Measurably Improving Your Requirements Based on the CMMI℠

2003 CMMI℠ Technology Conference

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Objectives

Describe some requirements problems from industry.

Present a useful classification of requirements problems.

Describe some practical approaches that real organizations have used to successfully measure their requirements.

Provide some real measurement examples.

Answer any of your questions.

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Outline

Why Focus on Requirements?

CMMI^{SM} Requirements Overview

Practical Measurement Approaches

Requirement Measurement Examples

Some Advanced Approaches

Summary

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Why Focus on Requirements?

"The hardest single part of building a software 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."

Fredrick Brooks, Jr.

- Reference: Brooks, Fredrick P., Jr. "No Silver Bullet: Essence and Accidents of Software Engineering". IEEE Computer, 10-19, April 1987.

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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

Problems of requirements elicitation can be grouped into 3 categories:

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

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

3. **<u>Problems of Volatility:</u> the changing nature of requirements.**

- Reference: Christel, Michael G. and Kang, Kyo C. "Issues in Requirements Elicitation", CMU/SEI-92-TR-12, 1992.

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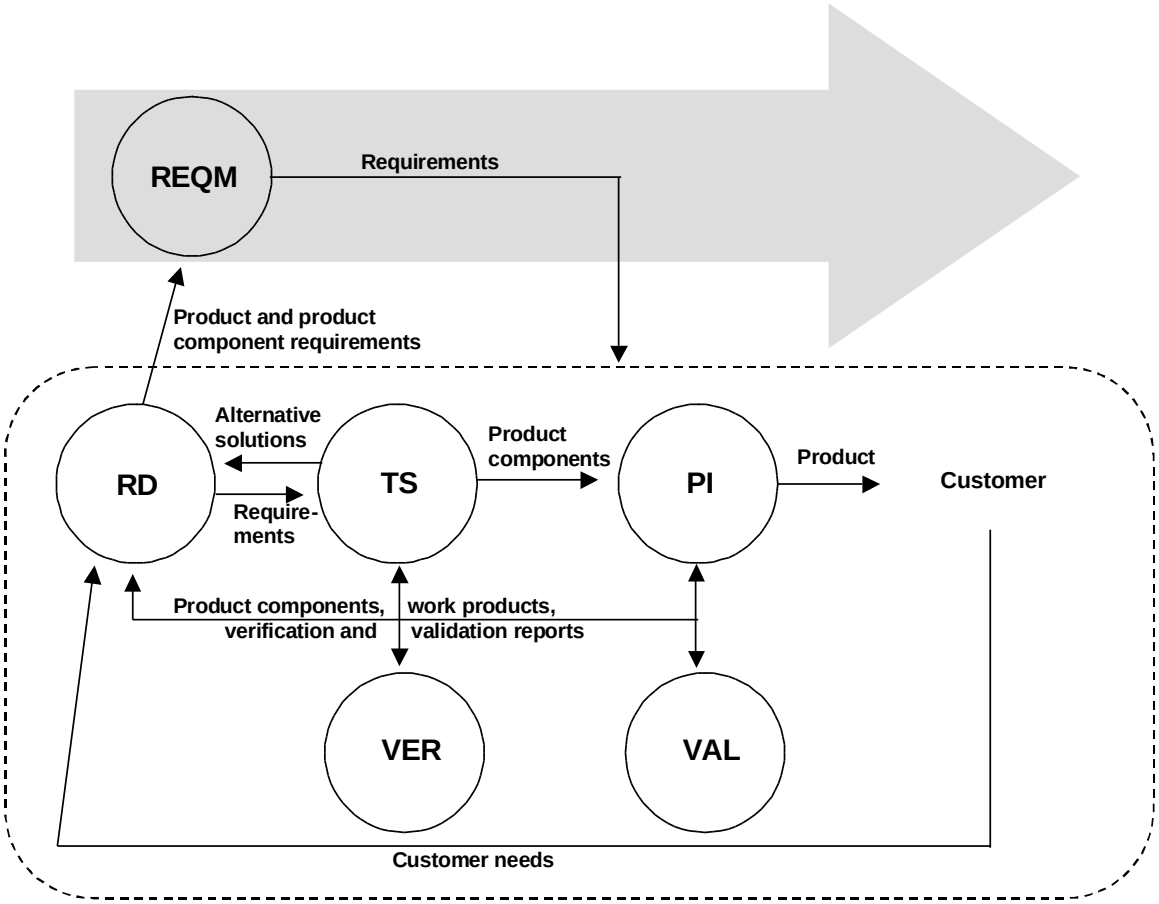
Engineering Process Areas



- Reference: "Capability Maturity Model® Integration (CMMI℠), Version 1.1", CMU/SEI-2003-TR-011, March 2003

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Requirements Development

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

- References: "Capability Maturity Model® Integration (CMMI) with Version 1.1" CMU/SEI-2002-TR-011, March 2003

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Requirements Management

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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CMMI^{SM} 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 also contains allocating requirements to teams (e.g., IPM for IPPD).

