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How Not to Waste Millions on the CMMI[®]: Performance versus Compliance

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Agenda

- Context: Performance vs. Compliance
- Overview of CMMI
- Costs, Benefits, Timeframes
- Improvement Programs
 - Scope
 - Assessments
 - Approaches
- Special cases
- Common Pitfalls

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How Not To Waster Millions on CMMI®

Context: Performance vs. Compliance

The Problems Models Address

Performance and Credibility

- **Performance:** how to increase speed, productivity, quality
- **Credibility:** convince others of your potential performance, assess others' potential performance
 - "Others": customers, other departments, senior management, suppliers



The Problems Models Address (2)

Evaluating Potential Suppliers

- Internal or external suppliers
- Combination of performance & credibility
- What are the risks in using this supplier?
- More later...



Historically...

- CMMI[®] derived from 5-level SW-CMM[®]
- Originally oriented to performance improvement
- Became used by major acquirers as selection method
- Gave rise to compliance mindset among users/consultants
 - Bureaucracy
 - Slower processes



Solutions to Problems

- Model was created through assessments
- Started with 5-level model, Watts Humphrey
- Typical problems, by Maturity Level
- *Attributes* of successful solutions

- For example, ...



Maturity Level One

- Commit before we know we can do it (& changes)
- Can't predict when it will really be done
- Can't predict how much it will really cost
- Bad news comes too late
- Success through heroes and firefighting
- Past success (or failure) doesn't predict future



What projects used to be like, and often still are.

Some ML 1 Specific Problems

- Infeasible commitments
- Vague requirements
- Inaccurate estimates
- Poor tracking
- Infeasible changes to requirements
- Subcontractor problems
- Ship the wrong version
- Performance falls apart under growth



Attributes of Some Solutions

- Requirements review, involve development
- Estimating based on size, not hours
- Tracking all hours, size, corrective action
- Requirements change impact analysis
- Specific “procedures”, training, verification



Higher MLs Have Different Problems

- Every project is one-off
 - Can't re-use process assets
 - Takes too long to start-up project
 - Can't move engineers between projects quickly
 - Reporting is different for each project
 - Can't tell real alarms from false
-
- → Different solution attributes, opportunities



Performance-Driven Improvement™

- The practices are solutions found in industry to prevent typical problems
- IF YOU DON'T HAVE THE PROBLEM, DON'T PUT THAT PRACTICE IN PLACE!!!!
 - You'll just get bureaucracy, and slow your teams down
 - All practices should be solving/preventing a clear problem
 - CMMI helps prioritize problems to address
- “Alternative Practices”



Compliance-Driven Approach

- “Checklisting” the model
- Process for its own sake
- Getting the badge
- Good for credibility when client doesn’t know you
- Good for market position
- May be table stakes or customer requirement
- Also helps in internal battles



Problems with Compliance Approach

- Often bears no relation to your problems
- Poor credibility with your project teams
- Slow adoption
- Inflexible or inappropriate solutions
 - Adopt, rather than adapt
- Shadow systems
- Slower performance

- “What’s the value added?”



Performance-Driven Approach

- Start with the problems
- Whose view?
 - Senior management
 - Middle management
 - Corporate quality staff
 - Methods people
 - Project managers
 - Practitioners (analysts, developers, testers...)
 - SQA

Talk to the people who do the work



Start with the Problems

- What's not working?
 - Focus groups of practitioner functions
 - “What gets in the way of you producing quality software, on time, on budget?”
 - Let them talk to each other
 - Can organize by process area
-
- Maturity level is reflected in problems



Start with the Problems...

- Important conditions for good data
 - Right people, coherent functions
 - Confidentiality
 - Non-attribution
 - Non-reporting relationships
 - Focus in on organization, not specific proj
 - Chance to give feedback on draft pres'n



Start with the Problems...

- For real power...
- Present findings to senior management in the presence of the participants!
 - (Manage the risks)



What You're Left With

- Prioritized set of problems
- Huge buy-in
- If combined with training
 - Huge momentum (which can be risky)
 - Evangelists
 - Savvy process creators
 - Savvy adopters



Contrast This With...

- Central methods group
- We have to use “best practices”, standards
- Buying a tool to fix everything

- “Pull”, not “Push”

- Note: depends on your current level!

Let's look at levels



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How Not to Waste Millions on CMMI®

Overview of the CMMI

What is CMMI?

