Achieving Success via Multi-Model Process Improvement

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SEPG 2007

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Outline

Value Proposition
- Our (Your) Multi-Initiative Reality
- Six Sigma & Lean Fundamentals
- Six Sigma as a Strategic Enabler

Multi-Model Improvement: CMMI + Six Sigma (base case)
- Case Profiles
- Strategies
- Design Connections

Multi-Model Improvement: The General Case
- Process
- Emerging Research
- Existing best practices to leverage today

Summary
Our Objectives

Our Objectives

• Use “CMMI + Six Sigma” implementations and research as a springboard for considering the broader topic of multi-model process improvement

• Enrich our views of what SEPGs (and their equivalents) do and how they do it, to enable efficient and effective multi-model process improvement

Ask the Audience

• What are your questions? Your current challenges?
• What are your expectations for today?
What Drives Process Improvement?

Performance issues: product, project—and, eventually, process issues

Regulations and mandates
• Sarbanes Oxley
• “Level 3” requirements to win contracts

Business issues and “burning platforms”
• lost market share or contracts
• continuous cost and cycle time improvement
• capitalizing on new opportunities

There is compliance-driven improvement, and there is performance-driven improvement.
Many Solutions
(not an exhaustive list)

What solutions is your organization implementing?
How do they support your organization’s mission?
Frequently Asked Questions about applying Six Sigma in Software

How do I leverage Six Sigma with software process improvement initiatives already underway in my organization?

Should I pick Six Sigma or CMMI? Or, how do I convince my management that it’s not an either/or decision?

What evidence is there that Six Sigma works in software and systems engineering? In IT?

How do I train software engineers when Six Sigma training is geared for manufacturing?

What are examples of Six Sigma projects in software? In IT?

Isn’t Six Sigma only about advanced statistics?

Exactly what is a software “opportunity”? And, how do I calculate sigma?
Myths about applying Six Sigma in Software

Six Sigma is only for high maturity organizations.

It’s all about statistics.

“Six” Sigma is the right performance goal.

Everything has to be six sigma (or x sigma) performance.

“Sigma level” corresponds to defect density.

It is all about defect density.

“We’re Level 5 therefore we must be Six Sigma.”

“We’re doing Six Sigma therefore we must be Level 4.”
What Is Six Sigma?

- a business improvement strategy
- a philosophy
- a performance measurement
- an improvement framework
- a set of improvement tools
- a critical mass of highly trained individuals who serve as analysts, problem solvers, change agents
Six Sigma Philosophy

Improve customer satisfaction by reducing and eliminating defects

Greater Profits
What is a Defect?

Six Sigma:

*Any product, service, or process variation which prevents meeting the needs of the customer and/or which adds cost, whether or not it is detected.*

- A non-conformance to a customer-driven specification
- A non-conformance or interruption of the flow or an intervention in the flow
Everything is a process
All processes have inherent variability
Data is used to understand variation and to drive decisions to improve the processes

Data Spread due to Common Cause Variation
Original Mean

Special Cause Variation
New mean after improvement
(Spread due to common cause variation will re-establish itself.)
Six Sigma Metrics

Defect Measures
• Defect Rate, parts per million (ppm)
  - “3.4 ppm” – most-cited metric
• Sigma Level
• Defects per Unit (dpu)
• Defects per Million Opportunities (dpmo)
• Yield

Practitioner Project Measures
• Defect measures
• Cycle time, cost, product performance, variability….
• Bottom-line savings
Example Sigma Levels

Sigma Level (ppm for shifted process)

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IRS - Tax Advice (phone-in)
Restaurant Bills
Doctor Prescription Writing
Payroll Processing
Air Line Baggage Handling
Orders Placed on Factory
US Navy Aircraft Accidents
Domestic Airline Flight Fatality Rate

Note: Sigma Levels vary +/-1s with source publication date

[Harrold 98], [Harry 00]

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Six Sigma Improvement Frameworks

DMAIC: Define – Measure – Analyze – Improve – Control
• improve existing processes and products by focusing on defects & variation

Design for Six Sigma (DFSS)
• design new products and processes
• redesign a process that is optimized but still does not meet specifications
• there are several approaches to DFSS, incl
  - DAMDV: Define – Measure – Analyze – Design – Verify
  - IDDOV: Identify – Design – Develop – Optimize – Validate
  - CDOV: Concept – Design – Optimize – Verify [Creveling]
  - I2DOV: Invention & Innovation – Develop – Optimize – Verify [Creveling]

Lean / Lean Six Sigma
• Improve existing processes by focusing on time & waste
  - Complements DMAIC
• Leverages seminal Lean principles*: value, value stream, value flow, customer pull, perfection

DMAIC Roadmap

Define
- Define project scope
- Establish 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 (pilot as needed)
- Evaluate

Control
- Define control method
- Implement
- Document

Phase Exit Review

[MPDI]

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## Six Sigma Toolkit

<table>
<thead>
<tr>
<th>Define</th>
<th>Measure</th>
<th>Analyze</th>
<th>Improve</th>
<th>Control</th>
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| • Benchmark  
• **Baseline**  
• Contract/Charter  
• Kano Model  
• **Voice of the Customer**  
• Voice of the Business  
• Quality Function Deployment  
• **Process Flow Map**  
• Project Management  
• “Management by Fact”  
• -4 What’s | • **7 Basic Tools**  
• Defect Metrics (i.e., “ppm”)  
• Data Collection Forms, Plan, Logistics  
• Sampling Techniques | • **Cause & Effect Diagrams**  
• Failure Modes & Effects Analysis  
• Decision & Risk Analysis  
• Statistical Inference  
• Control Charts  
• Capability  
• Reliability Analysis  
• **Root Cause Analysis**  
• -5 Why’s  
• Systems Thinking | • Design of Experiments  
• Modeling  
• Tolerancing  
• Robust Design | Statistical Controls:  
• Control Charts  
• Time Series methods  
Non-Statistical Controls:  
• Procedural adherence  
• Performance Mgmt  
• Preventive activities |

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What About Lean?

Seminal work in the automotive industry

Principles, per Womack
- articulate value for a product,
- identify the value stream,
- make the value flow,
- establish a customer pull system and
- pursue perfection.

Often coupled with Six Sigma
- Lean: focus on time, waste
- Six Sigma: focus on defects, variation
- Overlapping analytical toolkits
### Overall Yield vs Sigma

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**[Penn&Siviy 03]**

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Lean Tactics: Kaizen Events

Kaizen - Make people’s jobs easier by taking them apart, studying them, and making improvements.
• “KAI” - take apart and make anew
• “ZEN” - think, make good the actions of others, do good deeds and help others

Kaizen tips (VAL, M&A, QPM, CAR, OPP)
• Get rid of old assumptions.
• Look for ways to make things happen now.
• Say “NO” to the status quo.
• Don’t worry about being perfect.
• It doesn’t have to cost money.
• If something’s wrong, fix it on the spot.
• Ask “WHY” five times to get to the root cause.
• Look for wisdom from many people rather than one.
• Never stop improving.
• Full-time participation of team members.
• Keep all affected employees informed of changes.

