PRACTICAL SUPPORT FOR LEAN SIX SIGMA SOFTWARE PROCESS DEFINITION

Using IEEE Software Engineering Standards

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PRACTICAL SUPPORT FOR LEAN SIX SIGMA SOFTWARE PROCESS DEFINITION

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SUSAN K. LAND
DOUGLAS B. SMITH
JOHN W. WALZ

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PREFACE

Lean Six Sigma emphasizes that speed is directly related to process excellence. Many books have been written in support of streamlining core software processes or making core software processes and practices "lean." Additionally, numerous books and articles have been written in support of Six Sigma statistical measurement. This book begins by providing software developers with the fundamentals of software engineering. It then goes on to supply software project managers and development staff with the materials needed so that they can define their core software development processes and practices, and then proceeds to help support the refinement of these software and systems engineering processes using Lean Six Sigma methods.

Many times, organizations head down the road toward the implementation of the Lean Six Sigma methodologies without a common understanding of the firm underpinnings of software and systems engineering. Before organizations can have processes that rapidly (using lean production) produce products of high quality (high sigma), they must first define their basic software engineering processes and practices.

This book provides support for the foundation of a Lean Six Sigma program by providing detailed process and practice documentation guidance in the form of:

- An overview of Lean Six Sigma methodologies
- Detailed organizational policy examples
- An Integrated set of over 40 deployable document templates
- Examples of over 70 common work products required for support of process improvement activities
- Examples of organizational delineation of process documentation

This book provides a set of IEEE software engineering standards-based templates that support the process definition and work-product documentation required for all activities

associated with software development projects. The goal is to provide practical support for individuals responsible for the development and documentation of software processes and procedures. The objective is to present the reader with an integrated set of documents that support the initial requirements of a Lean Six Sigma program.

This book will provide specific support for organizations pursuing Lean Six Sigma guided software process definition and improvement. It is hoped that this knowledge provides the essential foundation on which to build toward the evolution of software process definition, documentation, and improvement, and should be an integral part of every software engineering organization.

The IEEE Computer Society Software and Systems Engineering Standards Committee (S2ESC) is the governing body responsible for the development of software and systems engineering standards. S2ESC has conducted several standards users' surveys; the results of these surveys reflected that standards users found the most value in the guides and standards that provided the specific detail that they needed for the development of their process documentation. Users consistently responded that they used the guides in support of software process definition and improvement but that these standards and guides required considerable adaptation when applied as an integrated set of software process documentation.

This book was written to support software engineering practitioners who are responsible for producing the process documentation, work products, or artifacts associated with support of software process definition and improvement. This book will be most useful to organizations with multiple products and having business customer relationships. In addition to members of project development and test teams working on products with multiple versions, this book will also be useful to members of organizations supporting software project development and testing who work in such areas as project management, configuration management, risk management, human resources, and information technology.

It is the hope of the authors that this book will help members of organizations who are responsible for developing or maintaining their software processes in order to support Lean Six Sigma requirements.

SUSAN K. LAND
DOUGLAS B. SMITH
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1

INTRODUCTION AND OVERVIEW

INTRODUCTION

Software is generated from thousands of lines of code which are developed by a number of people with a variety of skill sets using a multitude of development methods, standards, and rules. These lines of code have to come together at the right time, in the right order, at the right cost, and with the required quality. In order to try to confront this software development challenge, organizations have been employing:

- Software engineering practitioners with better software engineering skills
- Software engineering tools that better fit practitioners and their methods
- Software process improvement methodologies and controls that help to guarantee quality and delivery

Moving an organization from the chaotic environment of free-form development toward an environment that is managed for success using control and communication processes can be confusing to those tasked with making it happen. When those same individuals are also challenged to additionally produce "lean" and "efficient" processes, the task can be overwhelming. It is imperative that the people responsible for the development of software processes and practices understand the foundations of software engineering.