Supplier Sourcing requires managing supplier requirements.

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Practical Metric Approaches

1. Define the requirements process using best practices and measurement in mind (e.g., CMMI^{SM}, SW-CMM®, ETMX, etc).

2. Use CM and track number of CR/PRs to the requirements baselines. Also measure requirements volatility.

3. Use basic requirements metrics (e.g., priority, stability, risk, number of requirements, etc).

4. Use inspections/peer reviews and track defect metrics (e.g., defect types).

5. Use operational definitions to make requirements measurable.

6. Use the QIC Process Measurement Framework^{SM}.

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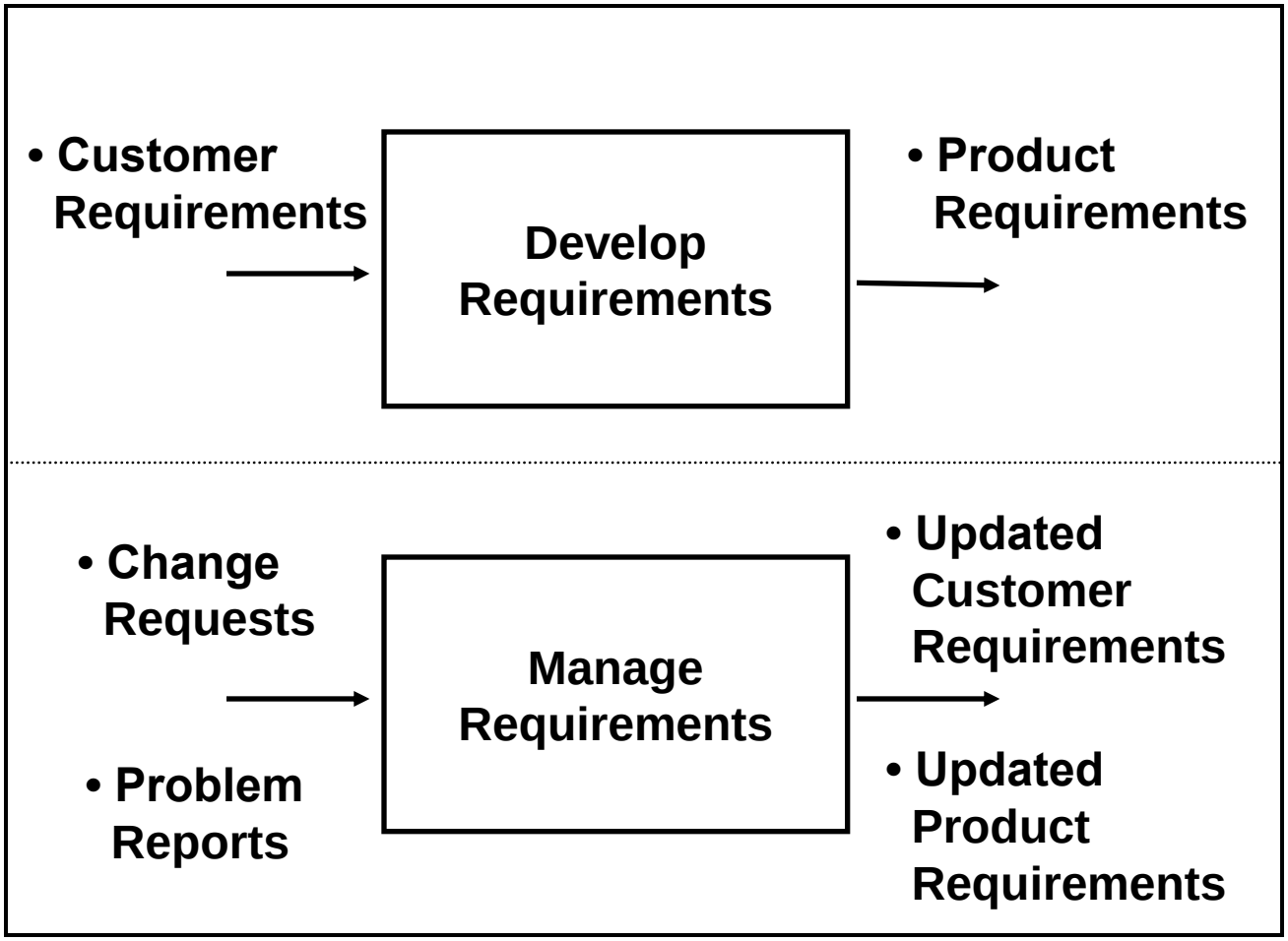
1. Example Requirements Process Based on CMMI℠