[Penn&Sivy 03]
Lean Tools

Many tools shared with “traditional” Six Sigma
  • brainstorming, the 7 basic tools and so on

Tools typically associated with Lean
  • value stream mapping*
  • cycle time and throughput analysis, Little’s Law*
  • process dynamics analysis*
  • pull systems (kanban)
  • setup reduction methods
  • mistake-proofing (poka yoke)
  • 5S Housekeeping (sort, set in order, shine, standardize, sustain), and
  • total productive maintenance (i.e., optimizing scheduled downtime
Outline

Value Proposition
  • Our (Your) Multi-Initiative Reality
  • Six Sigma Fundamentals
  • Six Sigma as a Strategic Enabler

Multi-Model Improvement: CMMI + Six Sigma (base case)
  • Case Profiles
  • Strategies
  • Design Connections

Multi-Model Improvement: The General Case
  • Process
  • Emerging Research
  • Existing best practices to leverage today

Summary
Six Sigma as Strategic Enabler

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

Hypothesis

- Six Sigma used in combination with other software, systems, and IT improvement practices results in
  - better selections of improvement practices and projects
  - accelerated implementation of selected improvements
  - more effective implementation
  - more valid measurements of results and success from use of the technology

Achieving process improvement… better, faster, cheaper.
Primary Conclusions

Six Sigma is feasible as an enabler of the adoption of software, systems, and IT improvement models and practices (a.k.a., “improvement technologies”).

The CMMI community is more advanced in their joint use of CMMI & Six Sigma than originally presumed.

Noting that, for organizations studied, Six Sigma adoption & deployment

• was frequently decided upon at the enterprise level, with software, systems, and IT organizations following suit
• was driven by senior management’s previous experience and/or a burning business platform
• was consistently comprehensive
• was consistently considered part of their “competitive edge” with respect to software and systems

Because of the proprietary nature of our data and the non-disclosure agreements in place, the results in this public briefing are intentionally at a high level.

[IR&D 04]
Selected Supporting Findings

Six Sigma helps integrate multiple improvement approaches to create a seamless, single solution.

Rollouts of process improvement by Six Sigma adopters are mission-focused, flexible, and adaptive to changing organizational and technical situations.

Six Sigma is frequently used as a mechanism to help sustain—and sometimes improve—performance in the midst of reorganizations and organizational acquisitions.

Six Sigma adopters have a high comfort level with a variety of measurement and analysis methods.

- adopters report quantitative performance benefits using measures they know are meaningful for their organizations and clients. For instance, ROI of 3:1 and higher, reduced security risk, and better cost containment

[IR&D 04]
CMMI-Specific Findings

Six Sigma is effectively used at all maturity levels.

Participants assert that the frameworks and toolkits of Six Sigma exemplify what CMMI high maturity requires.

Case study organizations do not explicitly use Six Sigma to drive decisions about CMMI representation, domain, variant, and process-area implementation order. However, participants agree that this is possible and practical.

CMMI-based organizational assets enable Six Sigma project-based learnings to be shared across software and systems organizations, enabling a more effective institutionalization of Six Sigma.

[IR&D 04]
IT-Specific Findings

High IT performers (development, deployment, and operations) are realizing the same benefits of integrated process solutions and measurable results.

• However, they are using the technologies and practices specific to their domain (ITIL, COBIT, and sometimes CMMI).

CMMI-specific findings apply to IT organizations who have chosen to use CMMI.

[IR&D 04]
Architecture-Specific Findings

Many survey respondents are in organizations currently implementing both CMMI and Six Sigma DMAIC, and many are in organizations progressing with DFSS.

- Of those implementing DFSS, the majority are at least progressing with CMMI (but some are not using CMMI at all), and few are using ATAM*

Those pursuing the joint use of Six Sigma, CMMI, and ATAM, note the strong connections among DFSS, ATAM, and the engineering process areas of CMMI.

There is much untapped potential here!

ATAM = Architecture Tradeoff Analysis Method

*At the time this research project was conducted [IR&D 04]
How Six Sigma leverages CMMI

CMMI offers mechanisms to institutionalize practices for long term organizational adoption, e.g.

• organizational learning practices

CMMI can help integrate Six Sigma, esp. DFSS, into the product development lifecycle model

Those involved with CMMI adoption/deployment are often well-suited to become Six Sigma Black Belts
Integrating Initiatives: Field Notes
(public domain literature)

Northrop Grumman Mission Systems

• “Northrop Grumman was able to accelerate achievement of Levels 4 and 5 using Six Sigma”
• “Six Sigma is an enabler for measuring the value of specific improvements”
• “Six Sigma provides a way to connect process improvement and business value”
• “Six Sigma projects can help focus and measure CMMI-driven process improvements”
• “…conducting Level 5 SCAMPI appraisals in 5-6 days…significant cost savings”

[Facemire 04], [Hefner 04]
Presentations available at http://seir.sei.cmu.edu
Integrating Initiatives: Field Notes 2
(public domain literature)

Tata Consultancy Services

- “…a development Center…. used SW-CMM and Six Sigma concepts to reduce its in-process failure costs from 5 to 1 percent.…”

Wipro

- Enterprise integrated system, includes ISO 9001, CMM, P-CMM, TL9000, British Standard 7799, Six Sigma
  - “…Six Sigma methodologies brought in quantitative understanding, cost savings, and performance improvement towards product quality.”
  - “Six Sigma… brought about a focused customer-centric and data-driven paradigm to product and process quality…”
- 'Defects are steadily falling in cylinder manufacturing,' Bagchi says. 'In the fixed deposits area of our financial services division, we have a process in place to eliminate non-value adding steps and mistake-proof the system. We're projecting a 30 per cent cycle time reduction in our computer business. The estimated short-term gains will be six to eight times the total investment we put into six sigma'

[Keeni 03], [Wipro 04], [Wipro 01]
Outline

Value Proposition
• Our (Your) Multi-Initiative Reality
• Six Sigma Fundamentals
• Six Sigma as a Strategic Enabler

Multi-Model Improvement: CMMI + Six Sigma (base case)
• Case Profiles (incl. other models)
• Strategies
• Design Connections

Multi-Model Improvement: The General Case
• Process
• Emerging Research
• Existing best practices to leverage today

Summary
Profile: Lockheed Martin Integrated Systems & Solutions (IS&S)

BACKGROUND, OVERVIEW

Current organizational context
- Four primary geographic regions (40+ sites)
- Seven Lines of Business
- 15,000 employees
- Standard Operating Process (Program Process Standard) across all programs
- Maintain the CMMI Maturity Level 5 through mergers and acquisitions

Fifteen years ago....
- Executive VP with a “passion for process”
- “Software Engineering & Management Manual”
- DoD requirements to be “Level 3” (currently SW CMM Level 2)
- Separate implementations of CMM, SE CMM, ISO 9000
IS&S Strategy

Strategy: Program Process Standard (PPS)
• minimum mandatory set of development processes
• updated using industry standards in which certifications were desired

Establishing a Process Architecture
• New organizational structure
• The “Required Development Process” (RDP)