- *Model* of how organization's processes evolve from chaotic to constantly optimizing
- Evolution has several distinct levels
 - each contains practices that describe what is mastered for that level
- The practices are taken from theory and experience
 - every practice has been seen somewhere in an existing organization



Source Models and Disciplines

- SW-CMM v1.1 → v2 draft C (Software Engineering)
- EIA/IS-731 (Systems Engineering)
- IPD-CMM v0.98 (Integrated Product Development)
- SA-CMM (Acquisition)

- CMMI product suite:
 - Reference models – several disciplines
 - Training products
 - Assessment methods



Successful Track Record

- CMMI or SW-CMM
- Since early '90s
- Many sectors: military, financial, commercial s/w, telecoms, IT departments, IT consulting
- Many sizes: small 10-person teams to multi-thousand developer organizations
- Many countries around the world

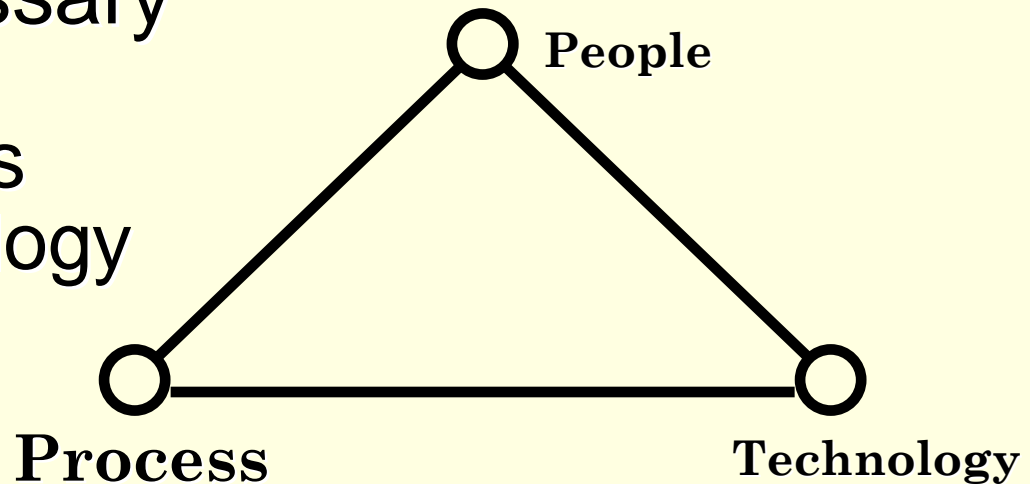


CMMI Scope

Process: A set of activities, methods, practices, and transformations that people use to develop and maintain software and associated products (CMM)

For any undertaking, three elements are necessary

- people
- process
- technology



The CMMI Is Based on a Few Fundamental Concepts

- Evolution is possible, but it takes time
- There are distinguishable stages
- Evolution → some things must be done before others (helps set priorities on biggest ROI items)
- Maturity will erode unless sustained



Process Evolution

Quantitative
Process
Improvement

Optimizing (5)
Focus on process
improvement

Quantitative
Project
Management

Quantitatively Managed (4)
Process measured
and controlled

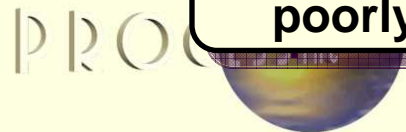
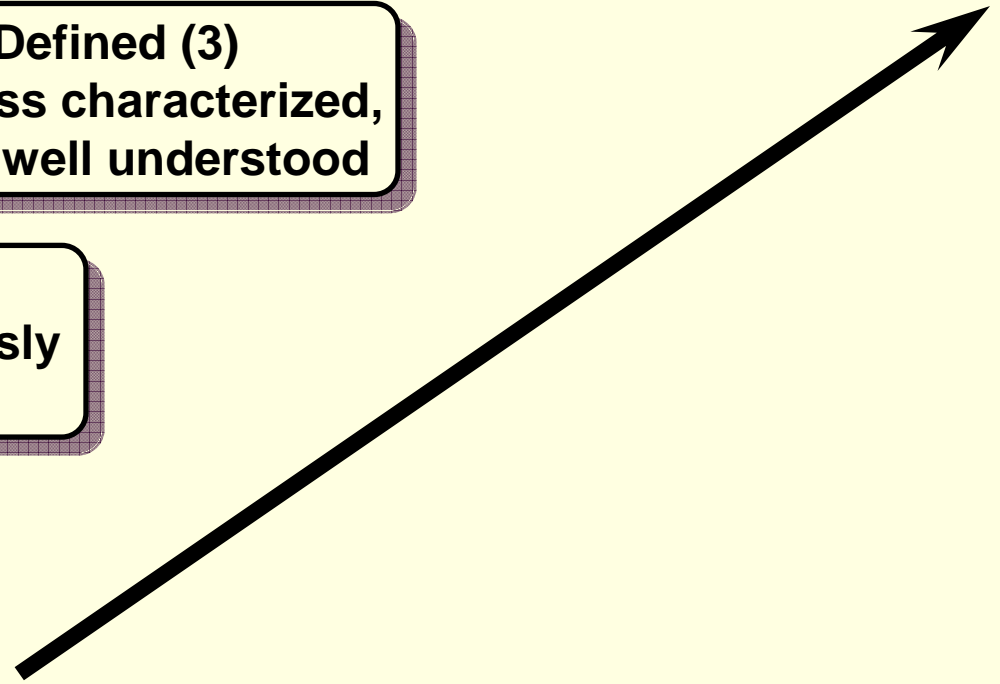
Standardization

Defined (3)
Process characterized,
fairly well understood

Basic
Management
Control

Managed (2)
Can repeat previously
mastered tasks

Initial (1)
Unpredictable &
poorly controlled



What Does Level 1 Look Like?

