
5.1	4.1.2.	Maintain team continuity between phases to maximize experiential learning, including preproposal and proposal phases.
5.1	4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.
5.1	4.6.1.	Ensure program governance has full view, control, and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.
5.1	4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, software, and hardware design.
5.1	4.7.2.	Maximize coordination of effort and flow.
5.1	4.9.6.	Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide communication bandwidth, standardization, work cells, and training.
5.1	6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.
5.1	6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
5.1	6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.
5.1	6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.
5.1	6.7.8.	Publish a directory and organizational chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.
5.2		**Project Assessment and Control Process**
5.2	4.6.	Integrate all program elements and functions through Program Governance.
5.2	4.6.2.	Employ program supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk, communication, and resource management)
5.2	4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage non-advocates in review process.
5.2	4.6.4.	Use a gated process for validating, planning, and execution of the program and leverage functional expertise at these gates.
5.2	6.1.	Make effective use of existing program management and organizational maturity standards.
5.2	6.1.1.	Use existing program management standards, guidelines and applicable organizational maturity models to the program's best advantage.
5.2	6.1.2.	Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.
5.2	6.1.3.	Integrate implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
5.2	6.1.5.	Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses or goals and track progress on the process improvement journey.
5.3		**Decision Management Process**
5.3	1.3.1.	Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.
5.3	4.5.	Pursue collaborative and inclusive decision making that resolves the root causes of issues.
5.3	4.5.1.	If decisions are based on assumptions that are likely to change, keep track of those assumptions, and adjust the decisions when they change.
5.3	4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.
5.3	4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision-making process.
5.3	4.5.2.	Define the information need as well as time frame for decision making. Adjust the needed information and analysis to reflect the allotted time for reaching a decision.
5.3	4.5.3.	Take the time necessary to reach good decisions. Always explore a number of alternatives.
5.3	4.5.4.	Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.
5.3	4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.
5.3	4.5.6.	If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.
5.3	4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest and converging on consensus.
5.3	4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.
5.3	4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
5.3	6.5.	Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.
5.3	6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.
5.3	6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
5.4		**Risk Management Process**
5.4	3.10.2.	Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).
5.4	3.10.3.	Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.
5.4	3.10.5.	Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.
5.4	3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.
5.4	3.5.12.	Include a detailed risk and opportunity identification, assessment and mitigation in the early program planning phases.
5.4	6.6.	Proactively manage uncertainty and risk to maximize program benefit.
5.4	6.6.1.	Focus program risk management on creating and protecting value for the program.
5.4	6.6.10.	Pay close attention to the opportunities and capture them along with risks.
5.4	6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.
5.4	6.6.3.	Support all critical decisions in the program with risk management results.
5.4	6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.
5.4	6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.
5.4	6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.
5.4	6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.
5.4	6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
5.4	6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.
5.5		**Configuration Management Process**
5.5	6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.
5.6		**Information Management Process**
5.6	3.8.3.	Use only few simple and easy to understand metrics and share them frequently throughout the enterprise.
5.6	3.8.4.	Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.
5.6	3.8.5.	Use only those metrics that meet a stated need, objective, or program benefit.
5.6	4.10.	Make program progress visible to all.
5.6	4.10.1.	Make work progress visible and easy to understand to all, including external customer.
5.6	4.10.10.	Track reduction of risk and uncertainty throughout program life cycle as KPI.
5.6	4.10.11.	Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.
5.6	4.10.2.	Track the program's overall progress to deliver the program benefits.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
5.6	4.10.7.	Align program metrics with intended benefits and stakeholder expectations.
5.6	4.10.8.	Establish clear line-of-sight between lower-level program and project metrics and top level program success metrics.
5.6	4.10.9.	Develop a snapshot/summary representation of the meaningful metrics (e.g., standard deck) to measure all phases of the project and program and make it available to all.
5.6	4.8.1.	Standardize program management metrics and reporting system.
5.6	4.9.10.	Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.
5.6	4.9.7.	Use minimum number of IT tools and make common wherever possible.
5.6	4.9.8.	Minimize the number of the software revision updates (e.g., noncritical updates) of IT tools and centrally control the update releases to prevent information churning.
5.6	4.9.9.	Adapt the IT tools to fit the people and process.
5.6	6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.
5.6	6.7.9.	Ensure timely and efficient access to centralized data.
5.7		**Measurement Process**
5.7	3.8.	Plan leading indicators and metrics to manage the program.
5.7	3.8.1.	Use leading indicators to enable action before risks become issues.
5.7	3.8.2.	Focus metrics around customer stakeholder value and program benefits.
6.		**Systems Engineering: Agreement Processes**
6.1		**Acquisition Process**
6.1	2.4.	Develop high-quality program requirements among customer stakeholders before bidding and execution process begins.
6.1	2.4.1.	Enssure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need, stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.
6.1	2.4.10.	Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.
6.1	2.4.11.	Clearly articulate the top-level objectives, value, program benefits, and functional requirements before formal requirements or a request for proposal is issued.
6.1	2.4.12.	Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.
6.1	2.4.2.	Use only highly experienced people and expert institutions to write program requirements, RFPs and contracts.
6.1	2.4.3.	If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.
6.1	2.4.4.	Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, mindless "cut-and-paste" of requirements from previous programs.
6.1	2.4.5.	Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.
6.1	2.4.6.	Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
6.1	2.4.7.	Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated.
6.1	2.4.8.	Always clearly link requirements to specific customer stakeholder needs and trace requirements from this top level to bottom level.
6.1	2.4.9.	Use peer-review requirements among stakeholders to ensure consensus validity and absence of conflicts.
6.1	2.6.	Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects.
6.1	2.6.1.	Strive to minimize and streamline the burden of paperwork for external stakeholders by actively engaging them in the process and clearly articulating and aligning the benefit generated by each report.
6.1	3.10.	Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
6.1	3.10.1.	Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before starting a large-scale program.
6.1	3.10.11.	Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
6.1	3.10.4.	Utilize program management strategies that produce the best balance between technology risk and reward in your program, such as evolutionary acquisition and incremental or spiral development.
6.1	3.10.6.	Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in the risk mitigation plan. Reexamine for integration into the program after significant progress has been made or defer to future systems.
6.1	3.10.7.	Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.
6.1	3.10.8.	Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").
6.1	3.4.	Ensure up-front that capabilities exist to deliver program requirements.
6.1	3.4.1.	Ensure strong corporate, institutional, and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.
6.1	3.4.2.	If a low-balling is detected on a fixed price contract, insist on continuing the fixed-price contract, or terminate the program, and rebid. Do not allow switching to cost-plus contracts.
6.1	3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.
6.1	5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
6.1	5.2.1.	Establish common contract structures throughout the program.
6.1	5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win–win situations.
6.2		**Supply Process**
6.2	1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow lone-wolf behavior."
6.2	3.7.	Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.
6.2	3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
6.2	3.7.10.	Include and manage the major suppliers as a part of your team.
6.2	3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
6.2	3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high-risk items, which must be handled at the top level.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
6.2	3.7.2.	Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.
6.2	3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
6.2	3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
6.2	3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.
6.2	3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.
6.2	3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests, and ensure the requirements are stable.
6.2	3.7.8.	Select suppliers who are technically and culturally compatible.
6.2	3.7.9.	Strive to develop a seamless partnership between suppliers and the product development team.
6.2	6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.