Lean (& Six Sigma) en route to high maturity
• RDP expanded to full-fledged PPS
• Measurement infrastructure (PSM; DMAIC implicit)
• New process methods such as architecture based design
• New Corporate Initiative: Lean
  - Enabled by CMM
  - Accelerated new CMMI PA implementation (lo & hi mat.)
  - Addressed biz processes outside of CMMI
  - Applied to appraisals

Growth & Sustainment
• CMMI
• Lean applied to appraisals
IS&S Process Architecture

Mission Req’t & Arch Def
SoS Req’t & Arch Def
System Req’ts Analysis
Architecture-Based Design
Detailed Design
Code & Unit Test
Hardware Assy & Unit Ver
Product Integration & Ver
System Integration & Ver
Delivery & Installation
SoS Integration & Ver
Transition to Operations
Operations & Maintenance

Program Mgt & Control
Contract Management
Subcontract Management
Program Finance
Supplier Management
Quality
Risk/Opportunity Mgt
Quantitative Management
Configuration/Data Mgt
Decision Analysis

Integrated Logistics Support (ILS)
SoS Readiness
Analysis & Modeling

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### IS&S PPS Mappings

#### Organizational Process Focus (OPF): SG1: Determine Process Improvement Opportunities
- GEN MPS 0002 PPS 2002
- ISO 9001 - 2000
- EIA-632-1999
- ISO/IEC 12207 - 1995

#### Organizational Process Definition (OPD): SG1: Establish Organizational Process Assets
- GEN MPS 0002 PPS 2002
- ISO 9001 - 2000
- EIA-632-1999
- ISO/IEC 12207 - 1995

#### Organizational Training (OT): SG1: Establish Organizational training Capability
- HRS MPE-0505 – Job Qualification & Training Procedure
- ISO 9001 - 2000
- EIA-632-1999
- ISO/IEC 12207 - 1995

#### Organizational Performance (OP): SG1: Establish Baselines and Performance
- ISO 9001 - 2000
- EIA-632-1999
- ISO/IEC 12207 - 1995

#### Project Planning (PP): SG1: Establish Estimates
- ISO 9001 - 2000
- EIA-632-1999
- ISO/IEC 12207 - 1995

### Six Sigma links:
- Level 2 Measurement & Analysis PA, Level 4/5 PAs

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IS&S Results & Benefits

Benefits of chosen strategy
• 30% cycle time reduction - idea to proposal
• Robust; easy to build in new models, practices
• Distinct contribution of any individual model difficult to extract
  - all worked together to achieve performance shown on next slide

Success Factors
• Built the vision while at “low maturity”
• Sr. Management sponsorship
• Key personnel with needed systems and strategic outlooks as well as breadth of experience
IS&S Results & Benefits

**IS&S Journey to CMMI L5**

- Software Productivity: Up 52%
- Potential Additional Award Fee Achieved: 52.5%
- SW Development Cost: Down 23%
- Wrap Rate: Down 5.5%
- Defect Find / Fix Cost: Down 21%

**Program Performance**

- 95.5% of programs > $50M have no serious problems.
- Improved Award Fee performance continues

**Drive World Class Performance / Competitiveness**

- S/W productivity increased 52% over baseline average capability
- S/W cost decreased 23% in Constant 2004 dollars
- Defect Find / Fix cost down by 21%
Case Profile: Motorola

BACKGROUND, OVERVIEW

For more than 75 years, Motorola has proven itself a global leader in wireless, broadband and automotive communications technologies and embedded electronic products.

A Fortune 100 company with global presence and impact, Motorola had sales of US$35.3 billion in 2005.

Motorola’s primary businesses consist of:

• Connected Home Solutions
• Mobile Devices
• Networks & Enterprise
Case Profile: Motorola

STRATEGY

Long history of independent deployment of ISO, Malcolm Baldrige, SEI SW CMM and CMMI, Six Sigma (DMAIC & DFSS)

Initial integration of assessments via the Motorola Quality Status Review (QSR) which integrated ISO, Malcolm Baldrige, and SEI SW CMM criteria into one assessment

Most recently began integration of process definition, training, deployment and assessment of SEI CMMI and Six Sigma (DMAIC & DFSS)
Motorola

The CMMI and DFSS adoption decision: What are the benefits?

Executive sponsorship and engagement

- Benchmarked with execs from a successful company: to witness the benefits first hand
- Execs gave the sales pitch -- their personal leadership sold it
- Established upward mentoring: MBB coach & CMMI expert for each exec

Deployment - Leveraging executive “pull”

- Exvs controlled adoption schedule, to meet critical business needs
- Modified the reward and recognition structure
- “Rising star” program for both technical and management tracks
- Training began at the top and worked its way down

Execution – Speaking the language of executives and the business

- Calculated costs & benefits of all proposals; listed the intangibles
- Risk reduction: Start small, pilot, and build on successes

[Siviy-Hefner 06]
Case Profile: Motorola

ORGANIZATION EXAMPLE

Strategic Improvement (Multi-year)
• Malcolm Baldrige, ISO, SEI IDEAL, SEI CMMI

New Product Development (For Each Product)
• Six Sigma for Product Development including DFSS

Operational Improvement (Weekly & Monthly)
• Six Sigma Dashboards

Tactical Improvement (3-6 months)
• DMAIC and DMADV
Case Profile: Motorola
MODEL CONNECTIONS ‘IN PLAY’

ISO, Malcolm Baldrige, TL9000

SEI IDEAL & CMMI

DMAIC & DMADV

Six Sigma Dashboards

Six Sigma for New Product Development (DFSS)
Case Profile: Motorola

RESULTS & BENEFITS OF STRATEGIC APPROACH

Delighted Customers
Confident Schedule, Quality and Budgets
Optimized Product Designs
Management via “Leading” Indicators
Agility via Quick Change and Improvement Capability
Strategic Improvement Framework integrated into the New Product Development Framework
Exercise 1 – Step 1  
a “Chaos Cocktail Party” (a la SuZ Garcia)

Write on a white index card your answer to this question:

• What is the most important benefit from working with >1 model in the same improvement effort?
  - Consider which 2+ models your organization may use
  - Consider benefits we have presented, as well as your own experience and other sources

A partial list of benefits (for reference)

Better selections of practices to adopt
Accelerated achievement of maturity level
Accelerated improvement
More effective (‘stickier’) implementation
More valid measurement

Improved focus on mission
Culture change
Sustain performance during reorganization
More efficient implementation (not reinventing wheels)
Improved measurement capability, “comfort level”
Robust process design/architecture
Exercise 1 – Step 2

Divide into groups of ~30

Exchange & Read
- exchange cards with someone, read the answer to 1B
- Repeat until we say “stop”
  - Try to read as many different answers as possible

Score (5 rounds)
- Find a partner
  - Read & *briefly* discuss the answers on the card
  - When time is called, divide a score of 7 between the two answers*
    - Record the score for each answer on its respective card
  - Repeat for 5 rounds, starting & stopping when time is called
    - Try to score cards you haven’t seen before

Tally the score on your card

*if we have an odd # of attendees, there will be a group of 3 in each round; divide a score of 10
Exercise 1 – Results

See zip file containing
- “as written” responses, sorted by score
- “as written” responses, sorted by grouping category
- Summary tables, by grouping category, by avg score
- Summary tables, by grouping category, by # responses
- Pareto and box plots
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Summary
Strategic Approaches
Observed Patterns in the Joint Implementation of CMMI and Six Sigma

Implement CMMI-based processes (or CMMI process areas) as “Six Sigma projects”

Use Six Sigma to improve all processes
• And serve as the tactical engine for high capability and/or high maturity.