Process Characteristics

- inconsistent management attention
- reaction-driven commitment system undermines good software engineering practices
- ad-hoc, intuitive process

Organization Characteristics

- success depends on heroic efforts
- schedule pressure overriding factor
- fire-fighting expected and rewarded
- pockets of excellence come and go

Process Capability

- unpredictable cost, schedule, and quality performance



What is Level 2?

- Realistic commitments and changes to commitments
- Involvement of project in making commitments
- Disciplined planning resulting in realistic schedules
- Disciplined tracking updates schedules & commitments
- Selection and management of contractors so you know what you'll get and when
- Senior management visibility into project discipline



Major drop in re-work.

What Does Level 2 Look Like?

Process Characteristics

- realistic project commitments established
- project plans and status known
- *project* standards defined and used - PPQA monitors
- S/W requirements and work products baselined

Organization Characteristics

- plans are communications vehicles
- raising a red flag not punished
- people given opportunity to succeed
- project pride

Process Capability

- reasonable control over cost & schedule
- quality unplanned - dependent on individuals



What is Level Three?

- A Learning Organization
 - Best practices leveraged
- Organizational resources targeted to project success
 - Disciplined training
 - Ability to 'load-level' effectively
 - Easy access to company assets: templates, examples, data
 - Intergroup issues addressed
- For the first time, organizational capability is quantifiable
 - Cost, quality, schedule, productivity



Rework drops again.

What Does Level 3 Look Like?

Process Characteristics

- *organization* standard software process documented
- projects tailor OSSP to meet project needs
- personnel trained in and follow defined process
- technical practices that improve quality in place

Organization Characteristics

- each project doesn't reinvent the wheel
- engineers freed up for true creativity
- mistakes become company assets
- organization pride

Process Capability

- reliable cost & schedule performance
- improving but unpredictable quality



What Do Levels 4 & 5 Look Like?

Process Characteristics

- quantitative product & process quality goals set
- S/W product quality planning & tracking
- S/W process database supports projects
- measured & controlled S/W process

Organization Characteristics

- negotiations based on data
- customers needs better understood
- quantitative predictions of impact of process change
- able to “build-in” quality

Process Capability

- predictably high quality S/W products
- Continuously improving performance



Process Areas

- Maturity Levels are made up of Process Areas
- Process Areas
 - Cluster of related practices
 - Achieve certain goals
 - E.g. Project Planning, Project Monitoring & Control, Verification, Organizational Training





Level	Focus	Process Areas	Category
5 Optimizing	<i>Continuous Process Improvement</i>	Organizational Innovation and Deployment Causal Analysis and Resolution	Adv. Process Mgmt. Adv. Support
4 Quantitatively Managed	<i>Quantitative Management</i>	Organizational Process Performance Quantitative Project Management	Adv. Process Mgmt. Adv. Project Mgmt.
3 Defined	<i>Process Standardization</i>	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management Risk Management Integrated Teaming Integrated Supplier Management Decision Analysis and Resolution Organizational Environment for Integration	Engineering Engineering Engineering Engineering Process Mgmt. Process Mgmt. Process Mgmt. Adv. Project Mgmt. Adv. Project Mgmt. Adv. Project Mgmt. Adv. Project Mgmt. Adv. Support Adv. Support
2 Managed	<i>Basic Project Management</i>	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management	Engineering Project Mgmt. Project Mgmt. Project Mgmt. Support Support Support
1 Initial			

Not Just the Engineers!

- Model expects specific things from senior management, e.g.:
- Review external commitments & changes
- Dealing with escalations of process violations
- Reviewing process deployment
- Setting business objectives





Maturity Levels Should Not Be Skipped

Each maturity level provides a necessary foundation for effective implementation of processes at the next level.

- Higher level processes have less chance of success without the discipline provided by lower levels.**
- The effect of innovation can be obscured in a noisy process.**

Higher maturity level processes may be performed by organizations at lower maturity levels, with the risk of not being consistently applied in a crisis.