7.		**Systems Engineering: Organizational Project Enabling Processes**
7.1		**Life Cycle Model Management Process**
7.1	4.2.6.	Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.
7.3		**Project Portfolio Management Process**
7.3	3.1.2.	Promote reuse and sharing of program assets. Utilize standards, standard processes, modules of knowledge, technical standardization. and platforms, and software libraries.
7.3	3.2.4.	Develop a clear vision and holistic view of the future state of the program enterprise, including future portfolio of products, including both the future organization as well as the future value stream. Provide guidance on a clear path forward and ensure that resources are aligned with this vision.
7.4		**Human Resource Management Process**
7.4	1.1.4.	Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
7.4	1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
7.4	1.4.	Expect and support people as they strive for professional excellence and promote their careers.
7.4	1.4.2.	Invest in workforce development.
7.4	1.4.3.	Ensure tailored Lean training for all employees.
7.4	1.4.4.	Give leaders at all levels in-depth Lean training.
7.4	1.4.5.	Promote and honor professional meritocracy.
7.4	1.4.7.	Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.
7.4	1.5.1.	Promote and reward continuous learning through education and experiential learning.
7.4	4.2.1.	Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical).
7.4	4.2.2.	Ensure continuity in the program manager position and avoid personnel rotation.
7.4	4.4.1.	Program management staff turnover and hiring rates must be kept low.
7.4	4.4.2.	Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.
7.4	6.7.5.	Match the communication competence of people with their roles when staffing the program.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
7.5		**Quality Management Process**
7.5	4.8.	Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.
7.5	6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects.
7.5	6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.
7.5	6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
7.5	6.4.	Use lessons learned to make the next program better than the last.
7.5	6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.
7.5	6.4.3.	Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.
7.5	6.4.4.	Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement resulting change.
7.5	6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
7.5	6.8.	Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.
7.5	6.8.1.	Utilize and reward bottom-up suggestions for solving employee-level problems.
7.5	6.8.2.	Use quick-response small teams comprised of program stakeholders for local problems and development of standards.
7.5	6.8.3.	Use formal, large improvement project teams to address program-wide issues.
7.5	6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.
8.1		**Systems Engineering: Tailoring Process**
8.1	2.6.2.	Minimize and streamline the program-internal reporting for program activities and subprojects by optimizing the internal reporting requirements. Only require reports that are clearly necessary and align reporting requirements to reduce redundant reporting.
8.1	2.6.3.	Ensure all review and approval steps are truly needed and value-adding in the program.
8.1	3.1.4.	Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks.
8.1	5.1.	Pull tasks and outputs based on need, and reject others as waste.
8.1	6.1.4.	Do not implement any standard purely for achieving any sort of mandated program certification.
EPP		**Systems Engineering: Enterprise Planning and Preparation**
EPP	1.4.1.	Establish and support communities of practice.
EPP	1.5.5.	Develop standards paying attention to human factors, including level of experience and perception abilities.
EPP	1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
EPP	3.2.7.	Lead and sustain the transformation to an integrated program management and systems engineering enterprise across customer and supplier organizations.
EPP	4.2.3.	Define and clearly communicate the program manager's RAA across all stakeholders.
EPP	4.3.	For every program, use a program manager role to lead and integrate the program from start to finish.
EPP	4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
EPP	4.3.2.	Ensure that the program manager possesses an appropriate background regarding business, general management, and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.
EPP	4.3.3.	Ensure that the competency, technical knowledge, and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.
EPP	4.3.4.	Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (for example by clear traceability of requirements and effective use of change management control boards).
EPP	4.4.	The top level program management (e.g., program management office) overseeing the program must be highly effective.
EPP	4.8.2.	Identify repeatable program management activities and standardize them.
EPP	4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
EPP	4.8.4.	Promote process standardization in development, management, and manufacturing.
EPP	6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
EPP	6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods and a Lean business case that ties Lean practices to achieving the program benefits.
EPP	6.2.3.	Set up a Lean management training infrastructure; mid-level and project managers must train and motivate their teams.
ALL		**Systems Engineering: All Systems Engineering Processes**
ALL	1.1.	Build a program culture based on respect for people.
ALL	1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.
ALL	1.1.10.	When resolving issues, attack the problem, not the people.
ALL	1.1.3.	Program leadership must be a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation, and drive for excellence.
ALL	1.1.6.	Practice “walk-around management." Do not manage from a cubicle; go to the work and see for yourself.
ALL	1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).
ALL	1.2.	Motivate by making the higher purpose of the program and program elements transparent.
ALL	1.2.1.	Create a shared vision which draws out and inspires the best in people.
ALL	1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.
ALL	1.3.	Support an autonomous working style.
ALL	1.3.2.	Eliminate fear from the work environment. Promote conflict resolution at the lowest level.
ALL	1.3.3.	Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.
ALL	1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto “rather ask for forgiveness than permission.”
ALL	1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.
ALL	1.4.6.	Establish a highly experienced core group ("grayhairs") that leads by example and institutionalizes positive behavior.
ALL	1.5.	Promote the ability to rapidly learn and continuously improve.
ALL	1.5.2.	Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
ALL	1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
ALL	1.5.6.	Immediately organize quick training in any new standard to ensure buy-in and awareness.
ALL	1.6.	Encourage personal networks and interactions.
ALL	1.6.3.	Promote direct human communication to build personal relationships.
ALL	1.6.5.	Engage and sustain extensive stakeholder interactions.
ALL	1.6.6.	Support the development of informal and social networks within the program and to key stakeholders in the program environment.
ALL	1.6.7.	Encourage (and document when appropriate) open information sharing within the program.
ALL	2.3.	Frequently engage the stakeholders throughout the program life cycle.
ALL	2.3.1.	Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.
ALL	2.3.2.	Establish frequent and effective interaction with internal and external stakeholders.
ALL	2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.
ALL	2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.
ALL	2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.
ALL	2.5.2.	Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items, and do not allow requirements creep.
ALL	2.5.5.	To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.
ALL	3.10.10.	Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.
ALL	3.5.6.	Propagate front-loading of the program throughout critical subprojects with similar workshops to those described in 3.5.5.
ALL	3.5.9.	For all critical activities, define who is responsible, approving, supporting, and informing (also known as RACI matrix), using a standardized tool, paying attention to precedence of tasks and documenting handoffs.
ALL	4.10.3.	Utilize visual controls in public spaces for best visibility (avoid computer screens).
ALL	4.10.4.	Develop a system that makes imperfections and delays visible to all.
ALL	4.10.5.	Use traffic light system (green, yellow, red) to report task status visually (good, warning, critical) and make certain problems are not concealed.
ALL	4.10.6.	Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.
ALL	4.2.	Ensure clear responsibility, accountability, and authority (RAA) throughout the program from initial requirements definition to final delivery.
ALL	4.2.4.	Hold people responsible for their contributions throughout the program life cycle. Upstream activities must be held responsible for issues they cause in downstream activities.
ALL	4.2.5.	In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding and appreciation of the necessities in each other's domain.
ALL	4.6.6.	Align incentives across the program enterprise.
ALL	4.7.	Use efficient and effective communication and coordination with the program team.
ALL	4.7.1.	Capture and absorb lessons learned from almost all programs.
ALL	4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise and with suppliers.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
ALL	4.7.4.	Use frequent, timely, open, and honest communication.