Apply Six Sigma to improve or optimize an organization’s improvement strategy and processes.

Institutionalize Six Sigma project results, via CMMI’s institutionalization practices

Integrate CMMI, Six Sigma, and other improvement models/references into a process standard to be used by every project throughout its life cycle

[Sivy 07]
CMMI Staged and Six Sigma
Considerations

1. 6σ may drive toward and accelerate CMMI solution
2. 6σ philosophy & method focus
   - 6σ “drilldown” drives local (but threaded) improvements
3. Infrastructure in place
   - Defined processes feed 6σ
4. Process characterized for the organization and is proactive
   - Defined
   - Process measured and controlled
5. Process unpredictable and poorly controlled
   - Initial
   - Process measured and controlled
   - Managed
   - Process characterized for projects and is often reactive
   - Quantitatively
   - Process improvement
   - Optimizing

Six Sigma is enterprise wide.
Six Sigma addresses product and process.
Six Sigma focuses on “critical to quality” factors.
Six Sigma and CMMI Continuous Considerations

One possible approach:
- Achieve high capability in PAs that build Six Sigma skills, such as MA, QPM, CAR, OPP
- Use capability to help prioritize remaining PAs

Remaining PAs ordered by business factors, improvement opportunity, etc. which are better understood using foundational capabilities. CMMI Staged groupings and DMAIC vs. DMADV are also factors that may drive the remaining order.

[Vickroy 03]
Outline

Value Proposition
• Our (Your) Multi-Initiative Reality
• Six Sigma Fundamentals
• Six Sigma as a Strategic Enabler

Multi-Model Implementation: CMMI + Six Sigma (base case)
• Case Profiles
• Strategies
• Design Connections

Multi-Model Improvement: The General Case
• Process
• Emerging Research
• Existing best practices to leverage today

Summary
Design Connectivity

PAs, GPs and Six Sigma Frameworks

- DMAIC and
  - MA, GPs 2.8, 3.2, 4.1, 4.2, 5.1, 5.2
  - QPM, CAR, OID (either “continuous” or high-maturity view)

- DFSS and
  - Engineering PAs

- Lean, Value Stream Mapping and
  - OPD, OPP, OID
  - VAL, CAR, TS, QPM
  - GP 3.2

*PAs through which Six Sigma is incorporated into organizational processes: OPF, OPD*

[Sivy 05-1]
DMAIC and PAs

1. **Select Business Goal**
   - Business Objective
   - Specify Performance Thresholds
   - Identified Thresholds

2. **Gather Data**
   - Identified Causes
   - Analyze Data
   - Establish Improvement Methodology

3. **Analyze Data**
   - • Project Performance
   - • Measures Quality
   - • SPI Implementation
   - • Snapshot (1st Iteration → Baseline)
   - • Issues (Validity of data, Quality of Data, Variance (performance))

4. **Prioritize Actual Causes**
   - Draft Improvement Goal (SMART) or Identify focus area
   - Start subprocess selection
   - No “Issues”

5. **Identify Potential Solutions**
   - Identify Focus Areas

6. **Develop Action Plan**
   - 1st Iteration → Final Goal

7. **Implement Improvement**

---

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DFSS/DMADV and PAs

Integrated Logistics Support (ILS) Human Engineering, Reliability, Maintainability, System Safety
DMAIC Roadmap & CMMI Goals, Practices

“Define” Roadmap Steps

- Define project scope ⇔ Align process improvements with business objectives
  - Organization Process Focus (SG 1)
  - Organization Process Performance (SG 1)
  - GP 4.1, GP 5.1

- Establish formal project ⇔ Establish improvement projects
  - Organization Process Focus (SG 1)
  - Organization Innovation and Deployment (SG 1)
  - Implied by GP 4.1, GP 5.1
DMAIC Roadmap & CMMI Goals, Practices

“Measure” and “Analyze” Roadmap Steps

• Define data and establish repositories
  - Measurement and Analysis (SG 1)
  - Organization Process Definition (SG 1)
  - Organization Process Performance (SG 1)
  - Causal Analysis and Resolution (SG 2)
  - Quantitative Project Management (SG 2)
  - GP 2.2, GP 3.2, GP 5.1

• Baseline data
  - Organizational Process Performance (SG 1)

• Analyze data
  - Measurement and Analysis (SG 2)
  - Organization Process Performance (SG 1)
  - Causal Analysis and Resolution (SG 1)
  - GP 2.8, GP 5.2
DMAIC Roadmap & CMMI Goals, Practices

“Improve” and “Control” Roadmap Steps

- Identify Improvement Alternatives
  - Decision Analysis and Resolution (SG 1)
  - Organization Innovation and Deployment (SG 1)
  - Organization Process Performance (SG 1)
  - GP 5.1

- Control Processes
  - Measurement and Analysis (SG 2)
  - Organization Process Performance (SG 1)
  - Organization Innovation and Deployment (SG 2)
  - Causal Analysis and Resolution (SG 2)
  - Quantitative Project Management (SG 2)
  - GP 2.8, GP 4.2
Design Connectivity

PAs and Six Sigma toolkit
- Decision Analysis & Resolution
  - e.g., concept selection methods, such as Pugh’s
- Risk Management
  - e.g., Failure Modes & Effects Analysis (FMEA)
- Technical Solution
  - e.g., Design FMEA, Pugh’s

Managing Six Sigma projects:
- PP, PMC, IPM
- OPP

CMMI outputs = Six Sigma inputs

[Sivy 05-1]
CMMI OPP and Six Sigma Tools

SP1.1 Processes  ➔ Big Y Business Goal-to-Vital x Process; Processes driving central tendency and variation

SP1.2 Measures  ➔ Critical Parameter Management; CTQ factors; Root Cause Analysis of subprocess factors

SP1.3 Objectives ➔ KJ Analysis; Analytic Hierarchy Process; Categorical Survey Data Analysis; Six Sigma Scorecards

SP1.4 Baselines ➔ Control Charts; Graphical Summaries in Minitab; Central Tendency and Variation; Confidence and Prediction Intervals

SP1.5 Models ➔ ANOVA; Regression; Chi-Square; Logistic Regression; Monte Carlo Simulation; Discrete Event Process Simulation; Design of Experiments; Response Surface Methodology; Multiple Y Optimization; Probabilistic Models
CMMI QPM and Six Sigma Tools