Staged & Continuous Representations

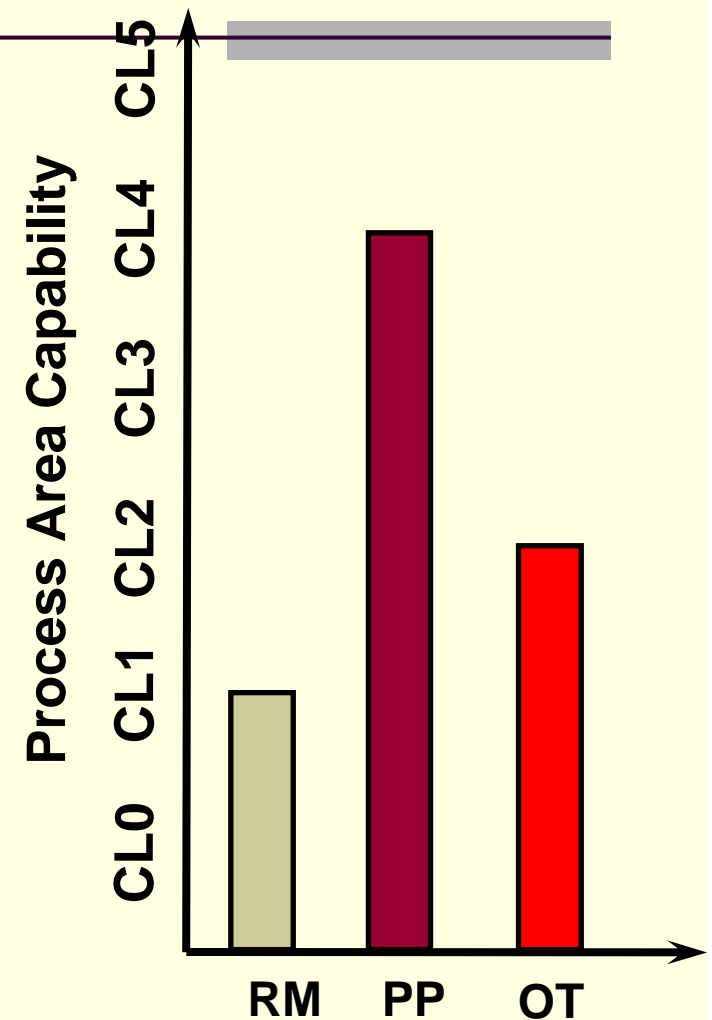
- So far, description has been “staged”
- Can also look at each process area independently
- See how it evolves in “capability”
- This is the “continuous” representation
- Exactly the same process areas, just different view
 - Staged view focuses on organization’s “*maturity*”
 - Continuous view focuses on individual process area’s “*capability*”



Staged & Continuous Representations

Level	Focus	Process Areas
ML5 Optimizing	<i>Continuous Process Improvement</i>	Organizational Innovation and Deployment Causal Analysis and Resolution
ML4 Quantitatively Managed	<i>Quantitative Management</i>	Organizational Process Performance Quantitative Project Management
ML3 Defined	<i>Process Standardization</i>	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Integrated Project Management for IPPD Risk Management Integrated Teaming Integrated Supplier Management Decision Analysis and Resolution Organizational Environment for Integration
ML2 Managed	<i>Basic Project Management</i>	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
ML1 Initial		

Diagram





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How Not to Waste Millions on CMMI®

Costs, Benefits, and Timeframes

Improvement

- At lower maturity levels
 - Aim is to stabilize processes
 - Major effect is reduction of re-work
 - Results in productivity, speed, quality
- At higher maturity levels
 - Explicit goals
 - Quantitative
 - Selected areas
 - Based on data and SPC



The Payback From Investing in CMM-Based Software Process Improvement (SPI)

Category	Range	Median
<i>The Investment:</i>		
Total annual cost of SPI activities	\$49 k - 1,202 k	\$245,000*
Years engaged in SPI	1 - 9	3.5
Cost of SPI activities / software engineer	\$490 - \$2,004	\$1,375 *
<i>The Payback:</i>		
Productivity gain / year	9 % - 67 %	35 %
Defects discovered in pre-test	6 % - 25 %	22 %
Yearly reduction in time to market	15 % - 23 %	19 %
Yearly reduction in post-release defect reports	10 % - 94 %	39 %
Return for each dollar invested in SPI:	\$4.0 - \$8.8	\$5 *

Source: Herbsleb J., Carleton, A et al. *Benefits of CMM-Based Software Improvement*, Software Engineering Institute, 1994.

* \$U.S.



Measurement of Improvement

Project Cost

Cost of Quality

Cost of Performance

Cost of Conformance

Cost of Nonconformance

Appraisal Costs

Prevention Costs

- Reviews
 - system
 - requirements
 - design
 - test plan
 - test scripts
- Walkthroughs (Code Inspection)
- Testing (first time)
- IV&V (first time)
- Audits

- Training
- Methodologies
- Tools
- Policy and Procedure
- Planning
- Quality Improvement Projects
- Data gathering and analysis
- Fault analysis
- Root cause analysis
- Quality reporting

- Re-reviews
- Re-tests
- Fixing defects
 - code
 - documentation
- Reworking any document
- CCB
- Engineering changes
- Lab equipment costs of retests
- Updating source code
- Patches to internal code, delivered code
- External failures

- Generation of plans, documentation
- Development of:
 - requirements
 - design
 - code
 - integration



Source Document: *Quantifying the Benefit of Software Process Improvement*,
Ray Dion, Raytheon, Nov 90

Measurement of Improvement Raytheon Experience

Return on Investment: 7.7 to 1

Cost types

- **Performance:** cost of building it right first time
- **Nonconformance:** cost of rework
- **Appraisal:** cost of testing
- **Prevention:** cost of preventing nonconformance

Change in average % project time by cost type

	Perform	Nonconf	Appraise	Prevent	
1988	34%	44%	15%	7%	Level 1
1990	55%	18%	15%	12%	Level 2
1992	64%	11%	18%	7%	Level 3