ALL	4.7.5.	Promote flat organization to simplify and speed up communication.
ALL	4.7.6.	Promote direct, informal, and face-to-face communication.
ALL	4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.
ALL	4.9.	Use Lean Thinking to promote smooth program flow.
ALL	4.9.1.	Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) Question everything with multiple “whys”; (b.) Align process flow to decision flow; (c.) Resolve all issues as they occur in frequent integrative events; and (d.) Discuss tradeoffs and options.
ALL	4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds and to maximize program stability, relying on technical expertise.
ALL	4.9.3.	Minimize handoffs to avoid rework.
ALL	4.9.4.	Optimize human resources when allocating value-added (VA) and required, non-value-added (RNVA) tasks: (a.) Use professionals to do value-adding professional work; (b.) When professionals are not absolutely required, use non-professionals (support staff) to do required, non-value-adding tasks
ALL	4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.
ALL	5.1.1.	Let information needs pull the necessary work activities.
ALL	5.1.2.	Promote the culture in which people pull knowledge as they need it and limit the supply of information to genuine users only.
ALL	5.1.3.	Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task—use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.
ALL	5.1.4.	Stay connected to the customer during the task execution.
ALL	5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
ALL	5.1.6.	For nonroutine tasks, avoid rework by coordinating task requirements with internal customer.
ALL	5.1.7.	When pulling work, use customer stakeholder value to separate value added from waste.
ALL	5.2.3.	Ensure that contracts support complete and open communication between the program stakeholders.
ALL	6.2.	Pursue Lean for the long term.
ALL	6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
ALL	6.2.5.	Integrate the Lean activities in program management into your overall change management and process improvement approach in order to assure sustainability of the improvements, as well as use synergies with existing process improvement activities.
ALL	6.2.6.	Start small by selecting the most beneficial Lean enablers for your program.
ALL	6.2.7.	Codify lessons learned and evaluate their effectiveness.
ALL	6.2.8.	Look for new and innovative ways to work that add value.
ALL	6.3.	Strive for excellence of program management and systems engineering.
ALL	6.3.2.	Follow basic problem solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.
ALL	6.3.3.	Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.
ALL	6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.
ALL	6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
ALL	6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.

SE Process #	LE #	Lean Enabler for Managing Engineering Programs
ALL	6.4.1.	Create mechanisms to capture, communicate, and apply experience.
ALL	6.4.6.	Identify best practices through benchmarking and professional literature.
ALL	6.7.	Strive for perfect communication, coordination, and collaboration across people and processes.
ALL	6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose unstructured memos. Keep underlying data as backup in case it is requested by the receiver.

A.5.4 Mapping to Lean Enablers for Systems Engineering (LEfSE)

The following table contains the mapping of the Lean Enablers for Systems Engineering (LEfSE, see Section 1.6) against the Lean Enablers for Program Management. About half of the Lean Enablers for Program Management were adapted from the Lean Enablers for Systems Engineering (Table A20 A20). The second half are new Enablers (Table A21 A21).

Table A20: Mapping of Lean Enablers for Systems Engineering against Lean Enablers for Managing Engineering Programs

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
1.	2	Lean Enablers to Maximize Program Value (Lean Principle 1)
1.2.	2.1.	Establish the value and benefit of the program to the stakeholders.
1.2.1.	2.1.1.	Define value as the outcome of an activity that satisfies at least three conditions: (a.) The external customer stakeholders are willing to pay for value; (b.) Transforms information or material or reduces uncertainty; (c.) Provides specified program benefits right the first time.
1.2.2.	2.1.2.	Define value-added in terms of value to the customer stakeholders and their needs.
1.2.3.	2.1.3.	Develop a robust process to capture, develop, and disseminate customer stakeholder value with extreme clarity.
1.2.4.	2.5.1.	Develop an agile process to anticipate, accommodate, and communicate changing customer requirements.
1.2.5.	2.1.4.	Proactively resolve potential conflicting stakeholder values and expectations, and seek consensus.
1.2.6.	2.1.5.	Explain customer stakeholder culture to program employees, that is, the value system, approach, attitude, expectations, and issues.
1.3.	2.3.	Frequently engage the stakeholders throughout the program life cycle.
1.3.1.	2.3.1.	Everyone involved in the program must have a customer-first spirit, focusing on the clearly defined program value and requirements.
1.3.2.	2.3.2.	Establish frequent and effective interaction with internal and external stakeholders.
1.3.3.	2.3.3.	Pursue a program vision and architecture that captures customer stakeholder requirements clearly and can be adaptive to changes.
1.3.4.	2.3.4.	Establish a plan that delineates the artifacts and interactions that provide the best means for drawing out customer stakeholder requirements.
2.	3	Lean Enablers to Optimize the Value Stream (Lean Principle 2)
2.2.	3.1.	Map the management and engineering value streams and eliminate non-value-added elements.
2.2.1.	3.11.1.	Develop and execute a clear communication plan that covers the entire value stream and stakeholders.
2.2.10.	3.5.9.	For all critical activities, define who is responsible for approving, supporting, and informing (also known as RACI matrix), using a standardized tool, paying attention to precedence of tasks, and documenting handoffs.
2.2.11.	3.9.5.	Plan for level workflow and with precision to enable schedule adherence and drive out arrival time variation.
2.2.12.	3.9.4.	Plan below full capacity to enable flow of work without accumulation of variability, and permit scheduling flexibility in work loading, that is, have appropriate contingencies and schedule buffers.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
2.2.13.	3.11.2.	Plan to use visual methods wherever possible to communicate schedules, workloads, changes to customer requirements, etc.
2.2.2.	3.1.3.	Have cross-functional stakeholders and program leadership work together to build the agreed value stream.
2.2.3.	3.9.1.	Create a plan to appropriately integrate and align program management, systems engineering and other high-level planning and coordination functions.
2.2.4.	4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.
2.2.5.	3.1.4.	Use formal value stream mapping methods to identify and eliminate management and engineering waste, and to tailor and scale tasks.
2.2.6.	2.4.1.	Ensure that the customer-level requirements defined in the request for proposal (RFP) or contracts are truly representative of the need, stable, complete, crystal clear, deconflicted, free of wasteful specifications, and as simple as possible.
2.2.7.	3.9.6.	Carefully plan for precedence of engineering and management tasks (which task to feed what other tasks with what data and when), understanding task dependencies and parent – child relationships.
2.2.8.	3.9.2.	Maximize concurrency of independent tasks and tasks that inform each other.
2.2.9.	3.9.3.	Synchronize work flow activities using scheduling across functions, and even more detailed scheduling within functions.
2.3	3.5.	Front-load and integrate the program.
2.3.1.	3.3.1.	Plan to utilize cross - functional teams made up of the most experienced and compatible people at the start of the project to look at a broad range of solution sets.
2.3.2.	3.3.2.	Explore the trade space and margins fully before focusing on a point decision and too small margins.
2.3.3.	3.5.11.	Anticipate and plan to resolve as many downstream issues and risks as early as possible to prevent downstream problems.
2.3.4.	3.5.1.	Plan early for consistent robustness and right the first time under "normal" circumstances, instead of hero-behavior in later "crisis" situations.
2.4.	3.1.1.	Plan to develop only what needs to be developed.
2.4.1.	3.1.2.	Promote reuse and sharing of program assets. Utilize standards, standard processes, modules of knowledge, technical standardization and platforms, and software libraries.