If an organization, and its employees, do not practice or understand the tenants of basic software engineering, trying to employ Lean Six Sigma methodologies is not advisable. Organizations must first have sound software engineering processes and practices. These processes and practices should be based upon standards and industry best practices. Employees must embrace, understand, and should be well trained in these supporting practices before any attempt can be made at increasing software development speed. It should

be noted that significant quality improvement gains can be made by simply defining processes and practices in organizations where none exist.

This book is written to support software engineering practitioners who are responsible for producing the process documentation and work products or artifacts associated with support of software process definition and improvement. This book specifically addresses how IEEE standards may be used to facilitate the development of processes, internal plans, and procedures in support of managed and defined software and systems engineering processes in support of Lean Six Sigma implementation [81].

The IEEE Computer Society Software and Systems Engineering Standards Committee (S2ESC) offers an integrated suite of standards based on using IEEE 12207 [40] as a set of reference processes. S2ESC recommends that organizations should use 12207 and related standards to assist them in defining their organizational processes in support of the implementation of the Lean Six Sigma process methodology. However, this book is based on the premise that the reader's processes may not have been defined in this fashion and that the reader seeks help in improving their processes. Therefore, the advice provided in this book does not make the assumption that the user's processes conform to 12207. In general, that advice will be consistent with 12207, but its intent is to assist with process documentation and improvement in the context of Lean Six Sigma. It is the premise of the information provided within these pages that IEEE software engineering standards [42] can be used to provide the basic beginning framework for this type of process improvement.

IEEE standards can be used as instruments to help with the process definition and documentation (e.g., work products) required in support of the process improvement of software and systems development efforts. Many of the IEEE software engineering standards provide detailed procedural explanations; they offer section-by-section guidance on building the necessary support material, and most importantly, they provide best-practice guidance in support of process definition as described by those from academia and industry who sit on the panels of standards reviewers.

In using this book, the key is to use the templates provided to develop simple processes that support your development efforts; team member involvement is critical. The Lean Six Sigma approach combines general quality guidance with a process-based management approach, describing the criteria that the processes should support. IEEE standards are prescriptive. These standards describe how to fulfill the requirements associated with all activities of effective software and systems project life cycle.

IEEE standards are highly specific. They are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics to ensure that materials, products, processes, and services are fit for their purpose. In contrast, Lean Six Sigma has been called an improvement method, or improvement engine, using data to identify and eliminate process problems [80]. This book is an attempt to bridge the gap between defined methods and the end goal of a practicing Lean Six Sigma organization.

It is often hard to separate the details associated with product development from the practices required to manage the effort. Simply providing a description of the Six Sigma methodology and lean manufacturing processes to a project lead or manager provides them with a description of an end results model. Pairing this with IEEE standards provides them with a way to work toward this desired end. IEEE standards do not offer a "cookie cutter" approach to management; rather, they support the definition of the management processes in use by describing what is required. IEEE standards provide much

needed guidance to organizations working to define their organizational processes and practices.

STIMULUS FOR LEAN SIX SIGMA

Organizations are motivated to use Lean Six Sigma from two directions: external and internal. External motivations may be customers, investors, or competitors. Lean Six Sigma requirements are now showing up in the form of Dept. of Defense (DoD) requirements. The Office of the Secretary of Defense (OSD) and all of the Services are embarked on multiyear continuous process improvement initiatives based on Lean Six Sigma, including the Air Force's Smart Operations for the 21 Century (AFSO21) and the Navy's AIRSpeed. DoD requests for proposals are increasingly asking for Lean Six Sigma qualifications. The Air Force in 2007 awarded a 5-year contract worth up to $99 million for lean expertise and training [123, 124].

Internal motivations for Lean Six Sigma implementation are improving company profitability through improved revenue growth, reduced costs, improved delivery times, and increased customer satisfaction [80]. Lean Six Sigma implementation normally is instigated by top management and enjoys on-going support due to its successes across many industries.

Many software engineering organizations have implemented Lean Six Sigma in minimal form but have not realized its full potential. This may be due to the general and abstract nature of Lean Six Sigma as contrasted with the inherent complexity of software engineering processes. However, it is much more likely that software development organizations may not be realizing the full benefits of Lean Six Sigma because they are trying to apply it to incomplete or nonrobust software engineering development activities. An organization must have sound software engineering practices before it can look to improve them using a methodology like Lean Six Sigma.

