Why Make the Switch?
Evidence about the Benefits of CMMI®

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Agenda

Objectives, recent and current work
Research on CMMI® Impact
Characterizing Impacts
Benefits of CMMI-based Process Improvement
Recently reported CMMI and CMM® results
Proposed future directions
Overall Objectives

Provide credible, objective evidence about organizations’ experiences with CMMI based process improvement.

Focus:
- Impact and value added
- Investment and costs incurred
- Conditions of successful adoption, transition, and documented improvement
- Pitfalls and obstacles to successful adoption and use

Conduct objective studies that inform the development and evolution of the CMMI product suite
Recent & Current Work

Collaborative case studies
- Early adopters with credible quantitative evidence of impact and benefits of CMMI
- Selected supplementary evidence

SEI Special Report
- *Demonstrating the Impact and Benefits of CMMI®: An Update and Preliminary Results*
- Based on case studies, supplementary materials, and comprehensive literature review

Track at 3rd Annual CMMI Technology Conference and User Group
- 14 case study presentations & keystone summary presentation
- Roundtable panel with discussion of next steps
<table>
<thead>
<tr>
<th>CMMI Conference Presenters</th>
<th>Others</th>
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<tbody>
<tr>
<td>Accenture</td>
<td>Boeing Ltd, Australia</td>
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<tr>
<td>CMS Information Services, Inc.</td>
<td>Bosch Gasoline Systems</td>
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<td>Harris Corporation</td>
<td>Fort Sill Fire Support Software Engineering Center</td>
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<td>Lockheed Martin Management and Data Systems</td>
<td>General Motors Corporation</td>
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<td>Sanchez Computer Associates, Inc.</td>
</tr>
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<td>Motorola Global Software Group, India</td>
<td>Thales Air Traffic Management</td>
</tr>
<tr>
<td>Northrop Grumman Defense Enterprise Systems</td>
<td>Thales Research &amp; Technology</td>
</tr>
<tr>
<td>Raytheon North Texas Software Engineering</td>
<td>Thales Training &amp; Simulation</td>
</tr>
</tbody>
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Plus 2 Anonymous
Research on CMMI Impact

Objectives, recent and current work
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Why Do We Need Objective Evidence?

Increasing numbers of organizations are considering using CMMI models. Trustworthy evidence is essential for:

- Addressing skepticism about model-based process improvement in general
- Demonstrating the value of CMMI over its source models
- Building commitment and obtaining resources within an organization
- Enhancing ongoing quantitative management
- Providing input for improving organizational processes and technologies
- Comparing results with those of comparable organizations
What is Legitimate Evidence of Impact?

Evidence based on:

• New processes or changes to existing processes due to CMMI

• Broadened organizational scope across disciplines
  - Especially for software intensive systems

• Process changes that are consistent with, but predate, CMMI
  - Especially in organizations appraised early at higher CMMI maturity levels

• Recent evidence based on the SW-CMM
  - Much of the same content is present in CMMI models
  - And, such evidence can be compelling to skeptics about any CMM-based process improvement
Generalizability

Case studies
• Offer a great deal of valuable detail and context
• Provide lessons learned which can be used to guide future improvement efforts
• Demonstrate what can happen under the right organizational and technical circumstances

• However, results from individual case studies cannot be generalized

Our task is to design studies that better reflect the experiences of the wider CMMI community
Characterizing Impacts

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Impacts: Costs and Benefits of CMMI

COSTS
• Investments
• Expenses

Process Capability & Organizational Maturity

ROI & Cost-Benefit

BENEFITS
• Process Adherence
• Cost
• Schedule
• Productivity
• Quality
• Customer Satisfaction
Seven Kinds of Performance Measures

From the previous set, we found examples of 7 different categories of performance measures:

- Process Adherence
- Cost
- Schedule
- Productivity
- Quality
- Customer Satisfaction
- Return on Investment
Impact of CMMI-Based Process Improvement

Objectives and review current work
Research on CMMI® Impact
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Impact of CMMI-based Process Improvement
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Impact: Process Adherence and Cost of Quality

- Work product completion improved dramatically (CMS Information Services, Inc.)
- Exceeded goal for reduction in cost of poor quality (Motorola Global Software Group, India)
- Improved adherence to quantitative management practices (Raytheon North Texas Software Engineering)
- Reduced cost of poor quality from over 45 percent to under 30 percent (Siemens Information Systems Ltd, India)
- Used Measurement and Analysis to significantly reduce the cost of quality in one year (reported under non disclosure)
Impact: Cost

- 33 percent decrease in the average cost to fix a defect (Boeing, Australia)

- 20 percent reduction in unit software costs (Lockheed Martin Management and Data Systems)

- 15 percent decrease in defect find and fix costs (Lockheed Martin Management and Data Systems)

- 4.5 percent decline in overhead rate (Lockheed Martin Management and Data Systems)

- Improved and stabilized Cost Performance Index (Northrop Grumman Defense Enterprise Systems)
Impact: Cost$_2$