Source: Dion, IEEE Software July, 1993



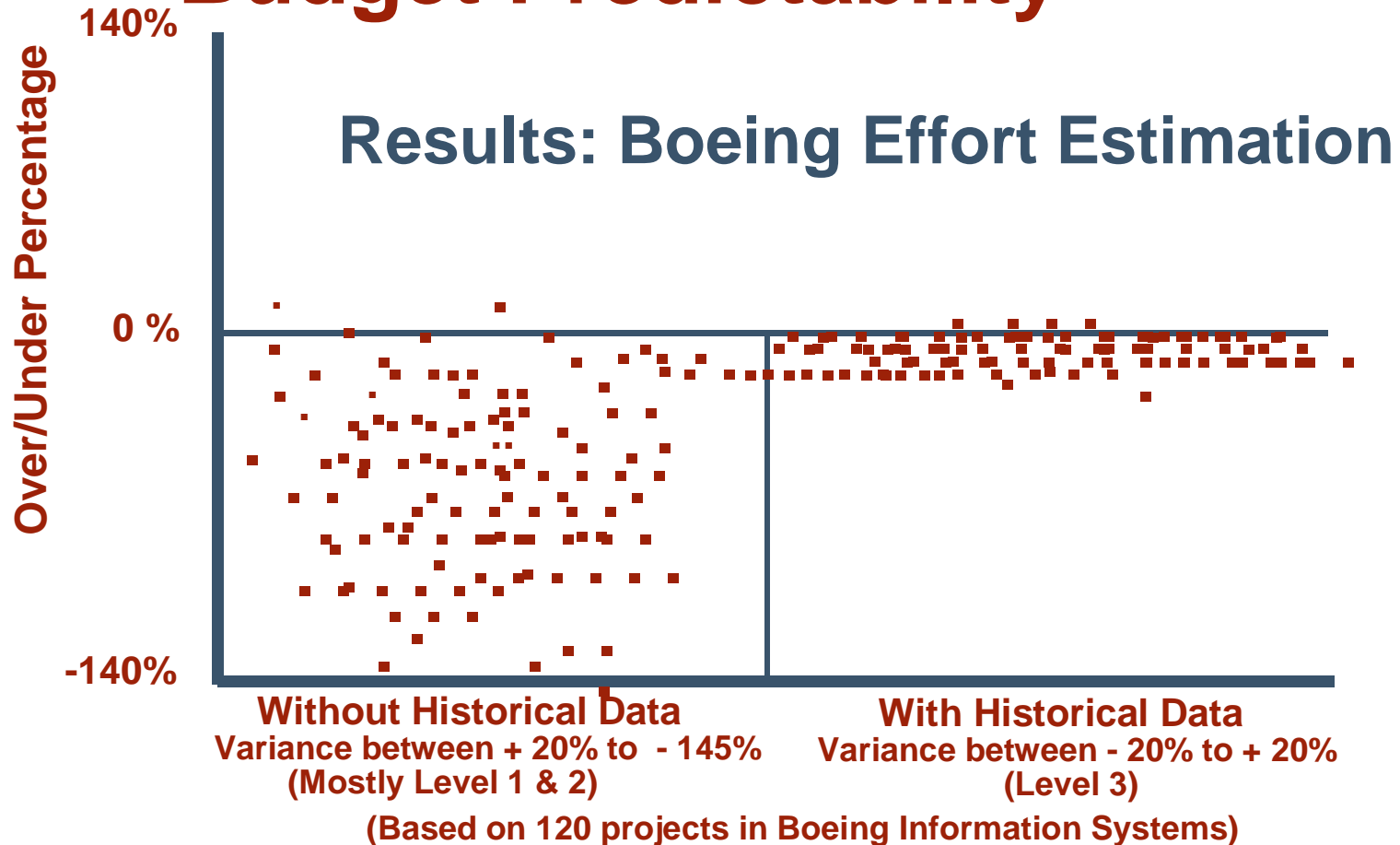
Costs

- Assessment
 - Process Focus
 - Training
 - Executive Time
 - This doesn't happen in spare time!!
-
- 5-15% of development budget
 - More money moves faster





