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How To Measurably Improve Your Requirements

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Objectives

Describe some requirements problems from industry.

Present a useful classification of requirements problems.

Describe some practical strategies and best practices that organizations have used to successfully develop, manage, and improve their requirements in a measurable way.

Provide real examples that address requirements problems.

Answer any of your questions.

Outline

Why Focus on Requirements?

A Practical Requirements Classification

CMMI® Requirements Overview

Practical Approaches for Requirements

Requirement Examples

Some Advanced Approaches

Summary

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Why Focus on Requirements?

**The hardest single part of building a system is deciding what to build...
No other part of the work so cripples the resulting system if done wrong. No other part is more difficult to rectify later.**

Adapted from Fredrick Brooks, Jar. [Brooks 87]

Why Focus on Requirements?

A research report from the Standish Group highlighted the continuing quality and delivery problems in our industry and identified three leading causes:

- **Lack of user input**
- **Incomplete requirements and specifications**
- **Changing requirement specifications**

- **Reference: "Chaos", Compass, The Standish Group, 1997, used with permission.**

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Problems with Requirements

According to the SEI [Christel 92], problems of requirements elicitation can be grouped into 3 categories:

1. **Problems of Scope: the requirements may address too little or too much information.**

2. **Problems of Understanding: problems within groups as well as between groups such as users and developers.**

3. **Problems of Volatility: the changing nature of requirements.**

Scope and Volatility

The list of 10 requirements elicitation problems given in [McDermid 89] can be classified according to the 3 categories in [Christel 92]:

Problems of Scope

- **The boundary of the system is ill-defined**
- **Unnecessary design information may be given**

Problems of Volatility

- **Requirements evolve over time**

Problems of Understanding

- Users have incomplete understanding of their needs
- Users have poor understanding of computer capabilities and limitations
- Analysts have poor knowledge of problem domain
- User and analyst speak different languages
- Ease of omitting "obvious" information
- Conflicting views of different users
- Requirements are often vague and untestable, e.g., "user friendly" and "robust"

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Requirements Management (REQM)

SG 1: Manage Requirements:

SP 1.1-1: Obtain an Understanding of the Requirements

SP 1.2-2: Obtain Commitment to Requirements

SP 1.3-1: Manage Requirements Changes

SP 1.4-2: Maintain Bidirectional Traceability of Requirements

SP 1.5-1: Identify Inconsistencies between Project Work and Requirements

• Reference: "Capability Maturity Model® Integration (CMMI), Version 1.1", CMU/SEI-2002-TR-011, March 2002

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Requirements Development (RD)

SG 1: Develop Customer Requirements:

SP 1.1-1: Collect Stakeholder Needs
SP 1.1-2: Elicit Needs
SP 1.2-1: Develop the Customer Requirements

SG 2: Develop Product Requirements:

SP 2.1-1: Establish Product and Product-Component Requirements
SP 2.2-1: Allocate Product-Component Requirements
SP 2.3-1: Identify Interface Requirements

SG 3: Analyze and Verify Requirements:

SP 3.1-1: Establish Operational Concepts and Scenarios
SP 3.2-1: Establish a Definition of Required Functionality
SP 3.3-1: Analyze Requirements
SP 3.4-3: Analyze Requirements to Achieve Balance
SP 3.5-1: Validate Requirements
SP 3.5-2: Validate Requirements with Comprehensive Methods

• Reference: "Capability Maturity Model® Integration (CMMI), Version 1.1", CMU/SEI-2002-TR-011, March 2002

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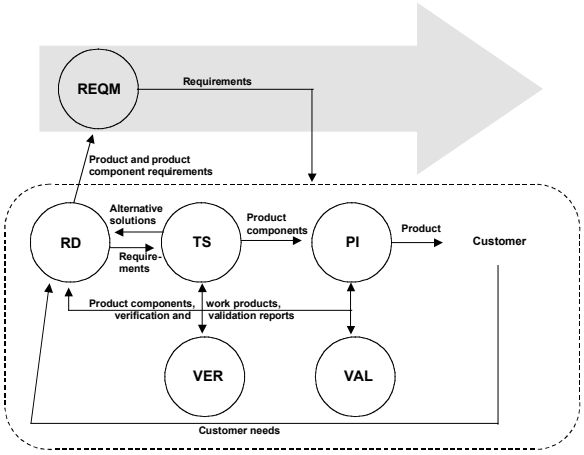
Engineering Process Areas



• Reference: "Capability Maturity Model® Integration (CMMI), Version 1.1", CMU/SEI-2002-TR-011, March 2002

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CMMI and Requirements

Requirement processes need to be defined, trained, and improved (e.g., OPF, OPD, OT, OID).

