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CMMI®

Making the Switch: Evidence about the Benefits of CMMI®

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Contents

Objectives, recent and current work

Research on CMMI® Impact

Characterizing Impacts

Impact of CMMI-based Process Improvement

Recently reported CMMI and CMM® results

Overall Objectives: The Big Picture

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

Focus:

- Impact and value added
- Investment and costs incurred

{ **Current Emphasis**

- 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$_1$

SEI Special Report (October 2003)

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

Tracks at 3rd and 4th Annual CMMI Technology Conference and User Group

Conference tutorials

- Guidance on calculating ROI
- Modeling & simulation for decision support

Benchmarking workshop

Subsequent development of additional training assets

Recent & Current Work$_2$

Case studies and review of existing literature

- Early adopters with credible quantitative evidence of impact and benefits of CMMI
- Special attention to ROI, cost of quality, and related cost-benefit measures
- Effective piloting, including experimental designs

Self-reported cases

- Re design and prototype existing template
- Design and prototype SEIR functionality and interface
- Broad scale implementation in 2005

Recent & Current Work$_3$

Expert workshop on appropriate ROI measures and approaches

- Adoption of CMMI
  - Amortization of long term investments
  - Short term cost-benefit of selected CMMI interventions (tactical as well as strategic)
- Identification of proper measures and analytic techniques (context, cost, benefit, as well as ROI *per se*)
- Calculations after the fact to validate the wisdom of past decisions
- Estimation before the fact to help make informed decisions
- Proactive simulation/business case/cost-benefit
  - Business case, cost-benefit analyses and what-if scenarios
  - Modeling and simulation
  - Predictive validity, and model optimization

Recent & Current Work$_4$

Benchmarking exercises

- Comparisons with experiences of similar organizations
  - Measures of effort, cost, organizational context, ROI & other selected performance measures
- Contributors-only workshop at 4th Annual CMMI Technology Conference and User Group
- Beginning in 2005
  - Larger scale state-of-the-practice surveys and benchmarking of ROI and related measures
  - Self reported cases

Related Work

- Adoption and transition in small settings
- Impact of Risk Management practices
- Impact of early attention to measurement
- Accelerating CMMI Adoption Through Six Sigma

Criteria for case study selection

Emphasis on systems engineering

- Processes with heritage in EIA 731 and precursors
- Organizational integration
- Integration of Systems and Software

Lower maturity organizations

- Early attention to measurement
- DAR / CAR / OID in lower maturity organizations

Other

- Disciplines
  - IPPD, Acquisition
- Sectors
  - Service, IT, Finance, etc.
- Interrelationships with other improvement initiatives, e.g.,
  - Six Sigma, ISO standards, Malcolm Baldridge, PSP/TSP

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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
- Demonstrate 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