SG1 Quantitatively Manage the Project

KJ Analysis; Analytic Hierarchy Process; Categorical Survey Data Analysis; Six Sigma Scorecards; Big Y Business Goal-to-Vital x Process; Process Mapping Methods and Value-Stream Analysis; central tendency and variation; Critical Parameter Management; CTQ factors; Root Cause Analysis of Sub-process factors

SG2 Statistically Manage Sub-process Performance

“Basic Tools” Control Charts; Central Tendency and Variation; Confidence and Prediction Intervals; ANOVA; Regression; Chi-Square; Logistic Regression; Monte Carlo Simulation; Discrete Event Process Simulation; Design of Experiments; Response Surface Methodology; Multiple Y Optimization; Probabilistic Models
CMMI CAR and Six Sigma Tools

SP1.1 Select Defect Data for Analysis
Measure Phase tools and methods

SP1.2 Analyze Causes
Root Cause Methods, e.g. Ishakawa Diagrams, statistical hypothesis tests to determine if segments are different

SP2.1 Implement the Action Proposals
Piloting; Comparative Studies; Technological and Cultural Change Management techniques

SP2.2 Evaluate the Effect of Changes
Before and After studies and Hypothesis tests; Survey categorical data analysis; compare to results of prediction models
CMMI OID and Six Sigma Tools

SG1 Select Improvements

Six Sigma Big Y to Vital x; Business Goal simulation and optimization models; Benchmarking; Capability data sharing; Theory of Inventing (TRIZ) methods; Empowered innovative thinking; Various decision models such as AHP, Pugh Method, Probabilistic decision trees

SG2 Deploy Improvements

Process and Design FMEA; Adoption Curve; Piloting; Risk-based deployment; Before and After comparisons with Hypothesis tests; Results compared to prediction models
Exercise 2 - Step 1

another Chaos Cocktail Party

Write on a green index card your answer to this question:

• What is the most significant challenge your organization faces regarding multi-model process improvement?
  - Reach back through the beginning of this tutorial
  - Feel free to include things we did not discuss

A partial list of challenges (for reference)

Models are perceived as competitors
Training
Alignment with business drivers
Model implementations are managed by independent groups
Insufficient measurement & analysis capability/infrastructure
Not able to envision a “designed” process
Exercise 2 – Step 2

Divide into groups of ~30

Exchange & Read
• exchange cards with someone, read the answer to 1B
• Repeat until we say “stop”
  - Try to read as many different answers as possible

Score (5 rounds)
• Find a partner
  • Read & briefly discuss the answers on the card
  • When time is called, divide a score of 7 between the two answers*
    - Record the score for each answer on its respective card
  • Repeat for 5 rounds, starting & stopping when time is called
    - Try to score cards you haven’t seen before

Tally the score on your card

*if we have an odd # of attendees, there will be a group of 3 in each round; divide a score of 10
Exercise 2 – Results

See zip file containing

• “as written” responses, sorted by score
• “as written” responses, sorted by grouping category
• Summary tables, by grouping category, by avg score
• Summary tables, by grouping category, by # responses
• Pareto and box plots
Outline

Value Proposition
- Our (Your) Multi-Initiative Reality
- Six Sigma Fundamentals
- Six Sigma as a Strategic Enabler

Multi-Model Improvement: CMMI + Six Sigma
- Case Profiles
- Strategies
- Design Connections

Multi-Model Improvement: The General Case
- Process
- Emerging Research
- Existing best practices to leverage today

Summary
Determining YOUR Approach

Key Questions
• What is your mission? What are your goals?
• Are you achieving your goals? What stands in your way?
• What process features are needed to support your goals?
  - What technologies provide or enable these features?
• What is the design of a cohesive (integrated), internal standard process that is
  - rapidly and effectively deployed
  - easily updated
  - compliant to models of choice

Considerations & Success Factors
• Process architecture & process architects
• Technology and organization readiness
• Technology adoption scenarios and strategy patterns
• Measurement as integrating platform

[Siviy 05-2]
Determining YOUR Approach
First Remember: Everything is a Process!

Technology R&D Organizations

- transition
- develop tech

Mgrs
- Establish Business mission, drivers

Organization’s Process Group
- Select Technology
- Implement trans. dev.
- Evaluate impact
- Biz Results, Compliance Ratings

Project or Operations Teams
- Implement/Integrate tech.
- Execute work
- Evaluate results
- Proj Results,
An Initial Reasoning Framework
Selected practices & emerging research

Mgrs

Establish Business mission, drivers

Measure & Analyze

- Mission/strategy planning
- "Mission Translation"
- Project portfolio management

Org. Process Group, incl “process architects/engineers”

Strategy & Tech Selection

Implement trans. dev.

Measure & Analyze

- Strategy/selection patterns
- Scenario planning
- Decision making, selection techniques

Evaluate impact

- Process design, architecture, and validation
- Transition management

Measure & Analyze

Cross-process practices

- Organizational Change Mgmt
- Measurement and Analysis methods, practices
Strategic Planning: Scenarios

Scenarios are attempts to describe in some detail a hypothetical sequence of events that could lead plausibly to the situation envisaged.

Herman Kahn

Scenario planning
• Strategic thinking
• planning for multiple, plausible future realities.

For more information on scenario planning:
• Numerous books: Kahn, Schwartz, van der Heijden, E. Kelly and others
• see http://en.wikipedia.org/wiki/Scenario_planning.
Scenario Planning

Common premises among different approaches
- Key question, issue or decision
- Drivers forces, critical uncertainties, implications
  - scenario framework/matrix
- Leading indicators
- Robust strategies
Mission Translation

Why?

How?

Deliver high quality products and services

Success Indicators
(Customer Survey)

Y’s

Inspect & test product, monitor field performance

Plot, plot, plot defect and reliability data:
• trends
• distributions
• control charts (c-charts)
• scatter plots

Plan and manage project cost and schedule

Plot, plot, plot cost and schedule data:
• trends
• distributions
• control charts (x, mr)
• scatter plots

Analysis Indicators

{other goals}

other factors

Why?

How?
Mission Translation: Goal Realignment

Position organization to win a larger percent of available business

Possible meta goals: *increase capacity, *reduce percent of effort spent in rework

Reduce variability of cost and schedule performance

Achieve/ Maintain Customer Satisfaction

Deliver High Quality Products, Services

Deliver projects within cost and schedule thresholds

Deliver products with zero (nearzero?) field defects

{other subgoals?}

While the re-alignment may not change the specific improvement activities, it will positively affect “change management” efforts.
Mission Translation (& Alignment)

Practices to Leverage

FAST-based Goal Structures
  • “front end” to Goal-Question-Indicator-Metric

Y to x Decomposition

Quality Function Deployment (QFD)

Critical Success Factors

Theory of Constraints: Systems Thinking Diagrams

Strategy Maps

Roadmapping
Project Portfolio Management

Different project types

• Enabling, e.g.
  - Establish measurement infrastructure

• Problem solving, e.g.
  - variance reduction, cycle time reduction, and so forth
  - *Reduce the total variance by decreasing the variance of the top 3 internal causes by 50% in 1 year.*
  - *Reduce the impact of external causes by 50%.*

• Design, incl.
  - Product design
  - Process design

• Other types?