2.4.2.	3.10.3.	Fully understand both the risks and opportunities involved in the use of new/immature technologies and new engineering/manufacturing processes.
2.4.3.	3.10.6.	Remove show-stopping research and unproven technology from the critical path of large programs. Issue separate development contracts, staff with colocated experts, and include it in the risk mitigation plan. Reexamine for integration into the program after significant progress has been made or defer to future systems.
2.4.4.	3.10.1.	Create transparency regarding the technology risks and associated cost and schedule risks before large-scale programs are contracted. Issue small contracts to mature critical technologies before a starting large-scale program.
2.4.5.	3.10.4.	Utilize program management strategies that produce the best balance between technology risk and reward in the program, such as evolutionary acquisition and incremental or spiral development.
2.5.	3.7.	Work with suppliers to proactively avoid conflict and anticipate and mitigate program risk.
2.5.1.	3.7.8.	Select suppliers who are technically and culturally compatible.
2.5.2.	3.7.9.	Strive to develop a seamless partnership between suppliers and the product development team.
2.5.3.	3.7.10.	Include and manage the major suppliers as a part of the team.
2.5.4.	3.7.2.	Have the suppliers brief the program management team on current and future capabilities during conceptual program phases.
2.6.	3.8.	Plan leading indicators and metrics to manage the program.
2.6.1.	3.8.1.	Use leading indicators to enable action before risks become issues.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
2.6.2.	3.8.2.	Focus metrics around customer stakeholder value and program benefits.
2.6.3.	3.8.3.	Use only few simple and easy to understand metrics and share them frequently throughout the enterprise.
2.6.4.	3.8.4.	Use metrics structured to motivate the right behavior. Be very careful to avoid the unintended consequences that come from the wrong metrics incentivizing undesirable behavior.
2.6.5.	3.8.5.	Use only those metrics that meet a stated need, objective, or program benefit.
3.	4	Lean Enablers to Create Program Flow (Lean Principle 3)
3.2.	2.5.	Clarify, derive, and prioritize requirements early, often, and proactively.
3.2.1.	2.5.2.	Follow up written requirements with verbal clarification of context and expectations to ensure mutual understanding and agreement. Keep the records in writing, share the discussed items and do not allow requirements creep.
3.2.2	2.5.6.	Actively promote the maturation of stakeholder requirements, for example, by providing detailed trade-off studies, feasibility studies, and virtual prototypes.
3.2.2.	2.5.8.	Create effective channels for clarification of requirements (e.g., involving customer stakeholders in program teams).
3.2.3.	2.5.3.	Use architectural methods and modeling to create a standard program system representation (3D integrated CAE toolset, mockups, prototypes, models, simulations, and software design tools) that allow interactions with customers and other stakeholders as the best means of drawing out requirements.
3.2.4.	2.5.4.	Listen for and capture unspoken customer requirements.
3.2.5.	2.5.6.	Actively promote the maturation of stakeholder requirements, for example, by providing detailed trade-off studies, feasibility studies, and virtual prototypes.
3.2.5.	2.5.9.	Fail early and fail often through rapid learning techniques (e.g., prototyping, tests, simulations, digital models or spiral development).
3.2.6.	2.5.5.	To align stakeholders, identify a small number of primary goals and objectives that represent the program mission, how it will achieve its benefits, and what the success criteria will be to align stakeholders. Repeat these goals and objectives consistently and often.
3.3.	3.5.	Front-load and integrate the program.
3.3.1.	3.3.4.	Explore multiple concepts, architectures, and designs early.
3.3.2.	3.3.5.	Explore constraints and perform real trades before converging on a point design.
3.3.3.	3.2.5.	Use a clear architectural description of the agreed solution to plan a coherent program, engineering, and commercial structures.
3.3.4.	3.3.6.	All other things being equal, select the simplest solution.
3.3.5.	3.7.11.	Invite suppliers as trusted program partners to make a serious contribution to SE, design, and development.
3.4.	4.1.	Use systems engineering to coordinate and integrate all engineering activities in the program.
3.4.1.	4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the preproposal phase to the final program delivery.
3.4.2.	4.1.1.	Seamlessly and concurrently engage systems engineers with all engineering phases from the preproposal phase to the final program delivery.
3.4.3.	4.1.2.	Maintain team continuity between phases to maximize experiential learning, including preproposal and proposal phases.
3.4.4.	4.1.2.	Maintain team continuity between phases to maximize experiential learning, including pre-proposal and proposal phases.
3.5.	4.7.	Use efficient and effective communication and coordination with program team.
3.5.1.	4.7.1.	Capture and absorb lessons learned from almost all programs.
3.5.2.	4.7.2.	Maximize coordination of effort and flow.
3.5.3.	4.7.3.	Maintain counterparts with active working relationships throughout the enterprise to facilitate efficient communication and coordination among different parts of the enterprise, and with suppliers.
3.5.4.	4.7.4.	Use frequent, timely, open, and honest communication.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
3.5.5.	4.7.6.	Promote direct, informal, and face-to-face communication.
3.5.6.	6.7.2.	Use concise one-page electronic forms (e.g., Toyota's A3 form) for standardized and efficient communication, rather than verbose, unstructured memos. Keep underlying data as backup in case it is requested by the receiver.
3.5.7.	6.7.3.	Similarly, use concise one-page electronic forms for efficient, real-time reporting of cross-functional and cross-organizational issues, for prompt resolution.
3.5.8.	3.7.7.	Communicate to suppliers with crystal clarity all expectations, including the context and need, and all procedures and expectations for acceptance tests; and ensure the requirements are stable.
3.5.9.	3.7.12.	Trust engineers to communicate with suppliers' engineers directly for efficient clarification, within a framework of rules, but watch for high risk items which must be handled at the top level.
3.6	4.9.	Use Lean Thinking to promote smooth program flow.
3.6.1.	4.9.1.	Use formal frequent comprehensive integrative events in addition to programmatic reviews: (a.) Question everything with multiple “whys”; (b.) Align process flow to decision flow; (c.) Resolve all issues as they occur in frequent integrative events; and (d.) Discuss tradeoffs and options.
3.6.2.	4.9.2.	Be willing to challenge the customer's assumptions on technical and meritocratic grounds, and to maximize program stability, relying on technical expertise.
3.6.3.	4.9.3.	Minimize handoffs to avoid rework.
3.6.4.	4.9.4.	Optimize human resources when allocating value-added (VA) and required, non-value-added (RNVA) tasks: (a.) Use professionals to do value-adding professional work; and (b.) When professionals are not absolutely required, use nonprofessionals (support staff) to do required, non-value- addied tasks.
3.6.5.	4.9.5.	Ensure the use of consistent measurement standards across all projects and database commonality.
3.6.6.	5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
3.7.	4.10.	Make program progress visible to all.
3.7.1.	4.10.1.	Make work progress visible and easy to understand to all, including external customer.
3.7.2.	4.10.3.	Utilize visual controls in public spaces for best visibility (avoid computer screens).
3.7.3.	4.10.4.	Develop a system that makes imperfections and delays visible to all.
3.7.4.	4.10.5.	Use traffic light system (green, yellow, red) to report task status visually (good, warning, critical) and make certain problems are not concealed.
3.8.	4.9.	Use Lean Thinking to promote smooth program flow.