Successful software engineering organizations should create well-formed internal work products, or artifacts, during development phases leading to a finished product or as by-products of their software process or practice definition. Although Lean Six Sigma does not describe these artifacts in detail, this book will describe and provide examples of the important artifacts that are aligned with the IEEE software engineering standards. The usage of IEEE related artifacts allows customers and investors additional opportunities for interaction during the various project phases leading to refined requirements, feedback, and expectations. IEEE-related artifacts provide increased clarity among project personnel, which promotes easier personnel movement between teams and organizations, better alignment between project/program management and software engineering, and better alignment between company goals, objectives, and project/program success factors.

For organizations that do not wish to pursue an implementation of the Lean Six Sigma techniques, this text will show how the application of IEEE standards, and their use as reference material, can facilitate the development of sound software and systems engineering practices. This book is geared for the Lean Six Sigma novice, the project manager, and software engineering practitioners and managers who want a one-stop source, a helpful document, that provides the details and implementation support required when pursuing process definition and improvement.

The plans and artifacts described in this book may be used as an integrated set in support of software and systems process definition and improvement. The plans and artifacts

are meant to elicit thought and help guide organizations and development teams through the definition of their own unique software development processes and practices. It should be noted that many of the plans offer examples; these examples are meant to show intent and offer only narrow perspectives on possible plan content.

In addition to Lean Six Sigma, there are also other well-known software process improvement models that have widespread popularity. Two of these models are the Capability Maturity Model Integration (CMMI(r)) and ISO 9001. The authors of this book have taken the realistic view that many software development organizations may have multiple motivators for software process improvement. Organizations may want lean processes, but they may also have dual requirements for CMMI or ISO 9001 certification.

Although these topics will not be covered in this book, they are covered extensively in related texts by the same authors* and deliberate efforts have been made to keep the foundation materials and artifacts provided for the creation of baseline software engineering processes and practices consistent. This is done so that organizations that may have a dual requirement—not only being a Lean organization, but also one meeting the capability requirements of a Level 2 or 3 CMMI organization, or ISO 9001 certified software developing entity. If employed, these plans and artifacts will help organizations establish the sound software engineering foundation required to help them then move on their way toward sound software process improvement.

The authors recommend attendance in the following, or similar, courses: Six Sigma Green Belt Training (5 days) and Lean Practitioner Training (4 days). The authors also recommend the acquisition of the IEEE Software Engineering Collection, which fully integrates over 40 of the most current IEEE software engineering standards onto one CD-ROM [42]. This book provides a list of the IEEE standards abstracts in Appendix C and the mapping IEEE 12207 clause numbers to both the relevant IEEE standards and the IEEE 12207 2008 version clauses in Appendix E.

USING THIS BOOK

The purpose of this book is to assist users in selecting IEEE software engineering standards and their related artifacts appropriate to their needs for process changes leading to Lean Six Sigma implementation. It is important that readers understand that process improvement begins when organizations have a strong foundation of software engineering process methodology. Processes must exist before they can be improved. This book provides two components: a set of templates to establish a core set of software engineering practices and processes, and a description of Lean Six Sigma techniques to accomplish software process improvement.

A key question is, where is your organization? What is its current state? Is your organization currently using

- Six Sigma for software engineering
- Lean software engineering

*Land, Susan K.; *Using IEEE Software Engineering Standards to Jumpstart CMM/CMMI Software Process Improvement,* IEEE/Wiley, 2005; Land, Susan K., and Walz, John, *Practical Support for CMMI-SW Software Project Documentation: Using IEEE Software Engineering Standards,* IEEE/Wiley, 2006; Land, Susan K., and Walz, John, *Practical Support for ISO 9001 Software Project Documentation: Using IEEE Software Engineering Standards,* IEEE/Wiley, 2006.