- Increased accuracy in cost estimation (Raytheon North Texas Software Engineering)

- 5 percent improvement in average cost performance index with a decline in variation (Raytheon North Texas Software Engineering)
  - As the organization improved from SW-CMM level 4 to CMMI level 5

- $2.1$ Million in savings in hardware engineering processes (reported under non disclosure)
Impact: Schedule

• 50% reduction in release turn around time (Boeing, Australia)

• 60 percent reduction in work and fewer outstanding actions following pre-test and post-test audits (Boeing, Australia)

• Increased the percentage of milestones met from approximately 50 percent to approximately 95 percent (General Motors)

• Decreased the average number of days late from approximately 50 to fewer than 10 (General Motors)

• Increased through-put resulting in more releases per year (JP Morgan Chase)
Impact: Schedule\textsubscript{2}

- Improved and stabilized Schedule Performance Index (Northrop Grumman Defense Enterprise Systems)

- Met every milestone (25 in a row) on time, with high quality and customer satisfaction (Northrop Grumman Defense Enterprise Systems)

- Reduced variation in schedule performance index (Raytheon North Texas Software Engineering)

- Reduced schedule variance over 20 percent (reported under non disclosure)

- Achieved 95 percent on time delivery (reported under non disclosure)
Impact: Productivity

- Improved productivity substantially, with “significantly more rigorous engineering practices” due to CMMI (Fort Sill Fire Support Software Engineering Center)

- Increased productivity after adoption of CMMI (Harris Corporation)

- 30 percent increase in software productivity (Lockheed Martin Management and Data Systems)

- Improved software productivity (including reuse) from approximately 80 percent in 1992 baseline to over 140 percent at CMMI ML 5 (Lockheed Martin Systems Integration)

- 25 percent productivity improvement in 3 years (Siemens Information Systems Ltd, India)

- 11 percent increase in productivity, corresponding to $4.4M in additional value (reported under non disclosure)
Impact: Quality

- Reduced software defects substantially, with “significantly more rigorous engineering practices” due to CMMI (Fort Sill Fire Support Software Engineering Center)

- Substantial decrease in code defects after adoption of CMMI (Harris Corporation)

- Reduced software-defects-per-million-delivered-SLOC by over 50 percent compared to defects prior to CMMI (Lockheed Martin Systems Integration)

- Reduced defect rate at CMMI ML5 approximately one third compared to performance at SW-CMM ML5 (Lockheed Martin Maritime Systems & Sensors – Undersea Systems)

- Met goal of 20 +/- 5 defects per KLOC (Northrop...
Impact: Quality

• Only 2 percent of all defects found in the fielded system (Northrop Grumman Defense Enterprise Systems)

• Reduced identified defects from 6.6 per KLOC to 2.1 over 5 causal analysis cycles (Northrop Grumman Defense Enterprise Systems)

• Increased focus on quality by developers (Northrop Grumman Defense Enterprise Systems)

• Improved defect removal before test from 50 percent to 70 percent, leaving 0.35 post release defects per KLOC (Siemens Information Systems Ltd, India)

• 44 percent defect reduction following causal analysis cycle at maturity level 2 (reported under non
Impact: Customer Satisfaction

- Increased award fees by 55 percent compared to an earlier SW-CMM baseline at maturity level 2 (Lockheed Martin Management and Data Systems)

- Received more than 98 percent of possible customer award fees (Northrop Grumman Defense Enterprise Systems)

- Earned a rating of “Exceptional” in every applicable category on their Contractor Performance Evaluation Survey (Northrop Grumman Defense Enterprise Systems)

- Improved average customer satisfaction rating 10 percent (Siemens Information Systems Ltd, India)
Impact: Return on Investment

- 5:1 ROI for quality activities (Accenture)
- 13:1 ROI calculated as defects avoided per hour spent in training and defect prevention (Northrop Grumman Defense Enterprise Systems)
- Avoided $3.72M in costs due to better cost performance (Raytheon North Texas Software Engineering)
  - As the organization improved from SW-CMM level 4 to CMMI level 5
- 2:1 ROI over 3 years (Siemens Information Systems Ltd, India)
- Processes for earlier defect detection, improved risk management, and better project control implemented after showing positive return on investment during pilot (Thales TT&S)
- 2.5:1 ROI over 1st year, with benefits amortized over less
Recently Report CMMI & CMM Results

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Proposed future directions
Selected CMMI Results
Lockheed Martin M&DS


Results

• captured a greater percentage of available award fees, now receiving 55 percent more compared to the baseline that remained unrealized at SW-CMM level 2

1996 - 2002

• Increased software productivity by 30%
• Decreased unit software cost by 20%
• Decreased defect find and fix costs by 15%

Improvements in:

- Customer satisfaction
- Productivity
- Product cost

Proprietary sources with permission; August 2003.
Northrop Grumman IT-1
Defect prevention using PSP and CAR at CMMI ML5

Improvements in:
Quality

Integrating PSP\textsuperscript{sm} and CMMI\textsuperscript{®} Level 5. Gabriel Hoffman, Northrop Grumman IT . May 1, 2003.
Northrop Grumman IT-2