Prioritization & alignment informed by “mission translation”
Project Portfolio Management Example

Meet Customers’ Needs
Owner:

- Stabilize Current Systems
  Owner:

  - Improve Product Delivery
    Owner:

  - Stabilize Software Engineering Processes
    Owner:

    - Provide “whole product” support

- Engineer the Future Systems
  Owner:

  - Develop a quality team (right people, right time, right job)
    Owner:

  - Establish Acquisition Processes
    Owner:

    - Improve product field performance

- Deliver Future Systems
  Owner:
Goal: Establish Acquisition Processes

Success Criteria

Strategy to accomplish goal
- Reference models: CMMI, SA CMM, IEEE/ISO 12207
- Leverage CMMI capabilities built in engineering: MA, REQM, RD, CAR
- Aim for CMMI capability in selected PAs: SAM, DAR, RSK, PP/PME, CM, PPQA
- Reference all SA-CMM Level 2 kPAs, noting overlaps with CMMI

Tasks to Accomplish goal
- Implement requirements management process
- Tailor existing project monitoring processes for acquisition managers
- 

Success Indicators
- process owners, training, CM, and documentation (future: procedural adherence)

Middle Mgmt Dashboard
- selected SPI plan EV data

Analysis Indicators
- Reqts completeness – original, at inspection, approved (for contract 1)

Sr. Mgmt dashboard
- quality trends
- selected project EV data

Middle Mgmt dashboard
- system documentation and testing

Sr. Mgmt scorecard; Middle Mgmt dashboard

Progress Indicators
- start, finish dates with progress noted (move toward EV)
Lockheed Martin IS&S Proj. Selection

Process Improvement Recommendation (PIR)
• Process Owner evaluates, determines feasibility, level of institutionalization and need for pilot

E-Transformation
• all business processes that affect overhead are applicable
• select based on ROI and relevance to business
  - Requires firm understanding of the “before” state
  - “Just do it” Projects
  - Kaizen event with rollout plan
• required use of Six Sigma methods/tools for optimization

Technology Change Management Working Group (TCMWG)
• once a year call for ideas, incl PIR pilots
• “before state” used to measure impact of the “after” state
• required use of Six Sigma methods, modeling for optimization
Motorola Project Selection

Big Y to Vital x project trees ensured systems thinking of improvement needs driven by business goals

Significantly reduced sub-optimization within individual disciplines and shifted focus to the overall business

Improvement projects received proper management sponsorship and resources because of Vital x nature

Performance highlighted to entire organization thereby motivating and enhancing team achievements!
Strategy/Selection Patterns: An Affinity Matrix

Governance

Organizational Infrastructure, readiness

Tactical

Enterprise / non-domain specific
domain specific

Lean
EFQM
Six Sigma
SOX
FDA/510K
CMMI
ISO12207
COBIT
P-CMM
ISO9000
ITIL
SWEBOK
ScOR
ITIL
ScOR

Organizational Infrastructure, readiness

(incl biz practices, engr practices, change/improvement practices)

Tactical
(procedural – both for improvement tasks and for engrg tasks)
LMCO IS&S Strategy/Selection Pattern

Enterprise / non-domain specific

Governance

SOX
Lean
Six Sigma

Organizational Infrastructure, readiness

(incl biz practices, engr practices, change/improvement practices)

ISO9000
P-CMM
AS9100

Tactical
(procedural – both for improvement tasks and for engrg tasks)

6S/DMAIC
Lean / Six Sigma

CMMI
JSTD-016

ISO12207
ISO14000

ISO20000
ISO 17666

IEEE 830
IEEE 1471

IEEE 829

IEEE 1471

IEEE 829

ISO/IEC 15288

LM IEP
PPS
RUP

Agile

PSM
Strategy/Selection Guidance

Strategy/Selection Patterns is an area of emerging research.

Considerations
- Technology readiness
- Organizational readiness & culture
- Decision authority
- Regulatory compliance
- Scenarios
- Interoperability

Methods
- Affinity groups
- QFD
- Pugh’s concept selection
- TRIZ
- Benchmarking and/or “Positive Deviance”

Model strategy & selections inform process architecture
Process Architecture

“Architecting” software processes is an area of emerging research

Process Content
• CMMI, ISO 12207 and other model content
• Process & Value Stream Mapping: “as is” and “to be”

Practices to leverage
• Diagramming: Process Map I/O, ETVX
• DFSS / LDFSS
• EPIC’s “validated architecture”
• UML

Design considerations
• Design connectivity (per this tutorial)
• PrIME and other meta model representations
• Interoperability

EPIC = Evolutionary Process for Integrating COTS-Based Systems
© 2007 by Carnegie Mellon University
PrIME: Process Improvement in Multi-Model Environments

Institutionalization Elements
- CMMI
- Generic Goals and Practices, e.g.
  - GG 3
  - GG 2
  - GG 1

Good-Practice Elements
- CMMI PA’s
- ISO 15504 12207
- PLA
- COBIT
- EFQM
- ISO 9001

Improvement Methods
- Change management techniques
- IDEAL
- Six Sigma

Implemented in Organization’s Process

Process 1
Process 2
Process 3
Process n
Effective Transition Planning

“Transition” is indicated by each of the following:
  • maturation, introduction, adoption, implementation, dissemination, rollout, deployment, or fielding

Features of effective transition planning include:
  • precision about the problem, clarity about the solution
  • transition goals and a strategy to achieve them
  • definition of all adopters and stakeholders and deliberate design of interactions among them
  • complete set of transition mechanisms: a whole product
  • risk management
  • either a documented plan or extraordinary leadership throughout the transition

[Forrester], [Schon], [Gruber]
“Whole Product”
A Feature of Effective Transition Planning

Economies of scale are needed in training.

A holistic, “connected” approach is needed in training.

Leaving students to their own devices to make connections can be risky and/or time-consuming.
Integrated Training Solutions

Integrated training solutions underway:

• DFSS training that includes awareness sessions of relevant technologies
  - SEI’s Product Line Practices, ATAM, CMMI engineering PAs
• DFSS training that leverages ATAM
• DMAIC training that references PSP-based instrumented processes