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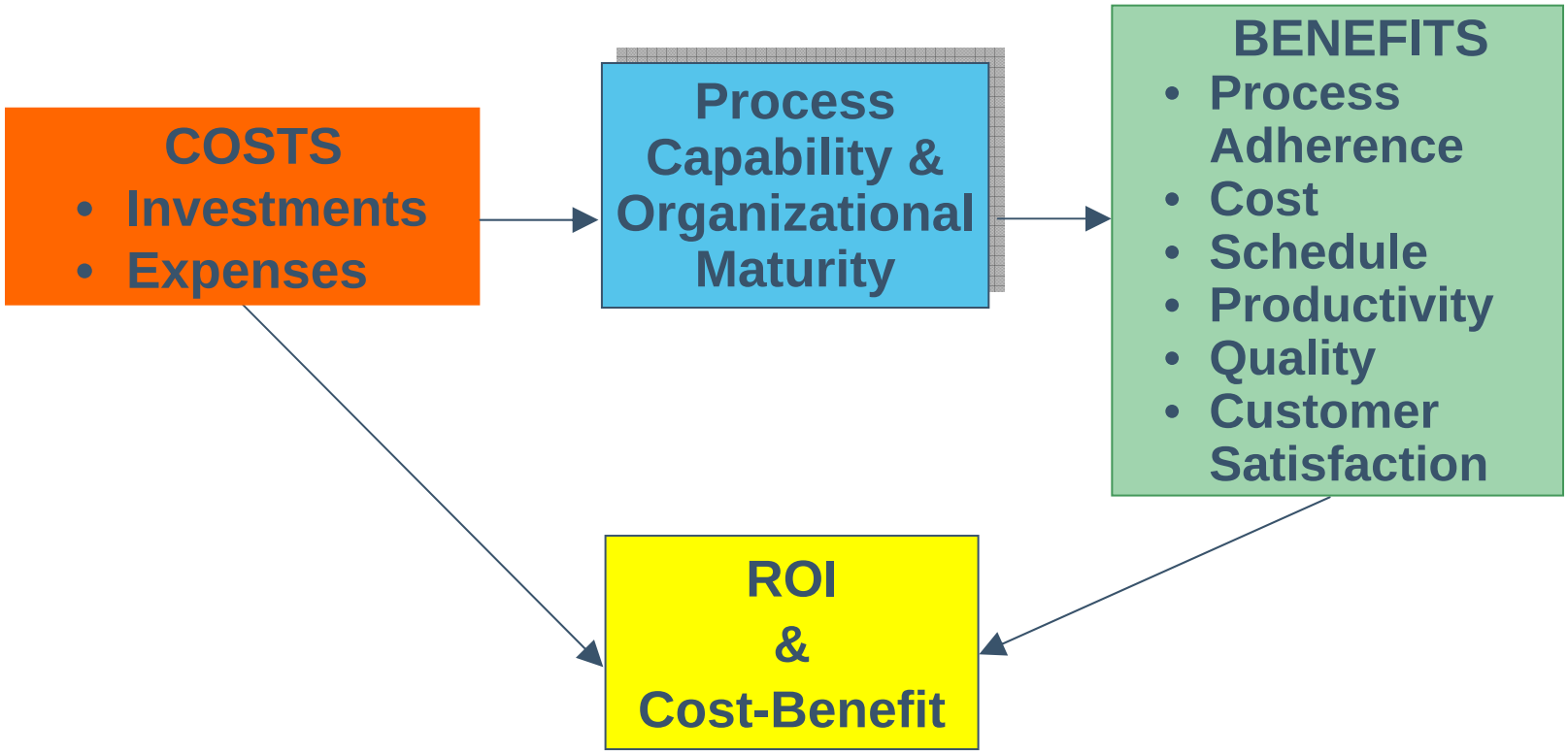
Impacts: Costs and Benefits of CMMI



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

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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: $Cost_1$

- 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$_1$

- 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$_2$

- 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 a 1992 baseline by approximately 80 percent at SW-CMM maturity level 5 In 1997 to over 140 percent at CMMI ML 5 in 2001 (Lockheed Martin Systems Integration)
- 25 percent productivity improvement in 3 years (Siemens Information Systems Ltd, India)
- Used Measurement & Analysis to realize an 11 percent increase in productivity, corresponding to $4.4M in additional value (reported under non disclosure)

Impact: Quality$_1$

- 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 Grumman Defense Enterprise Systems)

Impact: Quality$_2$

- 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 disclosure)

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 than 6 months (reported under non disclosure)

Performance Measures Summary$_1$

Of 21 organizations/cases:

- **Process Adherence**: Five cases show improvements in process adherence and cost of quality
- **Cost**: Five cases provide eight examples of cost-related benefits, including reductions in the cost to find and fix a defect, and overall cost savings
- **Schedule**: Six cases (ten examples) show evidence of schedule-related benefits, including decreased time needed to complete tasks and increased predictability in meeting schedules

Performance Measures Summary$_1$

Of 21 organizations/cases:

- **Productivity:** Six cases provide evidence of increased productivity
- **Quality**: Seven cases provide ten examples of measured improvements in quality, mostly related to reducing defects over time or by product life cycle
- **Customer Satisfaction**: Three cases show four examples of improvements in customer satisfaction, including demonstration of customer satisfaction through award fees
- **Return on Investment**: Six cases report positive returns on investment from their CMMI-based process improvement

Organizations

CMMI Conference Presenters	Others
Accenture	Boeing Ltd, Australia
CMS Information Services, Inc.	Bosch Gasoline Systems
Harris Corporation	Fort Sill Fire Support Software Engineering Center
Lockheed Martin Management and Data Systems	General Motors Corporation
Lockheed Martin Maritime Systems and Sensors – Undersea Systems	J.P. Morgan Chase & Co.
Lockheed Martin Systems Integration	Sanchez Computer Associates, Inc.
Motorola Global Software Group, India	Thales Air Traffic Management
Northrop Grumman Defense Enterprise Systems	Thales Research & Technology
Raytheon North Texas Software Engineering	Thales Training & Simulation
	Siemens Information Systems Ltd, India

Plus 2 Anonymous

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Selected CMMI Results

Lockheed Martin M&DS

SW CMM ML2 (1993) to ML 3 (1996) to CMMI ML5 (2002)

Improvements in:

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%

Customer satisfaction

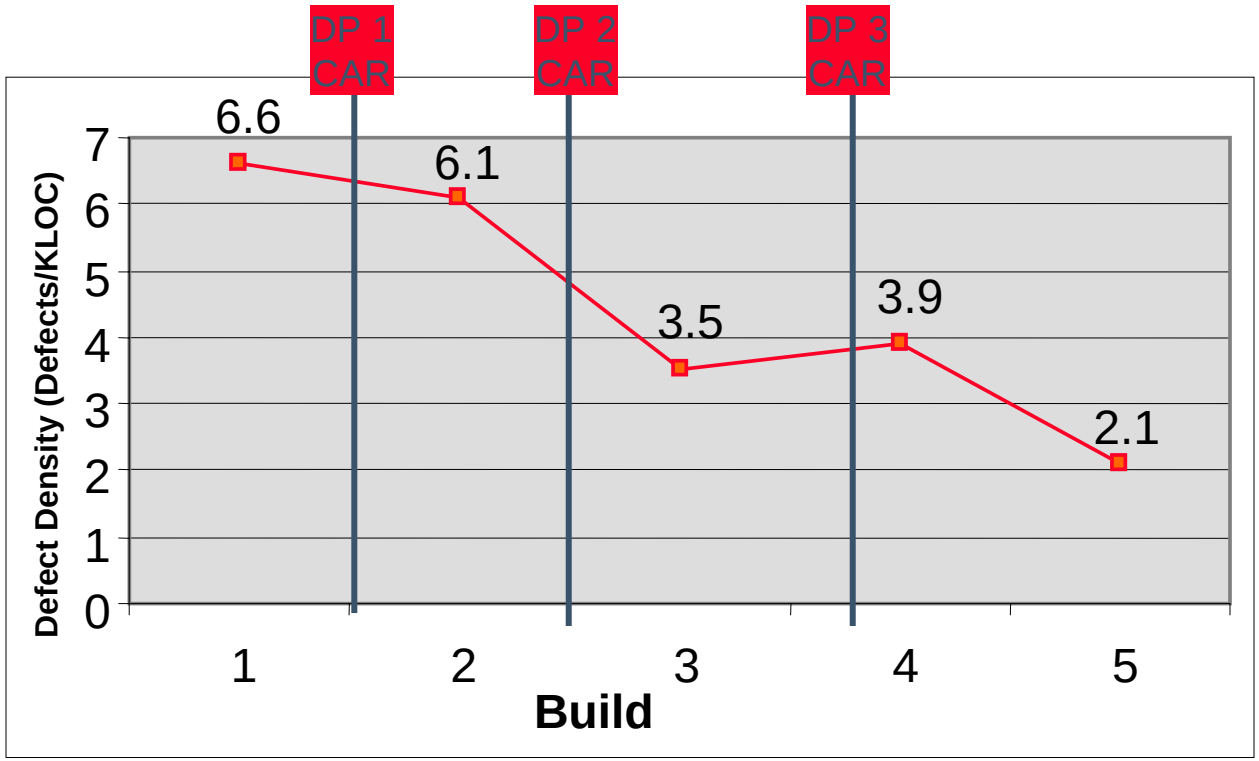
Productivity

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℠ and CMMI® 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:

Schedule / cycle time

Customer satisfaction

Quality

Cost of quality / ROI

Integrating PSP℠ 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

Costs:

Investment in Improvement

Key Content

Measurement and Analysis
DAR ➡ TS, RM, Change Control
IPPD ➡ visions, OEI
Generic Goals

Improvements in:

Results

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

Cost of quality / ROI

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

General Motors Corporation

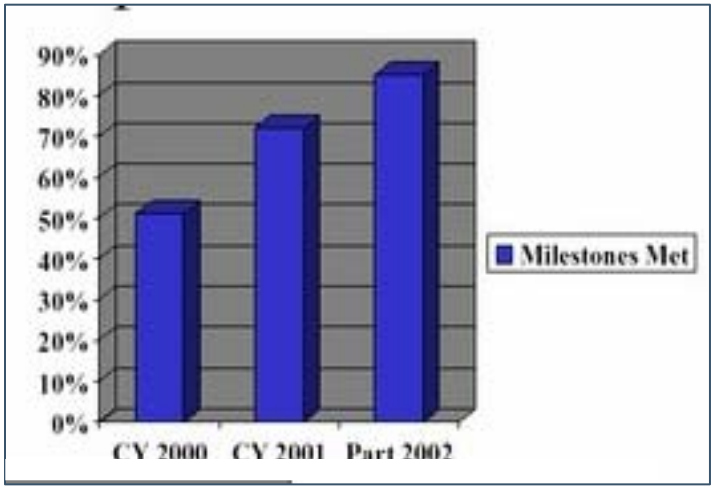
CMMI focus 2001

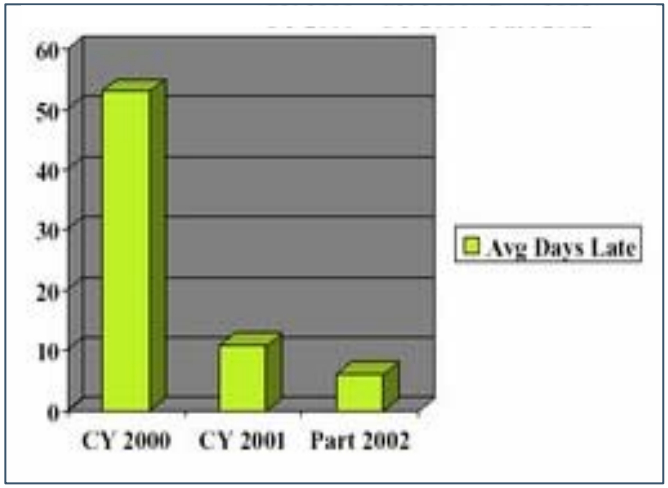
Goal is Integration of Supplier Work and GM Project Execution

Results:

Improvements in:

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





Schedule / cycle time

Camping on a Seesaw: GM's IS&S Process Improvement Approach. Hoffman, Moore & Schatz, SEPG 2003.

Boeing Ltd, Australia

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

Improvements in:

RESULTS on One Project

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

In Processes is there a Pay-Off? Terry Stevenson, Boeing Australia, Software Engineering Australia 2003 conference.

