Process Improvement Frameworks

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Overview

• Introduction to process improvement
• Integrated process improvement
• Process improvement frameworks
• CMMI Suite
• Multi-model improvement
• CMMI in industry
“If you can't describe what you are doing as a process, you don't know what you're doing.”

-W. Edward Deming
Process Basic

- All organizations use processes
- The use of process can raise accountability, increase efficiencies, and improve quality
- It is a way to remove degrees of risk and uncertainty and introduce methods of predictability that better ensure success
"Process improvement should be done to help business, not for its own sake."

Anon
Quality Management Foundation

• Dr. W. Edwards Deming
  – Plan-Do-Check-Act
• Joseph Juran
  – Quality trilogy
• Philip Crosby
  – Do it Right First Time
  – Zero Defect
Process Capability

- Capability is the ability of a process to produce planned results
- The goal is to increase the capability of work processes
- Companies mature as process capability steadily improves

Process Improvement Steps

• Look at what you do
• Focus in on the things you do well or want to do well
• Put tools in place to help everyone do it similarly well
• Keep watch for ways to make the approach better over time
Process Improvement Drivers

- Gain confidence in software development processes used by suppliers
- Improve quality of systems that depend on software
- Operational stability
- Cost savings

Process Improvement Drivers

• Better anticipate risks and constraints
• Plan for and coordinate the effective uses of resources
• Better manage position in overall environment to better meet its goals and objectives
• Quality assurance

Process Improvement Failure

- Someone mandates the solution
- Improve competitive position
- The organization is in trouble
- It is all about money
- No one in control of the processes

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- **Integrated process improvement**
- Process improvement frameworks
- CMMI Suite
- Multi-model improvement
- CMMI in industry
Integrated Process Improvement

- Single “language”
- Multiple disciplines
- Shared process improvement activities
- Unified focus on process improvement objectives

Why Integrated?

• Engineering environment is increasingly
• Engineering work has evolved
• Must combine success of process improvement models across different disciplines

Benefits of Integration

- Cost benefits
- Clarity of focus
- Process integration
- Flexibility

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• Process improvement frameworks
• CMMI Suite
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• CMMI in industry
Process Improvement Frameworks

• Used by companies to create process programs
• Integrate a series of practices, areas of focus, and methods into an approach that can support definition, control, and improvement of processes
• Customized to fit an organization’s needs
Process Improvement Frameworks

• Can be used alone or in combination with one another
• These models and standards have been proven to increase process capability
• A baseline for improvement and are used to measure progress as improvement activities proceed
Issuing Bodies

- Software Engineering Institute
- Carnegie Mellon
- ANSI
- ISO
- IEEE
- Electronic Industries Alliance
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Overview of SEI

• Software Engineering Institute at Carnegie Mellon University
• Works organizations to continually improve software-intensive systems
• Helps organizations to develop or acquire the right software, defect free, within budget and on time, every time
SEI Focus Areas

• Research software engineering problems
• Pilot program to test and refine solutions
• Provide training, licensing and publication of best practices
SEI

• Vision: Leading the world to a software-enriched society

• Mission: Advance software engineering and related disciplines to ensure the development and operation of systems with predictable and improved cost, schedule, and quality
SEI History

- SEI Established
- SW-CMM
- PSP
- People CMM
- TSP
- CMMI 1.1
- CMMI 1.2, CMMI-Dev
- CMMI-Service
- CMMI-Acquisition


CMMI Suite

• WHAT to do

• Not HOW and WHO should do it

• A benchmark of the maturity of an organization’s processes with industry state of practice
CMMI Suite

- It helps integrate once separate organizational functions
- Set process improvement goals and priorities
- Provide guidance for quality processes
- Provide a point of reference for appraising current processes
CMMI Suite

• CMMI is free and centrally managed
  – Tax payer dollars pay for it
• Training is not free but required
• CMMI is recognized globally
Components

CMMI-DEV

CMMI-SVC

CMMI-ACQ

SCAMPI & Training Material

CMMI For Development

- Specially structured for the IT industry
- To help IT organizations develop highly reliable management, engineering, and quality-support system
Driving Philosophy

Effective Processes → Produce Effectively → Better Cost & Quality Management
Process Areas (PA)

• Each PA is a collection of best practices that help a technology organization manage its activity and control its quality
• Each PA can be implemented on its own but many of the PAs are related and strengthen and build upon each other
Process Areas

Project Management
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Integrated Project Management + IPPD (IPM+IPPD)
- Quantitative Project Management (QPM)
- Risk Management (RSKM)
- Supplier Agreement Management (SAM)

Engineering
- Requirements Development (RD)
- Requirements Management (REQM)
- Technical Solution (TS)
- Validation (VAL)
- Verification (VER)
- Product Integration (PI)