Appraised at CMMI ML 5 in December 2002

Results

• met 25+ milestones in a row
• earned a rating of “Exceptional” in every applicable category on a formal Contractor Performance Evaluation Survey

• Hours Invested: 124 in Defect Prevention (CAR)
• Hours saved: 1650 hours (15 hours per defect)
• ROI: 13:1

Improvements in:

Quality

Schedule / cycle time

Customer satisfaction

Cost of quality / ROI

Integrating PSPsm and CMMI® Level 5. Gabriel Hoffman, Northrop Grumman IT. May 1, 2003
Accenture

Transition SW-CMM to CMMI ML 3

- May 2001 to May 2002
- Transition Time: 1149 person hours

Key Content
- Measurement and Analysis
- DAR, TS, RM, Change Control
- IPPD, visions, OEI
- Generic Goals

Results
- ROI: 5:1 (for quality activities)

Innovation Delivered. CMMI® Level 3 in a Large Multi-Disciplinary Services Organization. Bengzon, SEPG 2003
General Motors Corporation

CMMI focus 2001
Goal is Integration of Supplier Work and GM Project Execution

Results:
- Improved schedule – projects met milestones and were fewer days late

Boeing Ltd, Australia

Making transition to CMMI from SW-CMM and EIA 731; early CMMI pilot in Australia

RESULTS on One Project

- 33% decrease in the average cost to fix a defect
- Turnaround time for releases cut in half
- 60% reduction in work from Pre-Test and Post-Test Audits; passed with few outstanding actions
- Increased focus on product quality
- Increased focus on eliminating defects
- Developers seeking improvement opportunities

Improvements in:

- Product cost
- Schedule / cycle time
- Quality

CMMI Level 4 helps THALES meet their business objectives.

- Ability to see into the future with a known level of confidence
- Increasing number of processes under statistical control
- Measurement based process improvement

• Return on investment due to
  - earlier defect detection
  - improved risk management
  - better control of projects

CMMI® Level 4 Preparation: The Story of the Chicken and the Egg. Anne De Goeyse and Anne Sophie Luce, Thales ATM; and Annie Kuntzmann-Combelles, Q-Labs France, ESEPG 2003.
Thales Training & Simulation

- Began process improvement with SW-CMM in 1992; Level 3 achieved in 1996
- Refocused on CMMI to broaden effort to systems engineering

- Lessons Learned:
  - quarterly internal “CBA IPI like” assessments measure progress and help avoid regression
  - experience gained during implementation of SW-CMM was a key factor in CMMI success
  - data collected on software has shown decreases in project cost and schedule variances as maturity increased

Improvements in:

- Product cost
- Schedule / cycle time

Recent CMM® (& CMMI) Results
Thales Research & Technology

CMM data from another Thales Unit used by Thales Research & Technology as part of rationale to begin PI with CMMI.

Improvements in:

- Product cost
- Schedule / cycle time
- Quality
- Customer satisfaction

Bosch Gasoline Systems

CMM based improvements

• **Predictability** -- Internal On-Time Delivery improved by 15%

• **Less Rework** – first pass yield improved by 10%

• **Product Quality** – reduction in error cases in the factory by one order of magnitude

Next Steps include

• Move to CMMI and applying it to software, system and hardware

• Expand process improvement program to include sales, hardware and component development

Sanchez Computer Associates, Inc.

**CMM** Level 1 to Level 3 in 15 months. 6 Months later,
- saved $2 million in first 6 months, most through early detection and removal of defects

In addition,
- improved quality of code
- robust training program
- applicability of process outside of software programming

J.P. Morgan Chase & Co

1st CMM success 2001
today, 28 teams at CMM Level 2
CMMI success – 1st team ML3 in 2003

Investment in PI = $4 million

Results:
• Improved predictability of delivery schedule
• Reduction of post-release defects
• Reduced severity of post-release defects

And, from CMMI specifically
• Increased through-put = more releases per year

Goal to achieve CMMI throughout organization

With permission from presentation to the SEI, September 2003.
Proposed Future Directions

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Proposed for FY2004 and Beyond

Impact and benefits of systems engineering
• Processes with heritage in EIA 731 and precursors
• Organizational integration

Additional case studies
• In-depth collaboration with the SEI
• Self reported \textit{via} the SEIR

Broadly based studies
• State-of-the-practice surveys of CMMI impact and transition
• Analyses using existing commercial databases
• Community benchmarking of process and performance
Proposed for FY2004 and Beyond

Related studies
- Research and development on costs and benefits of CMMI appraisal methods
- Guidance on calculating cost-benefit, cost effectiveness, ROI, and cost of quality
- CMMI adoption and impact in small and medium enterprises

Decision support
- Proactive guidance for Decision Analysis and Resolution
- Combining computer modeling and simulation with empirical results
- Validating predictions empirically

Guidance on using measurement effectively
Technical Report, conference presentations and journal articles
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