3.8.1.	4.9.6.	Use Lean tools to promote the flow of information and minimize handoffs. Implement small batch sizes of information, low information in inventory, low number of concurrent tasks per employee, small task times, wide communication bandwidth, standardization, work cells, and training.
3.8.2.	4.9.7.	Use minimum number of IT tools and make common wherever possible.
3.8.3.	4.9.8.	Minimize the number of the software revision updates (e.g., noncritical updates) of IT tools and centrally control the update releases to prevent information churning.
3.8.4.	4.9.9.	Adapt the IT tools to fit the people and process.
3.8.5.	4.9.10.	Avoid excessively complex and overly feature-rich IT tools. Tailor tools to program needs, not the other way around.
4.	5	Lean Enablers to Create Pull in the Program (Lean Principle 4)
4.2.	5.1.	Pull tasks and outputs based on need, and reject others as waste.
4.2.1.	5.1.1.	Let information needs pull the necessary work activities.
4.2.2.	5.1.2.	Promote the culture in which people pull knowledge as they need it and limit the supply of information to genuine users only.
4.2.3.	3.1.	Map the management and engineering value streams and eliminate non-value-added elements.
4.2.4.	5.1.3.	Train the team to recognize who the internal customer (receiver) is for every task as well as the supplier (giver) to each task— use a SIPOC (supplier, inputs, process, outputs, customer) model to better understand the value stream.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
4.2.5.	5.1.4.	Stay connected to the customer during the task execution.
4.2.6.	5.1.6.	For non-routine tasks, avoid rework by coordinating task requirements with internal customer.
4.2.7.	5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations.
4.2.8	5.1.5.	Promote effective, real-time direct communication between each giver and receiver in the value flow, based on mutual trust and respect, and ensure both understand their mutual needs and expectations
4.2.9.	5.1.7.	When pulling work, use customer stakeholder value to separate value added from waste.
5.	6	Lean Enablers to Pursue Program Perfection (Lean Principle 5)
5.2.	6.3.	Strive for excellence of program management and systems engineering.
5.2.1.	6.3.1.	Implement the basics of quality. Do not create, pass on, or accept defects.
5.2.2.	6.3.3.	Promote excellence under "normal" circumstances and reward proactive management of risks, instead of rewarding "hero" behavior in crisis situations.
5.2.3.	6.3.4.	Use and communicate failures as opportunities for learning emphasizing process and not people problems.
5.2.4.	6.3.5.	Treat any imperfection as an opportunity for immediate improvement and lesson to be learned, and practice frequent reviews of lessons learned.
5.2.5.	6.3.6.	Maintain a consistent, disciplined approach to program management and systems engineering, including agreement on goals, outcomes, processes, and communication and standardizing best practice.
5.2.6.	6.3.7.	Promote the idea that the program should incorporate continuous improvement in the organizational culture.
5.2.7.	6.3.8.	Pursue refinement and excellence only if it creates additional value and benefits. Avoid overproduction and overprocessing of waste. Ensure that the process can be executed "right the first time" from then on.
5.2.8.	6.3.9.	Use a balanced matrix/project organizational approach. Avoid extremes, such as isolated functional organizations and separated all-powerful project organization.
5.3	6.4.	Use lessons learned to make the next program better than the last.
5.3.1.	6.4.	Use lessons learned to make the next program better than the last.
5.3.2.	6.4.1.	Create mechanisms to capture, communicate, and apply experience.
5.3.3.	6.4.5.	Insist on standardized root cause identification and process for implementing corrective action and related training.
5.3.4.	6.4.6.	Identify best practices through benchmarking and professional literature.
5.3.5.	6.4.7.	Share metrics of performance of external partners back to them and collaborate with them on improvements on both sides.
5.4.	6.7.	Strive for perfect communication, coordination, and collaboration across people and processes.
5.4.1.	6.7.1.	Develop a general program policy/guideline/framework that outlines expectations regarding communication, coordination, and collaboration.
5.4.2.	6.7.5.	Match the communication competence of people with their roles when staffing the program.
5.4.3.	6.7.4.	Develop a plan that implements the policy and ensures accountability within the entire program team in communications, coordination, and decision-making methods at the program beginning.
5.4.4.	6.7.6.	Publish instructions for e-mail distributions, instant messaging, and electronic communications.
5.4.5.	6.7.7.	Publish instructions for artifact content and data storage, central capture versus local storage, and for paper versus electronic, balancing between excessive bureaucracy and the need for traceability.
5.4.6.	6.7.8.	Publish a directory and organization chart of the entire program team and provide training to new hires on how to locate the needed nodes of knowledge.
5.4.7.	6.7.9.	Ensure timely and efficient access to centralized data.
5.4.8.	6.7.10.	Develop an effective body of knowledge that is easily accessible, historical, searchable, and shared by team and a knowledge management strategy to enable the sharing of data and information within the enterprise.
5.5.	4.3.	For every program, use a program manager role to lead and integrate the program from start to finish.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
5.5.1.	4.2.3.	Define and clearly communicate the program manager's RAA across all stakeholders.
5.5.2.	1.6.8.	Program manager must have respect and personal relationship with all four main stakeholder groups: customers, superiors, program employees, and key contractors/suppliers.
5.5.3.	4.3.2.	Ensure that the program manager possesses an appropriate background regarding business, general management and engineering experience; leadership and people skills; and experience working on highly technical engineering programs.
5.5.4.	4.3.1.	Groom an exceptional program manager with advanced skills to lead the development, the people, and ensure program success.
5.5.5.	4.4.3.	Maximize co-location opportunities for program management, systems engineering, business leadership and other teams to enable constant close coordination, and resolve all responsibility, communication, interface, and decision-making issues up-front early in the program.
5.6.	4.8.	Standardize key program and project elements throughout the program to increase efficiency and facilitate collaboration.
5.6.1.	4.8.3.	Promote design standardization with engineering checklists, standard architecture, modularization, busses, and platforms.
5.6.2.	4.8.4.	Promote process standardization in development, management, and manufacturing.
5.6.3.	4.8.5.	Promote standardized skill sets with careful training and mentoring, rotations, strategic assignments, and assessments of competencies.
5.7.	6.8.	Promote complementary continuous improvement methods to draw best energy and creativity from all stakeholders.
5.7.1.	6.8.1.	Utilize and reward bottom-up suggestions for solving employee-level problems.
5.7.2.	6.8.2.	Use quick- response small teams comprised of program stakeholders for local problems and development of standards.
5.7.3.	6.8.3.	Use formal, large improvement project teams to address program-wide issues.
6.	1	Lean Enablers to Treat People as Your Most Important Asset (Lean Principle 6)
6.2.	1.1.	Build a program culture based on respect for people.
6.2.1.	1.2.1.	Create a shared vision that draws out and inspires the best in people.
6.2.10.	1.3.5.	Keep management decisions crystal clear while also empowering and rewarding the bottom-up culture of continuous improvement and human creativity and entrepreneurship.
6.2.11.	1.1.6.	Practice "walk-around management." Do not manage from a cubicle; go to the work and see for yourself.
6.2.12.	1.3.4.	Within program policy and within their area of work, empower people to accept responsibility and take action. Promote the motto "rather ask for forgiveness than permission."
6.2.13.	1.1.7.	Build a culture of mutual trust and support (there is no shame in asking for help).