Support
- Process and Product Quality Assurance (PPQA)
- Configuration Management (CM)
- Measurement and Analysis (MA)
- Causal Analysis and Resolution (CAR)
- Decision Analysis and Resolution (DAR)

Process Management
- Organizational Innovation and Deployment (OID)
- Organizational Process Definition + IPPD (OPD+IPPD)
- Organizational Process Focus (OPF)
- Organizational Process Performance (OPP)
- Organizational Training (OT)
Components

Process area

Specific goals
- Specific practices
  - Typical work products
  - Subpractices
- Subpractices

Generic goals
- Generic practices
  - Generic practice elaboration
- Related Process Areas
- Introductory Notes
- Purpose Statement

Introductory Notes

Related Process Areas

Generic practice elaboration
5 Generic Goals

• Generic Goal 1: Achieve specific goals
• Generic Goal 2: Institutionalize a managed process
• Generic Goal 3: Institutionalize a defined process
5 Generic Goals

• Generic Goal 4: Institutionalize a quantitative manage process
• Generic Goal 5: Institutionalize an optimizing process
CMMI Implementation

<table>
<thead>
<tr>
<th>Continuous Representation</th>
<th>Staged Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process areas are organized by process area functional categories.</td>
<td>Process areas are organized by maturity level.</td>
</tr>
<tr>
<td>Improvement is measured using <strong>capability levels</strong> that apply to an organization’s process improvement achievement in individual process areas. Capability levels range from 0 through 5.</td>
<td>Improvement is measured using <strong>maturity levels</strong> of a set of processes across an organization. Maturity levels range from 1 through 5.</td>
</tr>
<tr>
<td>0 - Incomplete</td>
<td>1 - Initial</td>
</tr>
<tr>
<td>1 - Performed</td>
<td>2 - Managed</td>
</tr>
<tr>
<td>2 - Managed</td>
<td>3 - Defined</td>
</tr>
<tr>
<td>3 - Defined</td>
<td>4 - Quantitatively Managed</td>
</tr>
<tr>
<td>4 - Quantitatively Managed</td>
<td>5 - Optimizing</td>
</tr>
<tr>
<td>Capability levels are used to organize the generic practices.</td>
<td>Common features are used to organize generic practices.</td>
</tr>
<tr>
<td>All generic practices are included in each process area.</td>
<td>Only the level 2 and level 3 generic practices are included.</td>
</tr>
</tbody>
</table>
Maturity Levels

1. Initial
   - Process unpredictable, poorly controlled, and reactive
2. Managed
   - Process characterized for projects and is often reactive
3. Defined
   - Process characterized for the organization and is proactive
4. Quantitatively Managed
   - Process measured and controlled
5. Optimizing
   - Focus on continuous process improvement
Process Areas

Project Management
- Project Monitoring and Control (PMC)
- Project Planning (PP)
- Integrated Project Management + IPPD (IPM+IPPD)6
- Quantitative Project Management (QPM)
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- Requirements Development (RD)
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CMMI Level 2

- Requirements Management
- Project Planning
- Project Monitoring and Control
- Measurement and Analysis
- Supplier Agreement Management
- Process and Product Quality Assurance
- Configuration Management
Requirements Management

- Objective: Manage the requirements of the project’s products and product components and to identify inconsistencies between those requirements and the project’s plans and work products
Requirements Management

• SG 1 Manage requirements
  – SP 1.1 Obtain an understanding of requirements
  – SP 1.2 Obtain commitment to requirements
  – SP 1.3 Manage requirements changes
  – SP 1.4 Maintain bidirectional traceability of requirements
  – SP 1.5 Identify inconsistencies between project work and requirements
Requirements Management

• GG 2 Institutionalize a managed process
  – GP 2.1 Establish an Organizational Policy
  – GP 2.2 Plan the process
  – GP 2.3 Provide resources
  – GP 2.4 Assign responsibility
  – GP 2.5 Train people
  – GP 2.6 Manage configurations
Requirements Management

- *GP 2.7* Identify and involve relevant stakeholders
- *GP 2.8* monitor and control the process
- *GP 2.9* objectively evaluate adherence
- *GP 2.10* Review status with higher level management
Advancing Maturity Levels

- As an organization achieves the generic and specific goals for the set of process areas in a maturity level, the organizational maturity is increasing.
- Each maturity level forms a foundation for the next and skipping levels is counterproductive.
CMMI Assessments

• Why conduct an assessment
  – Determine how well an organization’s processes compare to CMMI best practices and identify areas for improvement
  – Inform external customers and suppliers about how well the organization’s processes compare to CMMI best practices
  – To meet contract requirements of customers
SCAMPI Appraisal Methods

• Class A
  – Most rigorous
  – Only method that can result in a maturity rating level
  – Full comprehensive
  – Thorough model coverage