- Measurements of software engineering processes
- Process frameworks such as CMMI-DEV®
- Formalized management systems such as ISO 9001
- Some of the above on selected projects, but not all projects
- None of the above

A typical journey for newly formed software engineering organizations is to reverse the seven bulleted items above by taking steps, one at a time, starting on a pilot project and applying the learning to all projects in the organization.

Lean manufacturing initiatives are becoming relatively commonplace in the world of manufacturing. Lean manufacturing helps eliminate production waste, introduce value-added measurements, and push for continuous improvements. The Six Sigma methodology uses data and statistical analysis tools to identify, track, and reduce problem areas and defects in products and services.

As Six Sigma is complementary to lean processes, the two are combined into Lean Six Sigma, which strives to present the same types of gains for software engineering companies. Once the waste is removed from software development and production is truly "lean," then the Six Sigma tool set is applied to reduce defects in the value-adding parts of the process.

The subsequent application of Six Sigma methodology supports risk management and problem identification and resolution. In addition to the lean tools to reduce waste and Six Sigma tools to reduce defects, some organizations also include Goldratt's Theory of Constraints [83] in their continuous improvement toolkit to use on bottlenecks. Although we do not cover Theory of Constraints in detail in this book, it is a very compatible approach that, at a high level, consists of a five step process:

1. *Identify* the system's constraint.
2. *Exploit* (maximize throughput of) the system's constraint.
3. *Subordinate* other processes to the constraint; reduce suboptimzation.
4. *Elevate* the constraint (make it more capable).
5. *Repeat* the cycle (what limits the system now that you have broken its previous constraint?).

The Theory of Constraints and its application to scheduling (also called the Critical Chain) are similar to the lean principle of *flow,* and lean's emphasis on reducing multitasking [83].

The Lean Six Sigma approach combines general quality guidance with a process-based management approach, describing the criteria that the processes should support. Just as lean implementation should generally precede the application of Six Sigma techniques, the combined Lean Six Sigma requires a robust management and process measurement system foundation such as ISO 9001 or the CMMI-DEV framework prior to the application of its improvement methodologies. This book is oriented toward organizations whose current state is any of the seven bulleted levels above.

This book provides the coherent software life cycle processes as defined in IEEE 12207 and related software engineering standards to assist organizations in defining their organizational processes and artifacts in support of the implementation of the Lean Six

Sigma methodology. The software engineering standards are used as instruments to help with the process definition and documentation (e.g., work products or artifacts) required in support of the software process improvement toward the desired organizational state. These desired states can be reached in steps: first achieving the robust management system foundation, followed by primary life cycle software processes measurements, and, finally, implementation of the Lean Six Sigma methodology. This journey requires adaptation and tailoring of standards and their artifacts as "one size does not fit all." Projects must design and use their objective experiences to determine what works best when using selected best practices.

Many organizations with a robust management system foundation are pursuing process improvement by establishing a set of organizationally adopted processes to be applied by all of their projects, and then improving them on the basis of their experience. This "experience" is factored by both the lean principles and the Six Sigma principles, resulting in the use of specific Lean Six Sigma improvement techniques that validate specific process changes to be deployed across the organization. Whenever objective experiences demonstrate the need for changes to processes and artifacts, then this book will show the appropriate IEEE software engineering standards to be selected and analyzed so that their best practices can be incorporated into processes, internal plans, procedures, and other artifacts, to support Lean Six Sigma implementation.

Change management is not solely a technical endeavor of engineering process experts. Whether the Lean Six Sigma motivation is from external or internal sources, top management support is required for organizational change management. Top management has the responsibility of providing overall direction, resources, and the control framework for managing the change process. The organizational changes result in changes to participant's skills, their tools, and their work processes and artifacts. This book focuses on the software engineering and improvement work processes and artifacts that support Lean Six Sigma implementation. Although process engineers have major roles, team member involvement in organizational and process changes is critical.

This book will guide your organization to use the provided software engineering standards and artifacts such as document templates to develop or enhance processes that support your development efforts with Lean Six Sigma.