Support processes are critical for measuring and managing requirements (e.g., CM, MA, PPQA).

Defects need to be removed and prevented in requirements (e.g., PI, VER, VAL, CAR).

IPPD (i.e., integrated product teams) also contains allocating requirements to teams (e.g., IPM).

Supplier Sourcing requires managing supplier requirements (e.g., SAM).

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Practical Strategies

1. Define a lean Requirements Management (REQM) Process.
2. Use lean Configuration Management (CM) and CM Metrics.
3. Use Requirements Metrics (e.g., priority, stability, risk, number of requirements, defect density, etc).
4. Define the requirements process (RD), and use lessons learned from quality (e.g., QFD, Juran, etc).
5. Tailor a requirements standard (e.g., IEEE).
6. Use early defect detection and defect prevention.
7. Use operational definitions to define requirements.

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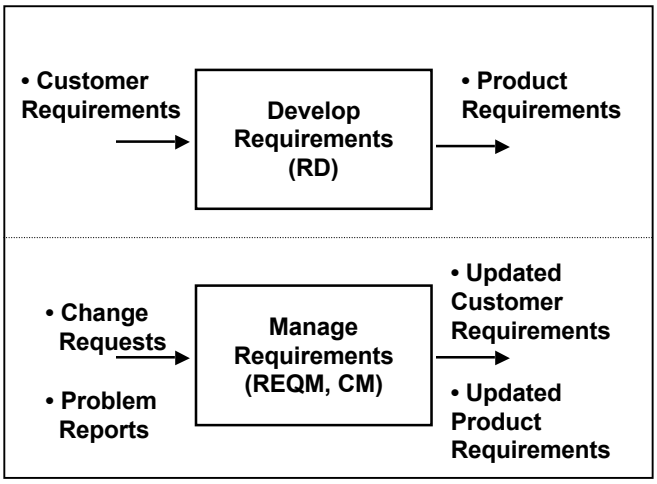
1. Define Lean Requirements Processes (REQM, RD)



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1. Manage Requirements (REQM)

Purpose: Effectively Manage Requirements Changes

Inputs	Entry	Tasks	eXit	Outputs
• Customer Req. • Product Req. • Change Requests • Problem Reports	Cust Req./ Prod Req. Inspected AND Baselined AND CR/PR's Not all Closed	1. Perform CCB Meeting Procedure 2. Perform Change Control Procedure 3. Perform Release Procedure **Best-In-Class Metrics**	• CR/PRs are Resolved AND Cust Req./ Prod Req. Inspected AND Under CM	• Customer Req. • Product Req. • Baselines • Releases

Roles: Project Manager (PM), CCB

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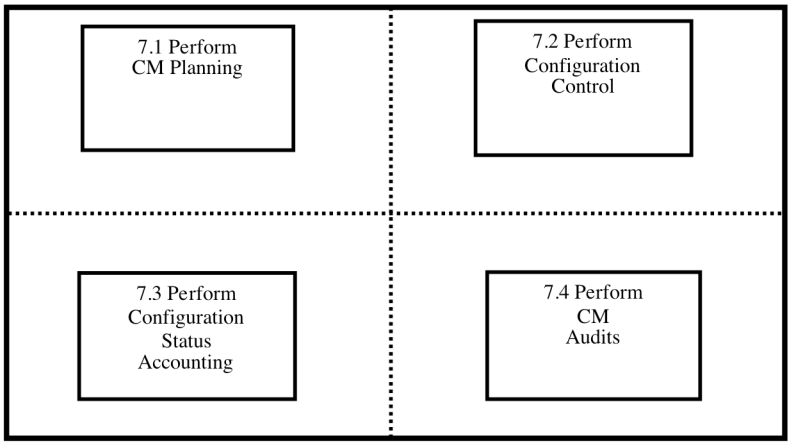
1. Example Lean NASA JPL MGSS CM Process



[Olson 2006a] Olson, Timothy G., "Defining a Lean CM Process at NASA JPL", Presentation, NDIA CMMI Conference, November 2006.