Improved Schedule and Budget Predictability

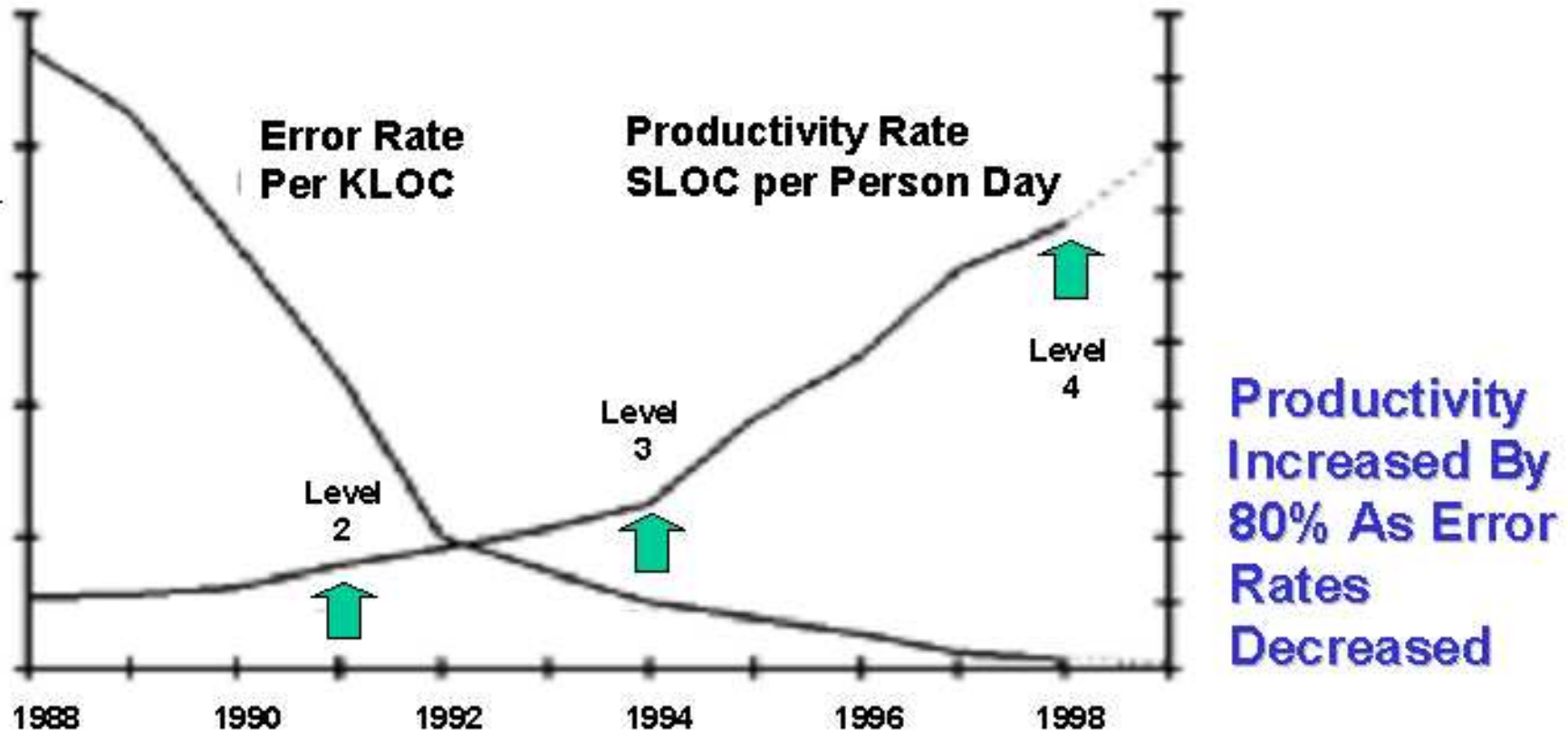


Reference: John D. Vu. "Software Process Improvement Journey: From Level 1 to Level 5."
7th SEPG Conference, San Jose, March 1997.