6.2.14.	1.6.1.	Prefer physical team co-location to the virtual co-location.
6.2.2.	1.1.2.	Invest in people selection and development to address enterprise and program excellence. Ensure that hiring process matches the real needs of the program for talent and skill.
6.2.3.	1.1.3.	Program leadership must be a mentor and provide a model for desired behavior in the entire program team, such as trust, respect, honesty, empowerment, teamwork, stability, motivation, and drive for excellence.
6.2.4.	1.1.4.	Hire people based on passion and "spark in the eye" and broad professional knowledge, not only based on very specific skill needs (hire for talent, train for skills). Do not delegate this critical task to computers scanning for keywords.
6.2.5.	1.6.3.	Promote direct human communication to build personal relationships.
6.2.6.	1.4.5.	Promote and honor professional meritocracy.
6.2.7.	1.1.5.	Reward based upon team performance and include teaming ability among the criteria for hiring and promotion. Encourage teambuilding and teamwork.
6.2.8.	1.3.1.	Use and communicate flow down of responsibility, authority and accountability (RAA) to make decisions at lowest appropriate level.

# LEfSE	# LE	Lean Enabler for Managing Engineering Programs
6.2.9.	1.3.2.	Eliminate fear from the work environment. Promote conflict resolution at the lowest level.
6.3	1.4.	Expect and support people as they strive for professional excellence and promote their careers.
6.3.1.	1.4.1.	Establish and support communities of practice.
6.3.2.	1.4.2.	Invest in workforce development.
6.3.3.	1.4.3.	Ensure tailored Lean training for all employees.
6.3.4.	1.4.4.	Give leaders at all levels in-depth Lean training.
6.4.	1.4.	Expect and support people as they strive for professional excellence and promote their careers.
6.4.1.	1.4.7.	Perpetuate professional excellence through mentoring, friendly peer-review, training, continuing education, and other means.
6.4.2.	1.5.1.	Promote and reward continuous learning through education and experiential learning.
6.4.3.	1.5.2.	Provide easy access to knowledge experts as resources and for mentoring, including "friendly peer review."
6.4.4.	1.5.	Promote the ability to rapidly learn and continuously improve.
6.4.5.	1.5.3.	Value people for the unconventional ideas they contribute to the program with mutual respect and appreciation.
6.4.6.	1.5.4.	Capture and share tacit knowledge to stabilize the program when team members change.
6.4.7.	1.5.5.	Develop standards paying attention to human factors, including level of experience and perception abilities.
6.4.8.	1.5.6.	Immediately organize quick training in any new standard to ensure buy-in and awareness.
6.5.	1.1.1.	Understand that programs fail or succeed primarily based on people, not process. Treat people as the most valued assets, not as commodities.

Table A21: New Lean Enablers not Related to Lean Enablers for Systems Engineering

# LE	Lean Enablers for Managing Engineering Programs
1.1.8.	Promote close collaboration and relationship between internal customers and suppliers. Do not allow "lone wolf behavior."
1.1.9.	When staffing the top leadership positions (including the program manager), choose team players and collaboratively minded individuals over perfect-looking credentials on paper.
1.1.10.	When resolving issues, attack the problem, not the people.
1.2.	Motivate by making the higher purpose of the program and program elements transparent.
1.2.2.	Ensure everyone can see how their own contributions contribute to the success of the program vision.
1.3.	Support an autonomous working style.
1.3.3.	Allow certain amount of "failure" in a controlled environment at lower levels, so people can take risk and grow by experience.
1.4.6.	Establish a highly experienced core group ("grayhairs") that leads by example and institutionalizes positive behavior.
1.6.	Encourage personal networks and interactions.
1.6.2.	For virtually colocated teams, invest time and money up-front to build personal relationship in face-to-face settings.
1.6.4.	Engage in boundary spanning activities across organizations in the enterprise (e.g., value stream mapping).
1.6.5.	Engage and sustain extensive stakeholder interactions.
1.6.6.	Support the development of informal and social networks within the program and to key stakeholders in the program environment.
1.6.7.	Encourage (and document when appropriate) open information sharing within the program.
2.2.	Focus all program activities on the benefits that the program intends to deliver.
2.2.1.	All program activities, including communications and metrics, must be focused on the intended outcomes of the program—the program's planned benefits.

# LE	Lean Enablers for Managing Engineering Programs
2.2.2.	Align program resources to achieve planned benefits and incorporate activities that will enable the benefits achieved to be sustained following the close of the program.
2.2.3.	Ensure program staff and teams fully understand how program execution and benefits relate to high-level organizational goals (e.g., competitiveness and profitability)
2.3.10.	Clearly track assumptions and environmental conditions that influence stakeholder requirements and their perception of program benefits.
2.3.11.	Use program component selection and review with the key stakeholders as an opportunity to continuously focus the program on benefits delivery.
2.3.5.	Structure communication among stakeholders (who, how often, and what).
2.3.6.	Create shared understanding of program content, goals, status, and challenges among key stakeholders.
2.3.7.	Communicate accomplishments and major obstacles with stakeholders regularly and with transparency.
2.3.8.	Build trust and healthy relationships with stakeholders by establishing open communication and early engagement with the program planning and execution.
2.3.9.	Listen to the stakeholders' comments and concerns patiently and value their views and inputs.
2.4.	Develop high-quality program requirements among customer stakeholders before bidding and execution process begins.
2.4.10.	Require an independent mandatory review of the program requirements, concept of operation, and other relevant specifications of value for clarity, lack of ambiguity, lack of conflicts, stability, completeness, and general readiness for contracting and effective program execution.
2.4.11.	Clearly articulate the top-level objectives, value, program benefits, and functional requirements before formal requirements or a request for proposal is issued.
2.4.12.	Use a clear decision gate that reviews the maturity of requirements, the trade-offs between top-level objectives, as well as the level of remaining requirements risks before detailed formal requirements or a request for proposal is issued.
2.4.2.	Use only highly experienced people and expert institutions to write program requirements, RFPs, and contracts.
2.4.3.	If the customer lacks the expertise to develop clear requirements, issue a contract to a proxy organization with towering experience and expertise to sort out and mature the requirements and specifications in the RFP. This proxy must remain accountable for the quality of the requirements, including personal accountability.
2.4.4.	Prevent careless insertion of mutually competing and conflicting requirements, excessive number of requirements, standards, and rules to be followed in the program, mindless "cut-and-paste" of requirements from previous programs.
2.4.5.	Minimize the total number of requirements. Include only those that are needed to create value to the customer stakeholders.
2.4.6.	Insist that a single person is in charge of the entire program requirements to assure consistency and efficiency throughout.
2.4.7.	Require personal and institutional accountability of the reviewers of requirements until program success is demonstrated.
2.4.8.	Always clearly link requirements to specific customer stakeholder needs and trace requirements from this top level to bottom level
2.4.9.	Use peer-review requirements among stakeholders to ensure consensus validity and absence of conflicts.
2.5.10.	Employ agile methods to manage necessary requirements change and make the program deliverables robust against those changes. Make both program processes and program deliverables reusable, reconfigurable, and scalable.
2.5.7.	Facilitate communication between different and possibly diverging stakeholders to develop a shared understanding of the program among the stakeholders, clearly identifying and incorporating the various interests of different stakeholders (aligned, indifferent, or opposed), and establish trust.