• Class B
  – Initial/partial assessment

SCAMPI Appraisal Methods

- Class C
  - Quick assessment
  - Checking for specific risk areas
  - Inexpensive
  - Requires little training
  - Does not produce a maturity rating level
CMMI Implementation Steps

• Secure sponsorship, funding, and support from senior management
• Take core training
• Prepare your organization for change
• Form a process group

CMMI Implementation Steps

• Know where you are
• Know where you are going
• Communicate and coordinate
• Track your progress
Benefits of CMMI

• Activities are linked to business objectives
• Organization’s activities become more visible which helps ensure the products or services offered meet the customer’s expectations
• Continuous learning from new areas of best practice like measurement, analysis, and risk
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Multi-Model Approach

Six Sigma

- Created at Motorola in 1979 by Art Sundry and Bill Smith
- An open source standard
- Focus on measuring existing processes with a view to making them more efficient and effective
- Can be thought of as the evaluation side of process improvement

Philosophy

- Deliver quality
- Quality is what your customer wants
- Nothing else matters

Concepts

- Voice of the customer (VOC)
- $X = f(Y)$
- Defects per million opportunities for defects (DPMO)
- Six sigma

Steps to Six Sigma

1. Identify the product or service you provide
2. Identify your customer and determine what they consider important
3. Identify your needs
4. Define the process for doing the work
5. Mistake-proof the process and eliminate waste effort

Methodologies

- DMAIC: Define, measure, analyze, improve control
- DFSS: Design for Six Sigma
  - DMADV: Define, measure, analyze, design, verify
  - CDOV: Concept, design, optimize, verify
  - IDDOV: Identify, design, develop, optimize, validate

DMAIC

Define
- Define the project scope
- Estimate formal project

Measure
- Identify needed data
- Obtain data set
- Evaluate data quality
- Summarize & baseline data

Analyze
- Explore data
- Characterize process & problem
- Update improvement project scope & scale

Improve
- Identify possible solutions
- Select solution
- Implement
- Evaluate

Control
- Define control method
- Implement
- Evaluate
- Document

Six Sigma Toolkit

Define
- Benchmark
- Baseline
- Voice of the customer
- Process flow map
- Project management

Measure
- Defect metrics
- Data collection forms, plans, logistics
- Sampling techniques

Analyze
- Cause & effect diagrams
- Decision & risk analysis
- Control charts
- Root cause analysis

Improve
- Design of experiments
- Modeling
- Robust design
- Preventive activities

Control
- Control charts
- Time series methods
- Performance management
- Preventive activities

Six Sigma As A Strategic Enabler

• SEI conducted research to explore the feasibility of Six Sigma as a transition enabler for software and systems engineering best practices

Hypothesis

• SS used in combination with other software, systems, and IT improvement practices results in
  – Better selection of improvement practices and projects
  – Accelerated implementation
  – More effective implementation
  – More valid measurements of results and success from use of technology
Conclusions

• SS is a feasible enabler and accelerator of the adoption of improvement technologies
• SS and CMMI and complementary
• SS is effective at all CMMI maturity levels
• CMMI is more advanced in their joint use of CMMI & SS that originally presumed
Supporting Findings

• SS helps integrate multiple improvement approaches to create one seamless solution
• Process improvement deployments by SS adopters are mission-focused and adaptive to changing organizational and technical situations
• SS adopters are well versed in a variety of measurement and analysis methods
Supporting Findings

• SS can be used at all maturity levels
• SS can be used to drive decisions about CMMI representation, domain, variant, and process-area implementation order
• The framework and toolkit provided by SS is just want CMMI high maturity requires
• CMMI-based assets enable SS project-based learnings to be shared across software and systems organizations
Why Six Sigma Needs CMMI

- CMMI offers mechanisms to institutionalize practices for long term organizational adoption
- CMMI offers organizational learning practices
- CMMI offers a formalized process approach to overall decision-making within projects and the organization
- CMMI offers prove mechanisms to appraise project and process implementation
Why Six Sigma Needs CMMI

• CMMI offers a complete discussion of stakeholder involvement within relevant process areas
• CMMI PAs add deeper dimensions to concept of SS critical parameter management
• CMMI helps integrate SS into an organization’s existing product development life cycle
CMMI Staged and Six Sigma

- Organization-wide 6σ improvements and control
- Correlation between key process areas & 6σ methods
- 6σ used within CMM efforts

- Infrastructure in place
  - Defined processes feed 6σ

- 6σ philosophy & method focus
  - 6σ "drilldown" drives local (but threaded) improvements
  - 6σ may drive toward and accelerate CMMI solution

Six Sigma is enterprise wide.
Six Sigma addresses product and process.
Six Sigma focuses on "critical to quality" factors.
Process Integration of Six Sigma and CMMI