Increased Productivity and Quality

Productivity Rate and Quality Performance * For Software Programs

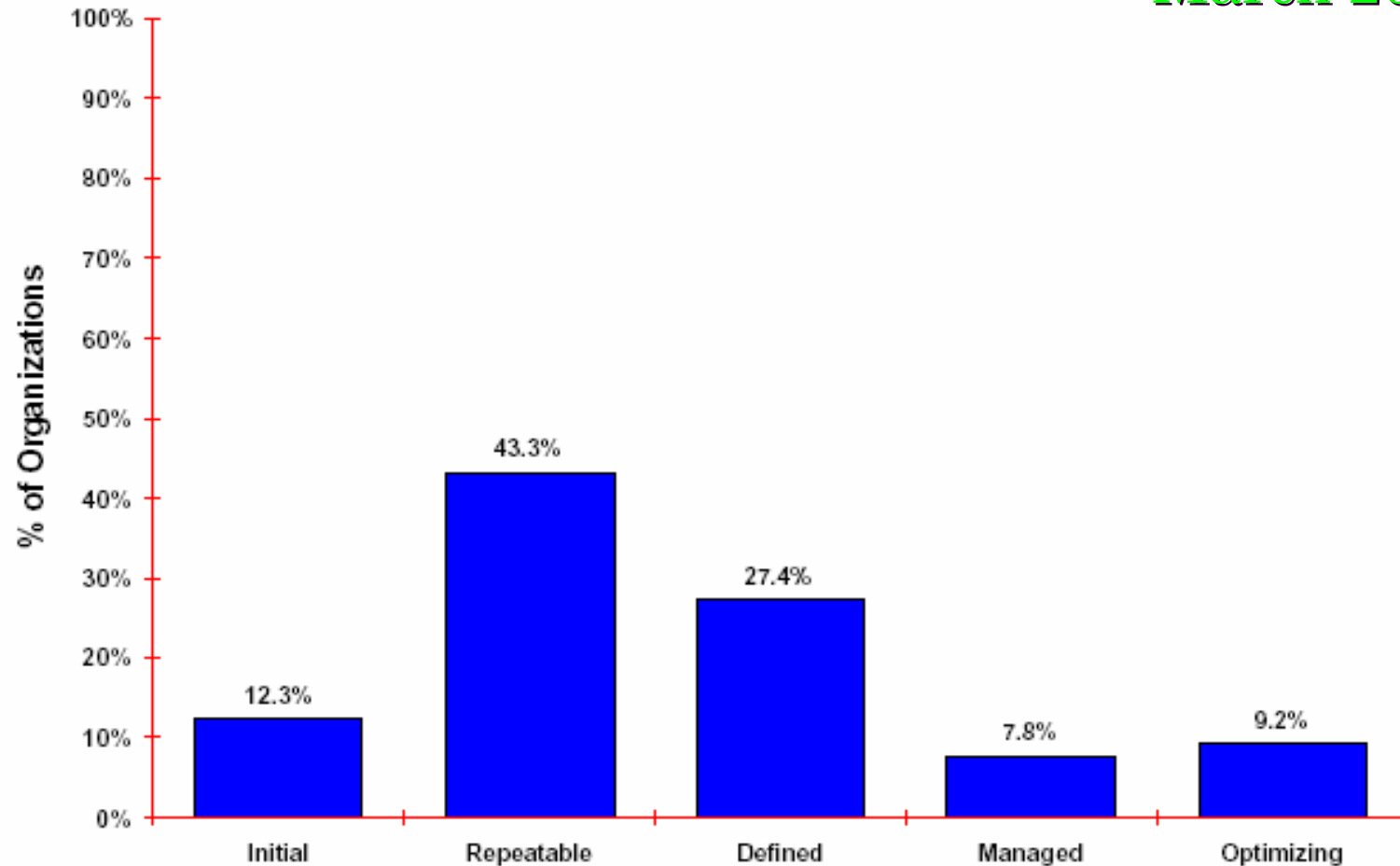


Productivity
Increased By
80% As Error
Rates
Decreased



Maturity Profile by All Reporting Organizations

SW-CMM
March 2004

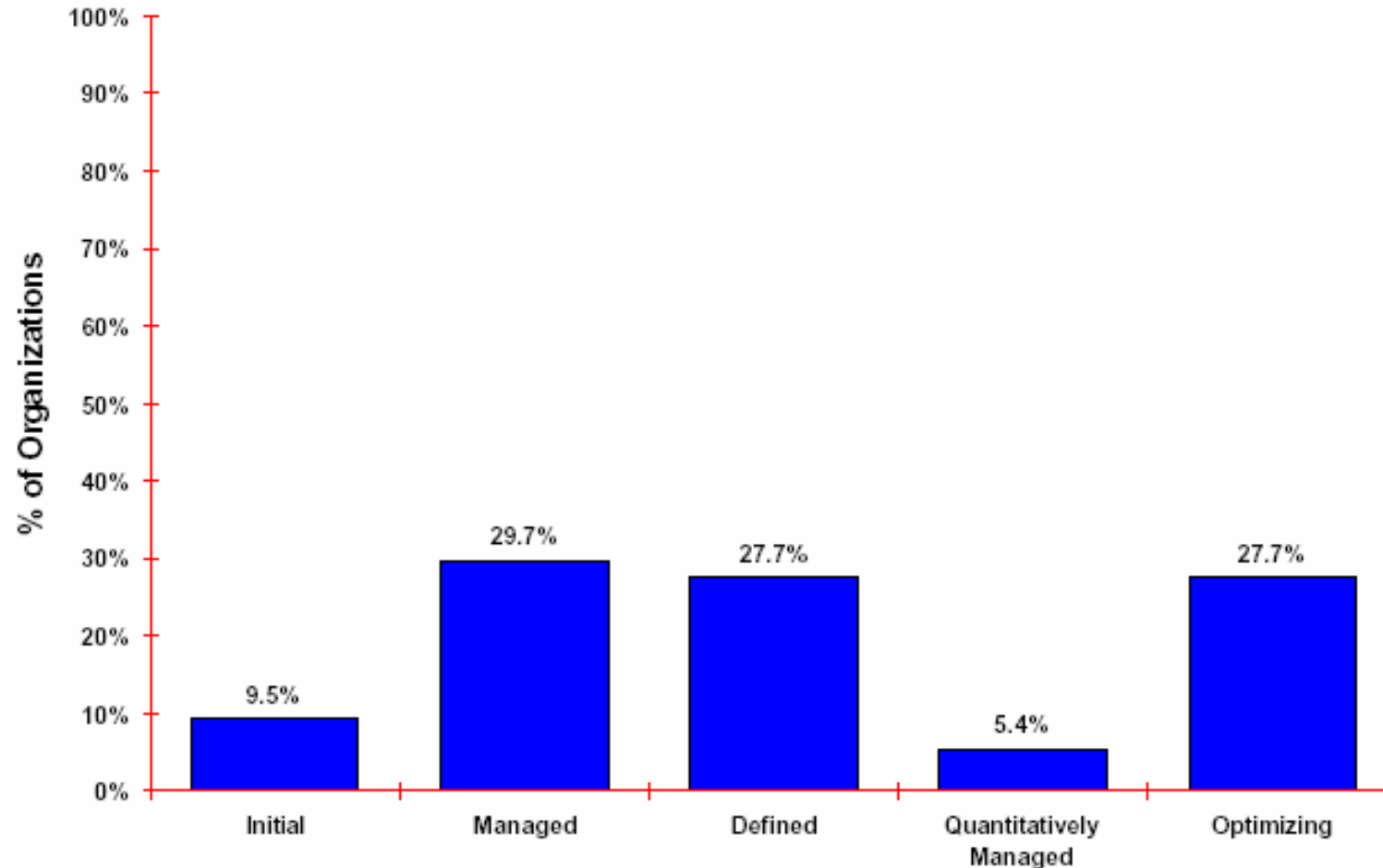