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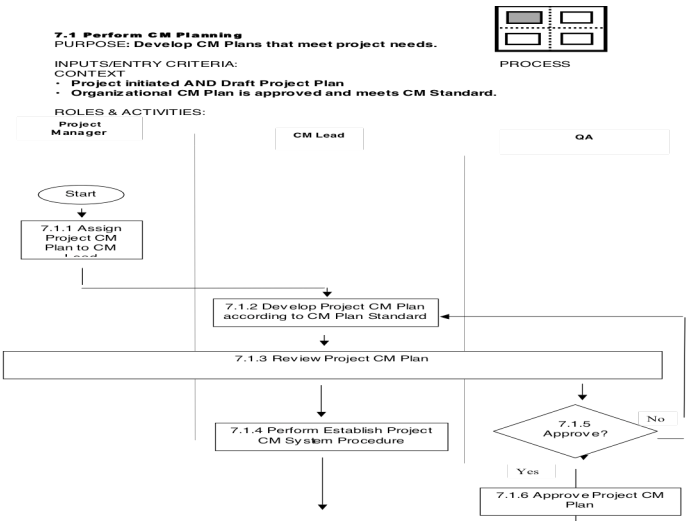
1. Example Lean CM Process

5 W's on 1 Page in a Process Model



Patent Pending Approach

[Olson 2006a] Olson, Timothy G., "Defining a Lean CM Process at NASA JPL", Presentation, NDIA CMMI Conference, November 2006.

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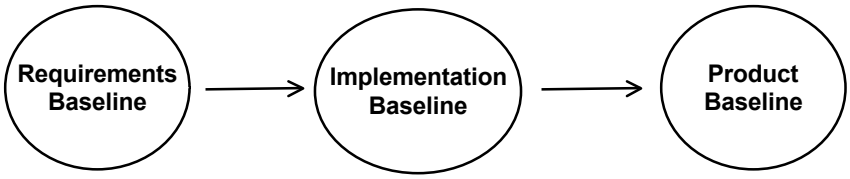
2. Use CM and CM Metrics

Fundamental Baselines



Place the requirements under formal CM and use CCB's to control changes.

<u>Example CM Metrics</u>:

- Number of CRs/PRs (e.g., open vs. closed over time)
- Requirements Volatility (e.g., number of CRs per requirement)

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3. Example Requirement Metrics

#	Requirement	Reference (e.g., customer)	Allocation	Stability (H/M/L)	Risk (H/M/L)	Priority (H/M/L)
1	System shall send an RTF FAX	SOW # 10-20.3	Software	H	L	M
2	Aircraft position shall be updated by the Inertial Navigation System (INS) Solution	ORD #2-30-20.3.4.4	Software	M	M	H

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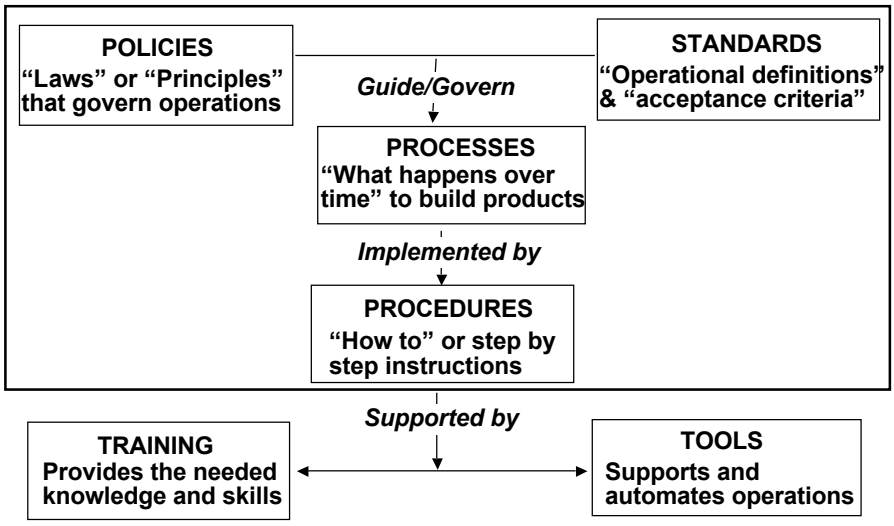
4. Documentation Framework



• Slide adapted from"A Software Process Framework for the SEI Capability Maturity Model", CMU/SEI-94-HB-01