2.6.	Actively minimize the bureaucratic, regulatory, and compliance burden on the program and subprojects.
2.6.1.	Strive to minimize and streamline the burden of paperwork for external stakeholders by actively engaging them in the process and clearly articulating and aligning the benefit generated by each report.

# LE	Lean Enablers for Managing Engineering Programs
2.6.2.	Minimize and streamline the program-internal reporting for program activities and subprojects by optimizing the internal reporting requirements. Only require reports that are clearly necessary, and align reporting requirements to reduce redundant reporting.
2.6.3.	Ensure all review and approval steps are truly needed and value-adding in the program.
3.10.	Manage technology readiness levels and protect program from low-TRL delays and cost overruns.
3.10.10.	Ensure clear, program-wide understanding of agreed-upon technologies and technology standards.
3.10.11.	Utilize independent technical reviews to confirm a capability to deliver and integrate any new technology that could delay the program or cause schedule overruns.
3.10.2.	Institute clear guidelines for technology maturation and insertion process in your program. Clearly define what type and level of technology, cost, and schedule risk is acceptable under what circumstances (paralysis by analysis vs. program failure).
3.10.5.	Extensively use risk management to accept appropriate levels of technology risk and ensure sufficient mitigation actions are in place.
3.10.7.	Provide stable funding for technology development and maturation. This will support a steady, planned pipeline of new technologies to be inserted into the program.
3.10.8.	Match technologies to program requirements. Do not exceed program needs by using unnecessarily exquisite technologies ("gold plating").
3.10.9.	Perform robust system architecting and requirements analysis to determine technology needs and current technology readiness levels.
3.11.	Develop a communications plan.
3.2.	Actively architect and manage the program enterprise to optimize its performance as a system.
3.2.1.	Keep activities during early program phases internal and collocated, as there is a high need for coordination.
3.2.2.	Set up a single, collocated organization to handle the entire systems engineering and architecting for the entire effort throughout the life cycle, in order to increase RAA.
3.2.3.	Ensure that systems engineering and architecting are a central part of program management and not outsourced or subcontracted, as these activities require a high level of coordination.
3.2.4.	Develop a clear vision and holistic view of the future state of your program enterprise, including future portfolio of products, including both the future organization as well as the future value stream. Provide guidance on a clear path forward and ensure that resources are aligned with this vision.
3.2.6.	Change the program “mindset” to focus on the entire program enterprise and the value it delivers to customer stakeholders.
3.2.7.	Lead and sustain the transformation to an integrated program management and systems engineering enterprise across customer and supplier organizations.
3.2.8.	Insist on adopting an adaptive architecture that meets the operational needs, while not catering to any proprietary technologies or capabilities of potential contractors.
3.3.	Pursue multiple solution sets in parallel.
3.3.3.	For key decisions, explore alternative options in parallel as long as feasible. For example, use the method of Set-Based Concurrent Engineering.
3.4.	Ensure up-front that capabilities exist to deliver program requirements.
3.4.1.	Ensure strong corporate, institutional, and personal accountability and personal penalties for "low-balling" of the budget, schedule, and risk and overestimating capabilities (e.g., the technology readiness levels (TRL)) in order to win the contract.
3.4.2.	If a low-balling is detected on a fixed-price contract, insist on continuing the fixed-price contract, or terminate the program termination, and rebid. Do not allow switching to cost-plus contracts.
3.4.3.	Ensure that planners and cost estimators are held responsible for their estimates during the execution of the program. Minimize the risk of wishful thinking.
3.5.10.	Transition the front-loading of the program and key projects into a continuous planning and improvement process with regular workshops.

# LE	Lean Enablers for Managing Engineering Programs
3.5.12.	Include a detailed risk and opportunity identification, assessment, and mitigation in the early program planning phases.
3.5.13.	Ensure that technical challenges within the program are adequately addressed by management staff during the planning process.
3.5.14.	The program manager must personally understand, clarify, and remove ambiguity, conflicts, and waste from key requirements and expectations at the program start.
3.5.15.	Heavily involve the key suppliers in program planning and at the early phases of program.
3.5.2.	Up-front in the program, dedicate enough time and resources to understand what the key requirements and intended program benefits really are.
3.5.3.	Establish a system and process that allows comprehensive, effective, and efficient up-front planning of program before execution begins.
3.5.4.	The program leadership team (program manager, technical managers, lead system engineers, etc.) must identify key stakeholders that will be involved throughout the program life cycle before the program execution begins.
3.5.5.	Hold a program kick-off meeting with key stakeholders that identifies the program benefits and the key mechanisms to realize these benefits (e.g., value stream mapping), identify and assign roles and responsibilities, identify key dependencies and risks in program, set key milestones, and establish an action plan.
3.5.6.	Propagate front-loading of program throughout critical subprojects with similar workshops to those described in 3.5.5.
3.5.7.	Ascertain what is available to the program (resources, talent, budget and timeline) and what not available prior to making commitment to the customers and other stakeholders.
3.5.8.	Hold Lean accelerated planning sessions at the program level and for key subprojects, engaging all stakeholders in developing master schedule, value stream map, risks and opportunities, key assumptions, and action items.
3.6.	Use probabilistic estimates in program planning.
3.6.1.	Develop probabilistic estimates for cost, schedule, and other critical planning forecasts.
3.6.2.	Base planning assumptions on confidence intervals, not on point estimates.
3.7.1.	Permit outsourcing and subcontracting only for program elements that are perfectly defined and stable. Do not subcontract early program phases when the need for close coordination is the strongest.
3.7.3.	Engage suppliers early in the program to identify and mitigate critical supplier-related risks.
3.7.4.	Respect your extended network of partners and suppliers by challenging them and helping them improve.
3.7.5.	Streamline supply chain processes and focus on just-in-time operations that minimize inventory carrying costs.
3.7.6.	When defining requirement sets for multiple suppliers, ensure that they are independent of each other, in order to minimize risk and reduce the need to manage dependencies among suppliers.
3.9.	Develop an integrated program schedule at the level of detail for which you have dependable information.
3.9.7.	Update detailed planning regularly to reflect new information, being consistent with the long-term strategic plan. Do not force programs to execute against a detailed, outdated plan that was developed based on incomplete information.
4.10.10.	Track reduction of risk and uncertainty throughout program life cycle as KPI.
4.10.11.	Track the efficiency and quality of organizational interfaces within the program enterprise with KPIs.
4.10.2.	Track the program's overall progress to deliver the program benefits.
4.10.6.	Provide guidance to the organization and subprojects to assess their level of performance and contribution to the overall program success.
4.10.7.	Align program metrics with intended benefits and stakeholder expectations.
4.10.8.	Establish clear line-of-sight between lower-level program and project metrics and top level program success metrics.
4.10.9.	Develop a snapshot/summary representation of the meaningful metrics (e.g., standard deck) to measure all phases of the project and program and make it available to all.
4.2.	Ensure clear responsibility, accountability and authority (RAA) throughout the program from initial requirements definition to final delivery.

# LE	Lean Enablers for Managing Engineering Programs
4.2.1.	Nominate a permanent, experienced program manager fully responsible and accountable for success of the entire program life cycle, with complete authority over all aspects of the program (business and technical).