SEI’s approach uses *measurement & analysis* as an *integrator.*
<table>
<thead>
<tr>
<th>Proposed Topics</th>
<th>DFSS</th>
<th>Curriculum</th>
<th>with SEI</th>
<th>Technology</th>
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</thead>
<tbody>
<tr>
<td><strong>Week One Topics</strong></td>
<td><strong>Week Two Topics</strong></td>
<td><strong>Week Three Topics</strong></td>
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<tr>
<td>• DFSS Overview</td>
<td>• Critical Parameter management</td>
<td>• Linear and Multiple Regression</td>
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<td>• CDOV Process</td>
<td>• DFMEA</td>
<td>• RSM</td>
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<td>• DFSS tools and PM</td>
<td>• Basic Stats/Minitab</td>
<td>• Monte Carlo Simulation</td>
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<td>• VOC/KJ</td>
<td>• Hypothesis testing</td>
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<td>• QFD</td>
<td>• Confidence Intervals</td>
<td>• Analytical/Empirical Tolerance Optimization</td>
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<tr>
<td>• 1st Prin. Modeling (Monte Carlo)</td>
<td>• ANOVA</td>
<td>• CPM</td>
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<td>• Pugh</td>
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<td>• Architecture and Design-based Software Reliability Modeling</td>
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<tr>
<td>• DFSS Scorecards</td>
<td>• SPC</td>
<td>• Software Reliability Growth Testing and Modeling</td>
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<tr>
<td>• Six Sigma and CMMI synergies</td>
<td>• Design and Process</td>
<td>• Motorola Lab’s TRAMS</td>
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<tr>
<td>• Parametric SW Project Forecasting</td>
<td>• Capability</td>
<td>• Taguchi Noise Testing</td>
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<td>• Reqs Management Processes</td>
<td>• DOE</td>
<td>• Small memory management</td>
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<tr>
<td>• Developing SW Opnl Profiles</td>
<td>• Full Factorial Designs</td>
<td>• Throughput and timing analysis</td>
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<tr>
<td>• SW Quality Attribute Workshops</td>
<td>• Fractional Factorial Designs</td>
<td>• Orthogonal Defect Classification</td>
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<td>• Attribute-Driven SW Architecture</td>
<td>• Modeling</td>
<td>• Advanced SW Inspection</td>
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<tr>
<td>• Active Reviews for Intermediate Designs</td>
<td>• Advanced DOE</td>
<td>• Human Error Analysis</td>
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<tr>
<td>• SW Architecture Tradeoff Analysis Method (ATAM)</td>
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<td>• Cleanroom Software Engineering</td>
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<tr>
<td>• Cost Benefit Analysis of Architecture Decisions</td>
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<td>• Agile/Extreme Programming</td>
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<tr>
<td>• Software Product Line Planning and Execution</td>
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<td>• SEI Personal and Team Software Process and relationships to DFSS</td>
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<td>• Usability Engineering</td>
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Motorola: DFSS Classes by Function 1

Platform Developers
- SW Product Lines (2 days)

SW Process Belts
- CMMI Intro (3 days)
- CMMI Inter-Mediate (5 days)
- SCAMPI Lead Assessor (5 days)

Key SW Architects
- SW Arch (2 days)
- SW Arch Design Analysis (2 days)
- ATAM Eval (2 days)
- ATAM Facilitator (2 days)
- Documenting SW Arch (2 days)

SW Testers
- Opnl Profile (2 days)
Managers
(of small Development Teams with strong Six Sigma Measurement needs)

- Intro to the People Capability Maturity Model (3 days)

- Team Software Process Executive Strategy Seminar (2 days)

- Managing Team Software Process Teams (3 days)

Human Resources
(Key source of HR Six Sigma Measurement and Key Practices)
Change Mgmt: Formulaic Approach

A selection of our “favorite” change management references

\[ D \times V \times F > R \]

\( D = \) Dissatisfaction with the present
\( V = \) Vision for the Future
\( F = \) First (or next) Steps
\( R = \) Resistance

[Beckhard]
Senge’s Ten Challenges
A Selection of our “favorite” change management references

Challenges of Initiating
1. Not Enough Time: "We don't have time for this stuff!"
2. No Help: "We're like the blind leading the blind!"
3. Not Relevant: "Why are we doing this stuff?"
4. "Walking the Talk" - Leadership values

Challenges of Sustaining Momentum
5. Fear and Anxiety: "This stuff is ----"
6. Assessment and Measurement: "This stuff isn't working"
7. Believers and Nonbelievers: "We have the right way!" say pilot group members. "They're acting like a cult!" say their other colleagues and peers.

from http://www.gwsae.org/ThoughtLeaders/SengeTenChallenges.htm
Based on Senge’s Dance of Change and Fifth Discipline Fieldbook
Senge’s Ten Challenges
A Selection of our “favorite” change management references

Challenges of System wide Redesign and Rethinking
  8. Governance: "They won't give up the power."
  9. Diffusion: "We keep reinventing the wheel!"
 10. Strategy and Purpose: "Where are we going? and "What are we here for?"
# Measurement Practices

## Goal-Driven (Software) Measurement (GDM)

<table>
<thead>
<tr>
<th>Goals → Questions → Indicators → Measures (GQIM)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>USER DEFINES INDICATORS &amp; MEASURES</strong></td>
</tr>
<tr>
<td>Based On:</td>
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<tr>
<td>• what’s needed to manage the User’s goals</td>
</tr>
<tr>
<td>• decisions and decision criteria related to managing the user’s goals</td>
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</table>

## Practical Software & Systems Measurement

<table>
<thead>
<tr>
<th>Common Issue Area → Measurement Category → Measures</th>
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<tbody>
<tr>
<td><strong>PREDEFINED</strong></td>
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<td><strong>PREDEFINED</strong></td>
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Goal-Driven Measurement (GDM)

When using goal-driven measurement, the primary question is NOT:

“What metrics should I use?”

rather, it is:

“What do I want to know or learn?”
“What decision do I want to make?”

Goal-driven measurement is NOT based on a predefined set of metrics.

[GQIM 96]
Practical Software & Systems Measurement (PSM)

This measurement process is funded by the DoD and is freely available at http://www.psmsc.com.

PSM process identifies project-specific issues:
- issues grouped into common software issue areas
- measurement categories correspond to issue areas
- each measurement category has a candidate set of proven measures

Measures are selected based on availability, environment, and other factors.
Advancing the State of the Practice

The SEI plans to launch an R&D/Transition effort in multi-model improvement later this year.

It will leverage and continue work already done
  • IRAD project, “Six Sigma as an Enabler”
  • PrIME
  • Multi-model strategies & tactics

If you are interested in collaborating with the SEI and/or supporting this effort, please contact
  • Jay Douglass, jcd@sei.cmu.edu
  • Jeannine Siviy, jmsiviy@sei.cmu.edu
  • Pat Kirwan, pkirwan@sei.cmu.edu
Exercise 3

What would most help your organization with its pursuit of multi-model process improvement?
• 3 ‘green votes’ to left of flip chart list

Which would definitely not work in your organization? (if any)
• Up to 1 ‘red vote’ to right of flip chart list

What additional practices or research areas should we consider?
• “write in” on blank flip charts

Candidates for r&d or further codification/transition for this multi-model impr.