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1. Manage Requirements Process

Purpose: Effectively Manage Req. Changes

Inputs	Entry	Tasks	eXit	Outputs
• Customer Req. • Product Req. → • Change Requests • Problem Reports	Cust Req. Prod Req. Inspected AND Baselined OR CR/PR is Open	1. PM checks for new CR/PRs 2. Bring CR/PRs to CCB 3. Use CM process **MEASUREMENT** • # of CR/PRs • Req. Volatility	• CR/PRs are Resolved AND Cust Req. Prod Req. Inspected AND Under CM	• Customer Req. → • Product Req.

Roles: Project Manager (PM), CCB

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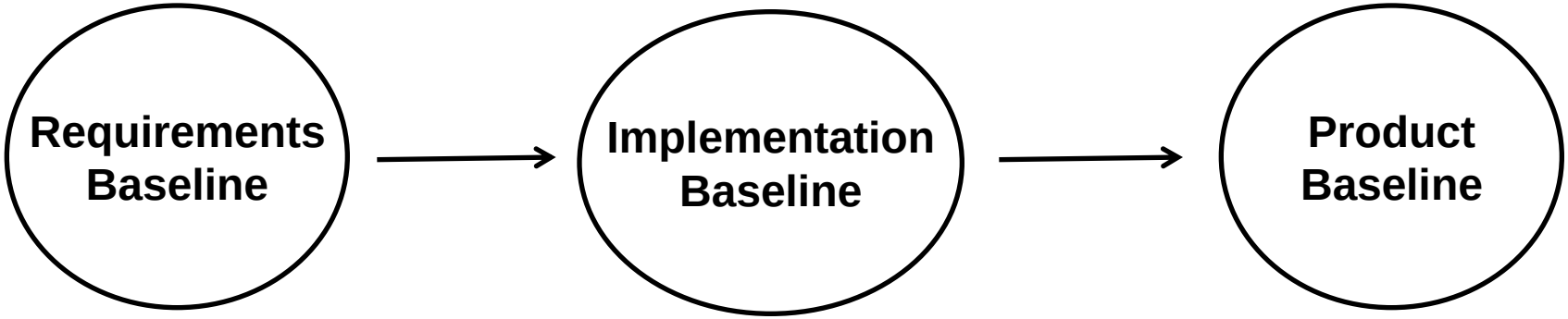
2. Use CM Metrics

Fundamental Baselines



- Place the requirements under formal CM and use CCB's to control changes.
- Measure change requests and problem reports (e.g., totals, trends, states, etc).
- Can also measure requirements volatility.

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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	INS Subsystem Team	M	M	H

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4. 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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5. 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:

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

• "Adapted from "Requirements Capture and Evaluation Process" Training Notebook, Lockheed Martin Space Information Systems, NASA Shuttle Onboard Software, 1996.

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5. 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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6. QIC Process Measurement Framework^{SM}

GOALS	KEY QUESTIONS	METRICS	DC	DS
PLAN		Cost, defects, effort, size, schedule, etc.		
CONTROL		Cost, defects, effort, size, schedule, etc.		
IMPROVE		Cost, defects, effort, size, schedule, etc.		

• DC = Data Collection; DS = Data Storage

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Juran Model: Customer requirements are written in the customer's language, then translated into the product requirements written in producer's language. This can work with CMMI^{SM}!

QFD/Juran's Quality Planning Process: Measurable requirements that meet customer needs using a defined process.

Usage Scenarios/Use Cases/Operational Scenarios: Measure requirements based on user needs.

Requirements written in formal languages and use formal metrics.

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

There are practical measurements that you can use today that will help you manage requirements.

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