4.2.2.	Ensure continuity in the program manager position and avoid personnel rotation.
4.2.4.	Hold people responsible for their contributions throughout the program life cycle. Upstream activities must be held responsible for issues they cause in downstream activities.
4.2.5.	In the top-level program management team and decision making, the different roles (e.g., business and technical) must exhibit a high level of teamwork, understanding, and appreciation of the necessities in each other's domain.
4.2.6.	Develop a process to ensure the timely and flawless coordination, interface, and hand-off (if needed) of RAA among relevant program stakeholders and execution teams throughout the program life cycle.
4.3.3.	Ensure that the competency, technical knowledge, and other relevant domain knowledge of the program manager and the other key members of the program team are on par with the technical complexity of the program.
4.3.4.	Ensure that the program manager has clarity over the impact of technical, requirement, and scope changes (for example by clear traceability of requirements and effective use of change management control boards).
4.4.	The top-level program management (e.g., program management office) overseeing the program must be highly effective.
4.4.1.	Program management staff turnover and hiring rates must be kept low.
4.4.2.	Invest heavily in skills and intellectual capital; engage people with deep knowledge of the product and technology.
4.5.	Pursue collaborative and inclusive decision making that resolves the root causes of issues.
4.5.1.	If decisions are based on assumptions that are likely to change, keep track of those assumptions and adjust the decisions when they change.
4.5.10.	Proactively manage trade-offs and resolve conflicts of interest among stakeholders. Do not ignore or try to gloss them over.
4.5.11.	Ensure that system design, organizational design, contract design, risk management, decision making among the stakeholders, metrics, and incentive structure are aligned to support this ongoing and dynamic decision- making process.
4.5.2.	Define the information needs as well as time frame for decision making. Adjust the needed information and analysis to reflect the allotted time for reaching a decision.
4.5.3.	Take the time necessary to reach good decisions. Always explore a number of alternatives.
4.5.4.	Never delay a decision because you are not willing to take the responsibility or are afraid to discuss the underlying issues.
4.5.5.	Break down complex decisions into independent components as much as possible. Do not bargain for power or status, but resolve each based on program and system requirements and constraints.
4.5.6.	If you cannot make a decision for whatever reason, keep track of it and periodically review unmade decisions.
4.5.7.	Define a clear, streamlined process for critical decision making, resolving conflicts of interest and converging on consensus.
4.5.8.	Problems are corrected by those who created them, where they occur, and as soon as possible.
4.5.9.	Make decisions carefully by consensus, maintaining clear responsibility and thoroughly considering all options. Search for solutions to issues that satisfy multiple stakeholders simultaneously. Stakeholder interests must converge over time.
4.6.	Integrate all program elements and functions through Program Governance
4.6.1.	Ensure program governance has full view, control, and influence over the entire program to effectively guide and balance the program and its individual components throughout its life cycle.
4.6.2.	Employ program-supporting processes to integrate program components for effective delivery of the program's benefits and outcomes (e.g., program risk, communication, and resource management).
4.6.3.	Seek and maintain independent reviews of the program. Assign teams outside of the program to observe and assess the execution and health of the program. Engage nonadvocates in review process.
4.6.4.	Use a gated process for validating, planning, and execution of the program and leverage functional expertise at these gates.

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4.6.5.	Ensure integration between different topical domains throughout the program life cycle, for example, architecture, software, and hardware design.
4.6.6.	Align incentives across the program enterprise.
4.7.5.	Promote flat organization to simplify and speed up communication.
4.8.1.	Standardize program management metrics and reporting system.
4.8.2.	Identify repeatable program management activities and standardize them.
5.2.	Establish effective contracting vehicles in the program that support the program in achieving the planned benefits and create effective pull for value.
5.2.1.	Establish common contract structures throughout the program.
5.2.2.	Align contracts and incentives throughout the program to fairly share the risk and opportunities inherent in the probabilistic estimates. Use this to avoid gaming of forecasts and create win-win situations.
5.2.3.	Ensure that contracts support complete and open communication between the program stakeholders.
6.1.	Make effective use of existing program management and organizational maturity standards.
6.1.1.	Use existing program management standards, guidelines, and applicable organizational maturity models to your program's best advantage.
6.1.2.	Focus on achieving the program benefits when selecting, customizing, and implementing program management standards, guidelines, and maturity models.
6.1.3.	Integrate the implementation process with existing program and business strategy to an overall program management and organizational maturity standard.
6.1.4.	Do not implement any standard purely for achieving any sort of mandated program certification.
6.1.5.	Review and use existing Lean-based enterprise and program self-assessment tools to quickly identify weaknesses, goals, and track progress on the process improvement journey.
6.2.	Pursue Lean for the long term.
6.2.1.	Develop an integrated, long-term approach to implement Lean management practices in product portfolio planning and the entire enterprise.
6.2.2.	Set up a centralized Lean management function that develops a general Lean management process framework for the enterprise, a central repository of Lean management methods, and a Lean business case that ties Lean practices to achieving the program benefits.
6.2.3.	Set up a Lean management training infrastructure: mid-level and project managers must train and motivate their teams.
6.2.4.	Create incentives within the program and subprojects that foster the acceptance of Lean practices.
6.2.5.	Integrate the Lean activities in program management into your overall change management and process improvement approach in order to assure sustainability of the improvements, as well as use synergies with existing process improvement activities.
6.2.6.	Start small by selecting the most beneficial Lean enablers for your program.
6.2.7.	Codify lessons learned and evaluate their effectiveness.
6.2.8.	Look for new and innovative ways to work that add value.
6.3.2.	Follow basic problem solving techniques (e.g., plan-do-check-act) and adopt a culture of stopping and permanently fixing problems when they occur.
6.4.2.	Clearly document context of "best practices" and "key learnings" in lessons learned to allow evaluation of appropriateness in new programs.
6.4.3.	Create a process to regularly review, evaluate, and standardize lessons learned and prepare them for implementation.
6.4.4.	Assign responsibility and accountability for reviewing, evaluating, and standardizing lessons learned and implement resulting change.
6.5.	Use change management effectively to continually and proactively align the program with unexpected changes in the program's conduct and the environment.

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6.5.1.	Proactively align the program with changes in the environment to keep focused on achieving program benefits. Redirect, replan, or stop individual program components.
6.5.2.	Establish a program change management process at the top level that incorporates all relevant stakeholders and program components.
6.6.	Proactively manage uncertainty and risk to maximize program benefit.
6.6.1.	Focus program risk management on creating and protecting value for the program.
6.6.10.	Pay close attention to the opportunities and capture them along with risks.
6.6.2.	Create transparency regarding the uncertainties affecting the program. Understand and document the key risk factors for programs and existing best practices to manage them.
6.6.3.	Support all critical decisions in the program with risk management results.
6.6.4.	Reduce program-internal uncertainties and other uncertainties that can be influenced to a maximum degree.
6.6.5.	Make the program resilient against external uncertainties or other uncertainties that cannot be influenced.
6.6.6.	Develop sufficient risk management skills in the program and provide adequate resources.
6.6.7.	Tailor the risk management process to the specific program needs and integrate it with the overall program management process.
6.6.8.	Ensure that risk management activities contribute to continuous improvement of program management processes and the organization of the program enterprise.
6.6.9.	Regularly monitor and review risks, risk mitigation actions, and the risk management system.
6.8.4.	Define a process that implements successful local improvements in other relevant parts of the program.