<table>
<thead>
<tr>
<th>Scenario planning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mission translation (goal structures, Y to x, CSF, QFD others)</td>
</tr>
<tr>
<td>Project portfolio management</td>
</tr>
<tr>
<td>Model Strategy/Selection Patterns (affinity matrix, qfd, triz, others)</td>
</tr>
<tr>
<td>Process architecture (practices, design connections, meta models)</td>
</tr>
<tr>
<td>Training (integration, cross-training, etc.)</td>
</tr>
<tr>
<td>Transition management (whole product, etc., specifically for multi-model)</td>
</tr>
</tbody>
</table>

Flip chart Left margin
3 “green dot” votes for “need most”

Flip chart Right margin
Up to 1 “red dot” votes for “won’t work”
Exercise 3 Results

What would most help your organization with its pursuit of multi-model process improvement? (3 votes/attendee)

80 Process architecture (practices, design connections, meta models)
40 Scenario planning
38 Mission translation (goal structures, Y to x, CSF, QFD others)
38 Project portfolio management
33 Model Strategy/Selection Patterns (affinity matrix, qfd, triz, others)
26 Training (integration, cross-training, etc.)
13 Transition management (whole product, etc., specifically for multi-model)
Outline

Value Proposition
• Our (Your) Multi-Initiative Reality
• Six Sigma Fundamentals
• Six Sigma as a Strategic Enabler

Multi-Model Improvement: CMMI + Six Sigma
• Case Profiles
• Strategies
• Design Connections

Multi-Model Improvement: The General Case
• Process
• Emerging Research
• Existing best practices to leverage today

Summary
Value Proposition

*CMMI + Six Sigma*

SEI special project
• Six Sigma as an enabler of domain-specific initiatives

Primary conclusions, *supported by data*
• Enabler
• Accelerator
• Synergistic and complementary
• Effective at all CMMI maturity levels

Key supporting findings
• Mission focus
• “Seamless” model integration
• Engineering process architecture & design
• Robustness to organizational change
• High comfort with measurement & analysis
• Culture Change
Strategies & Tactics

CMMI + Six Sigma

Implementation Strategies

- implement CMMI PAs as Lean/Six Sigma projects
- Apply Lean/Six Sigma to improve all processes
- improve or optimize org improvement processes
- institutionalize Six Sigma culture via CMMI
- develop an internal process standard

Design Connectivity

- Six Sigma frameworks and CMMI PAs, GPs
- Six Sigma analytical methods within CMMI process areas
- Six Sigma projects as the object of CMMI’s project management processes
- CMMI process outputs as inputs to Six Sigma
Last Words ~ Multi-Model Improvement

CMMI + Six Sigma lessons apply to the “general case”, e.g.
• well-designed training
• integrated, process architecture
• coordinated, aligned improvement project portfolio

Multi-model improvement is our reality
• Many considerations, many dimensions
• No single “silver bullet” answer
• Not necessarily easy – at first
• Pays off in the end

Leverage best practices and emerging research for design, transition and measurement of your multi-model solution

Everything should be made as simple as possible, but not one bit simpler
- Albert Einstein
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References


[BPD] Process Maturity / Capability Maturity, http://www.betterproductdesign.net/maturity.htm, a resource site for the Good Design Practice program, a joint initiative between the Institute for Manufacturing and the Engineering Design Centre at the University of Cambridge, and the Department of Industrial Design Engineering at the Royal College of Art (RCA) in London.

[Forrester] Forrester, Eileen, Transition Basics


[Hallowell/Siviy 05] Hallowell, Dave and Jeannine Siviy, Bridging the Gap between CMMI and Six Sigma Training, SEPG 2005, slides available at http://www.sei.cmu.edu/sema/presentations.html;

[Hefner 04] Hefner, Rick, Accelerating CMMI Adoption Using Six Sigma, CMMI Users Group, 2004


[MPDI] SEI Course, Measuring for Performance Driven Improvement 1, see http://www.sei.cmu.edu/products/courses/p49.html
## References

| [Siviy 04] | Siviy, Jeannine and Eileen Forrester, Accelerating CMMI Adoption Using Six Sigma, CMMI Users Group, 2004 |
| [Siviy 05-2] | excerpted from working documents from internal SEI research on the joint use of Six Sigma and CMMI; refinement of guidance and subsequent publication is in progress; for more information, contact jmsiviy@sei.cmu.edu |
| [Siviy-Hefner 06] | Siviy, Jeannine and Rick Hefner, Six Sigma Tools for Early Adopters, SEPG 2006 |
| [Stoddard 02] | Adapted, with permission, from information provided by Robert Stoddard, Motorola, Inc. |
| [Vickroy 03] | Idea to strategically select MA, OPP, QPM as first PAs in which to achieve capability 5 offered by Robert Vickroy, ABS Group, at CMMI course on 17 January 2003 |
| [wipro1] | [www.iqa.org/publication/c4-1-38.shtml](http://www.iqa.org/publication/c4-1-38.shtml) |
Additional Readings


[BPD] Process Maturity / Capability Maturity, http://www.betterproductdesign.net/maturity.htm, a resource site for the Good Design Practice program, a joint initiative between the Institute for Manufacturing and the Engineering Design Centre at the University of Cambridge, and the Department of Industrial Design Engineering at the Royal College of Art (RCA) in London.

[Brecker] Linked QFD matrices for CTQ trace-ability from http://www.brecker.com


[Demery 01] Demery, Chris and Michael Sturgeon, Six Sigma and CMM Implementation at a Global Corporation, NCR, SEPG 2001, (slides available to SEIR contributors at http://seir.sei.cmu.edu)

[Forrester] Forrester, Eileen, Transition Basics

Additional Readings


[Harry 00] Harry, Mikel, Six Sigma: The Breakthrough Management Strategy Revolutionizing the World’s Top Corporations, Doubleday, 2000

[Hefner 02] Hefner, Rick and Michael Sturgeon, Optimize Your Solution: Integrating Six Sigma and CMM/CMMI-Based Process Improvement, Software Technology Conference, 29 April – 2 May 2002

[Hefner 02] Hefner, Rick and Michael Sturgeon, Optimize Your Solution: Integrating Six Sigma and CMM/CMMI-Based Process Improvement, Software Technology Conference, 29 April – 2 May 2002


[isixsigma] From [http://isixsigma.com](http://isixsigma.com)
Online Resources

Online Statistical Textbooks


Six Sigma Resources

isixsigma software channel – http://software.isixsigma.com

  • See presentations page and publications page

International Society of Six Sigma Professionals, http://www.isssp.org

Six Sigma in Software & Systems Engineering Yahoo Group – http://groups.yahoo.com/group/6S_SWSE
GDM Indicator Template

Additional Modifications by clients
- streamlined data collection & reporting sections using “swimlane” diagrams
- Addition of “corrective action guidelines”
- Subprocess selection (for CMMI)

[QGIM], [DZ 02]
PSM Common Software Issues – Measurement Categories

**Schedule and Progress**
- Milestones Performance
- Work Unit Progress
- Incremental Capability

**Product Size and Stability**
- Product Size and Stability
- Functional Size and Stability

**Process Performance**
- Process Compliance
- Process Efficiency
- Process Effectiveness

**Customer Satisfaction**
- Customer Feedback
- Customer Support

**Resources and Cost**
- Personnel
- Financial Performance
- Environment Availability

**Product Quality**
- Functional Correctness
- Supportability - Maintainability
- Efficiency
- Portability
- Usability
- Dependability - Reliability

**Technical Effectiveness**
- Technology Suitability
- Impact
- Technology Volatility
Performance Analysis Model

- Technical Adequacy
- Development Performance
- Growth and Stability
- Resources and Cost
- Schedule and Progress
- Customer Satisfaction
- Product Quality

[PSM 00]