Thales ATM

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

Improvements in:

Quality

Predictability

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

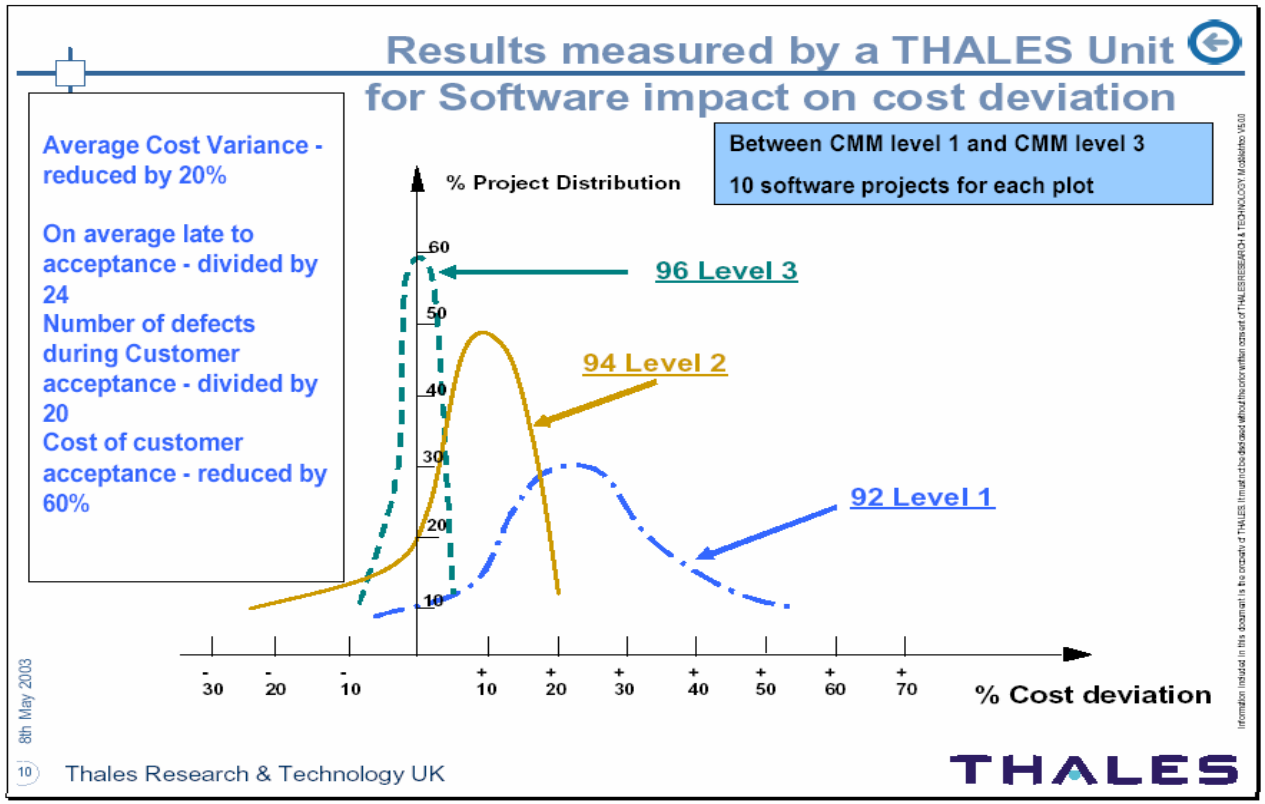
Schedule / cycle time

Achieving CMMI level 2: Keys to success. Robert Richard. ESEPG 2003.

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

Getting Started with Process Improvement Using the CMMI®. Carol Marsh, Patrick Vigier. ESEPG 2003.

Bosch Gasoline Systems

Improvements in:

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

Schedule / cycle time

Predictability

- Rework

Quality

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

Critical success factors for improvement in a large embedded systems organisation. Wolfgang Stolz, Robert Bosch GmbH Gasoline Systems GS-EC/ESP and Hans-Jürgen Kugler, Q-Labs Software Engineering, ESEPG 2003.

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

Improvements in:

Quality

+ REVENUE / SAVINGS

In addition,

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

Financial Services Software Developer Saves $2 Million in Six Months with CMM® Implementation. David Consulting Group, News Release.

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CMMI®

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

Improvements in:

Predictability

Quality

Schedule / cycle time

With permission from presentation to the SEI, September 2003.

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