• Six Sigma and CMMI improve the software overall process more rapidly and more efficiently

Process Integration of Six Sigma and CMMI

• The improvement of CMMI Process Area is an improvement project of Six Sigma
  – Definition the improvement opportunity
  – Improve and design the process by using statistical data

• Some SS methods and tools can be applied to existing process improvement and promote high maturity
Process Integration of Six Sigma and CMMI

CMMI

Direction for improvement

SS

Realize improvement & promote continuous improvement

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Multi-Model Approach

Personal Software Process

- Developed in 1993 by Watts S. Humphrey and SEI
- A disciplined and structured personal approach to developing software or other defined activity
- Developed to support CMMI goals at the personal level

Personal Software Process

• The PSP provides
  – a proven basis for developing and using an industrial-strength personal process
  – a discipline that shows you how to improve your personal process
  – the data to continually improve the productivity, quality, and predictability of your work

Goal

• Help software engineers
  – Improve their estimating and planning skills
  – Make commitments that they can meet
  – Manage the quality of their work
  – Reduce the number of defects in their products

The Process

Team Software Process

- Developed by SEI in 1996
- Developed to support CMMI goals at the project team level
- Defined process framework for managing, tracking, and reporting a team’s progress
- Helps organizations establish a mature and disciplined engineering practice that produces secure, reliable software
Team Software Process

- TSP along PSP, helps the high-performance engineer
  - Ensure quality software products
  - Create secure software products
  - Improve process management in an organization
TSP Theory

• Team formation: recruit team and provide training
• Team launch:
  – Goals of team
  – Role of each team member
  – Developing plan
  – Quality & schedule plan
  – Risk assessment

Team Work

The Process

TSP with CMMI

- TSP provides an efficient, effective vehicle for implementing CMMI-based improvement
  - PSP-trained engineers on TSP teams perform most of the CMMI generic practices
  - Software engineers working under PSP and TSP perform most of the practices that corresponds to CMMI level 5 at the individual and team level

TSP with CMMI

- CMMI acts as the umbrella for organizational capability
  - TSP enables teams to produce quality products on cost and schedule
  - PSP provides guidance for individual skill and discipline

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SEI 2008 Year-End Statistics

- 21141 projects
- 3446 Organizations or appraised entities of parent companies
- 564 Reappraised organizations
- 2544 Participating parent companies
- 4134 Appraisals

SEI 2008 Year-End Statistics

Organization Type

69.20%

17.5

Services

Manufacturing

SEI 2008 Year-End Statistics

Organization Size

- 1-100: 53.50%
- 101-200: 19.60%
- 201-2000: 26.90%

Maturity Level Progression

- Median time to move from:
  - Maturity level 1 to 2 is 4 months
  - Maturity level 2 to 3 is 18 months
  - Maturity level 3 to 4 is 19 months
  - Maturity level 4 to 5 is 13 months
Economic Benefits of CMMI

• 2003 report from SEI
• 12 cases from 11 organizations
• Performance measures
  – Cost
  – Scheduling
  – Quality
  – Customer satisfaction
  – Return on investment

Cost

- 33% decrease in the average cost to fix a defect (Boeing, Australia)
- 20% reduction in unit software costs
- 15% decrease in defect find and fix costs
- 4.5% decline in overhead rate (Lockheed Martin M&DS)
- Improved and stabilized Cost Performance Index (Northrop Grumman IT1)

Schedule

• Reduced by half the amount of time required to turn around releases (Boeing, Australia)
• Decreased the average number of days late from approximately 50 to fewer than 10 (GM)
• Increased through-put resulting in more releases per year (JP Morgan Chase)
• 30% increase in software productivity (Lockheed Martin M&DS)

Quality

- Reduction in number and severity of post-release defects (JP Morgan Chase)
- Increased focus on quality by developers (Northrop Grumman IT2)
- Most of $2 million savings resulted from early detection and removal of defects (Sanchez Computer Associates, Inc.)

Customer Satisfaction

• Received more than 98% of possible customer award fees (Northrop Grumman IT1)

• Earned a rating of “Exceptional” in every applicable category on their Contractor Performance Evaluation Survey (Northrop Grumman IT2)

ROI

- 5:1 ROI for quality activities (Accenture)
- 13:1 ROI for defects avoided per hour spent in training and defect prevention (Northrop)
- Processes for earlier defect detection, improved risk management, and better project control implemented after showing positive return on investment during pilot (Thales TT&S)

Conclusion

• Frameworks, standard, and models - OH MY!
• Process improvement is the identification, analyzing, and improving personal, team, and organization-wide processes to quality and efficiency
• CMMI alone or together with models such as Six Sigma or TSP/PSP guide process improvement
• The costs are high, but proven benefits