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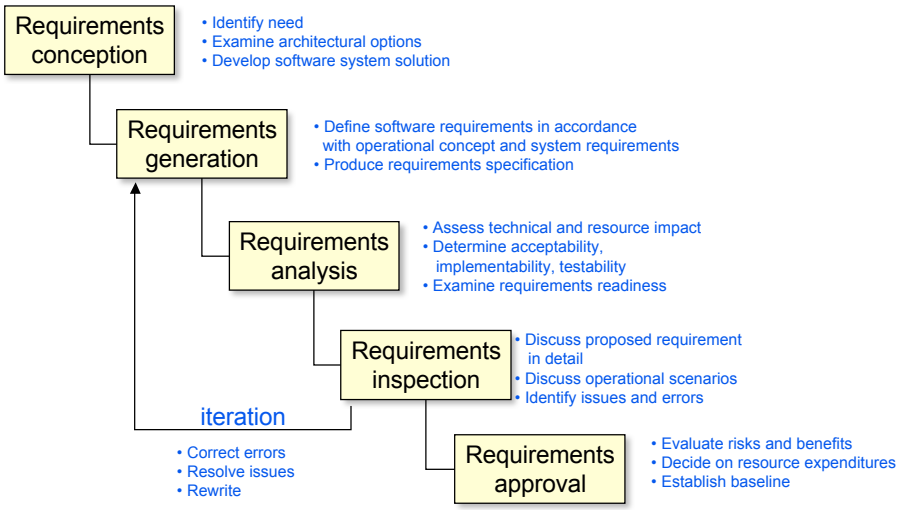
4. Requirements Process - NASA Onboard Shuttle Project



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5. IEEE SyRS and SRS Standard Outlines

SyRS	SRS
1.0 Introduction	1.0 Introduction
2.0 General System Description	2.0 Overall Description
3.0 System Capabilities, Conditions, and Constraints	3.0 Specific Requirements
3.1 Physical	3.1 External Interface Requirements
3.2 System Performance Characteristics	3.2 Functional Requirements
3.3 System Security	3.3 Performance Requirements
3.4 Information Management	3.4 Design Constraints
3.5 System Operations	3.5 Software System Attributes
3.6 Policy and Regulation	3.6 Other Requirements
3.7 System Life Cycle	Appendices
4.0 System Interfaces	Index

• Adapted from: IEEE Std 1233-1998

• Adapted from: IEEE Std 830-1998

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5. Organizing SRS Section 3

SRS Section 3 can be organized by:

- **Mode**
- **User Class**
- **Object**
- **Feature**
- **Stimulus/Response**
- **Functional Hierarchy**
- **Multiple organizations**

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6. Example Requirements Checklist Categories

1. **Clarity**
2. **Completeness**
3. **Complexity**
4. **Consistency**
5. **Constraints**
6. **Feasibility**
7. **Functionality/Logic**
8. **Interfaces**
9. **Standards**
10. **TBDs**
11. **Testability**
12. **Traceability**

Etc.

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7. Example Operational Definition

What is a good requirement? When is a requirement defined? Questions like these are difficult to answer without operational definitions.

An operational definition precisely and concisely defines a measurable requirement that states [NASA 96]:

- **What it has to do**
- **How well it has to do it**
- **Under what conditions it has to do it**

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7. Example Operational Definition

#	Requirement (What)	Conditions	Upper Limit	Lower limit	Base Measure
1	Report total percentage of students that passed the first test and graduated	Students that pass first test by => 70% score	Calculate Percentage to 3 decimal places	Plus or minus .001	Percent
2	Report total percentage of students that failed the second test and did not graduate	Students that failed second test by < a 70% score	Calculate Percentage to 3 decimal places	Plus or minus .001	Percent

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Some Advanced Strategies

Juran Model: Customer requirements are written in the customer's language, then translated into the product requirements written in producer's language.

QFD/Juran's Quality Planning Process: Measurable requirements that meet customer needs using a defined process (e.g., House of Quality).

Usage Scenarios/Use Cases/Operational Scenarios: A powerful way to identify requirements based on user needs.

Requirements written in formal languages.

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The hardest single part of building a system is the requirements.

The top requirements problems are inadequate requirements specifications, changes to requirements, and lack of user input.

Requirements elicitation problems fall into problems of scope, understanding, and volatility.

There are practical strategies that you can use today that will help you address problems with requirements.

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