Based on most recent appraisal, since 1999, of 1,593 organizations reporting a maturity level rating



Maturity Profile by All Reporting Organizations

CMMI
March 2004



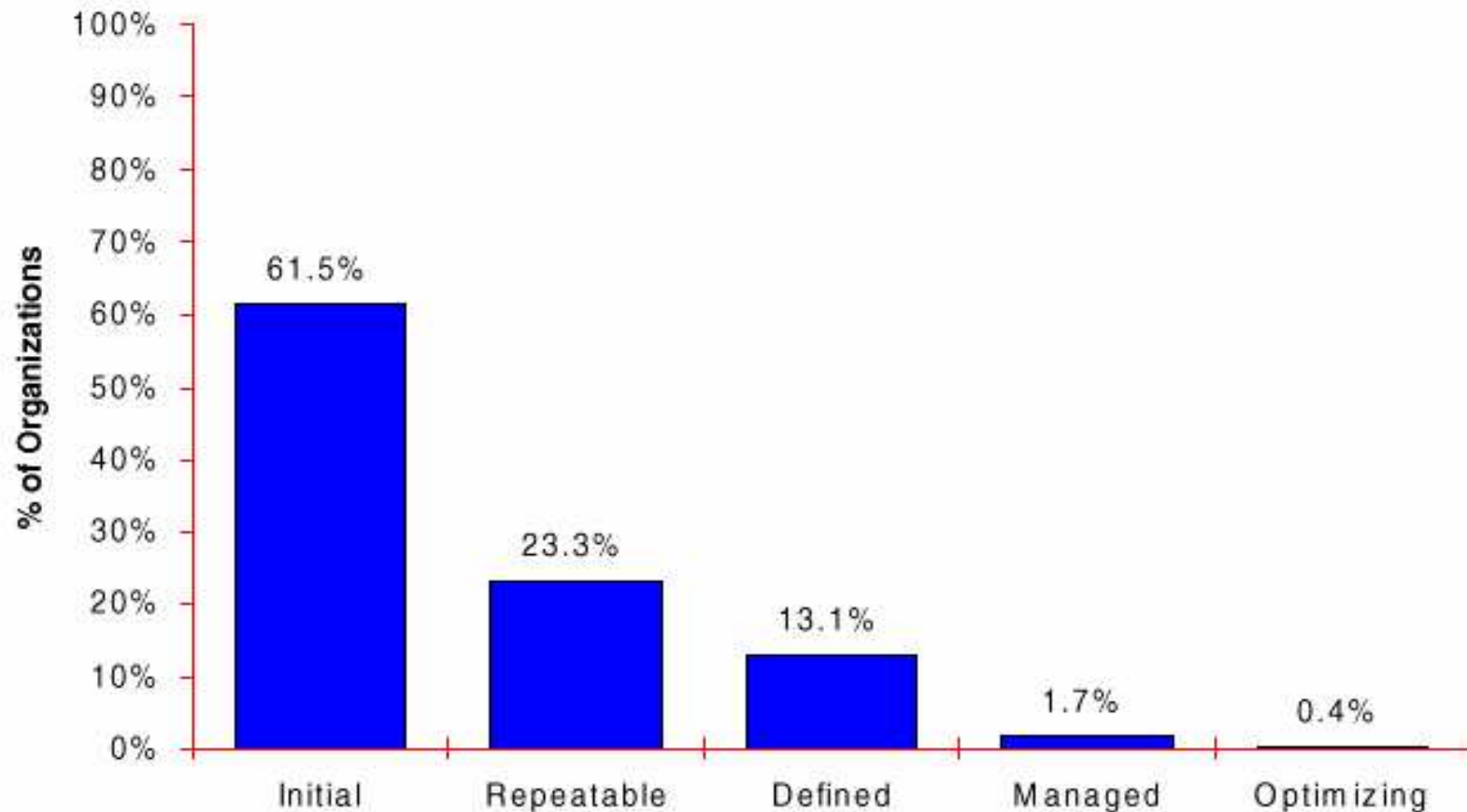
Based on most recent appraisal of 148 organizations reporting a maturity level rating



Organization Maturity Profile

April 1997

SW-CMM

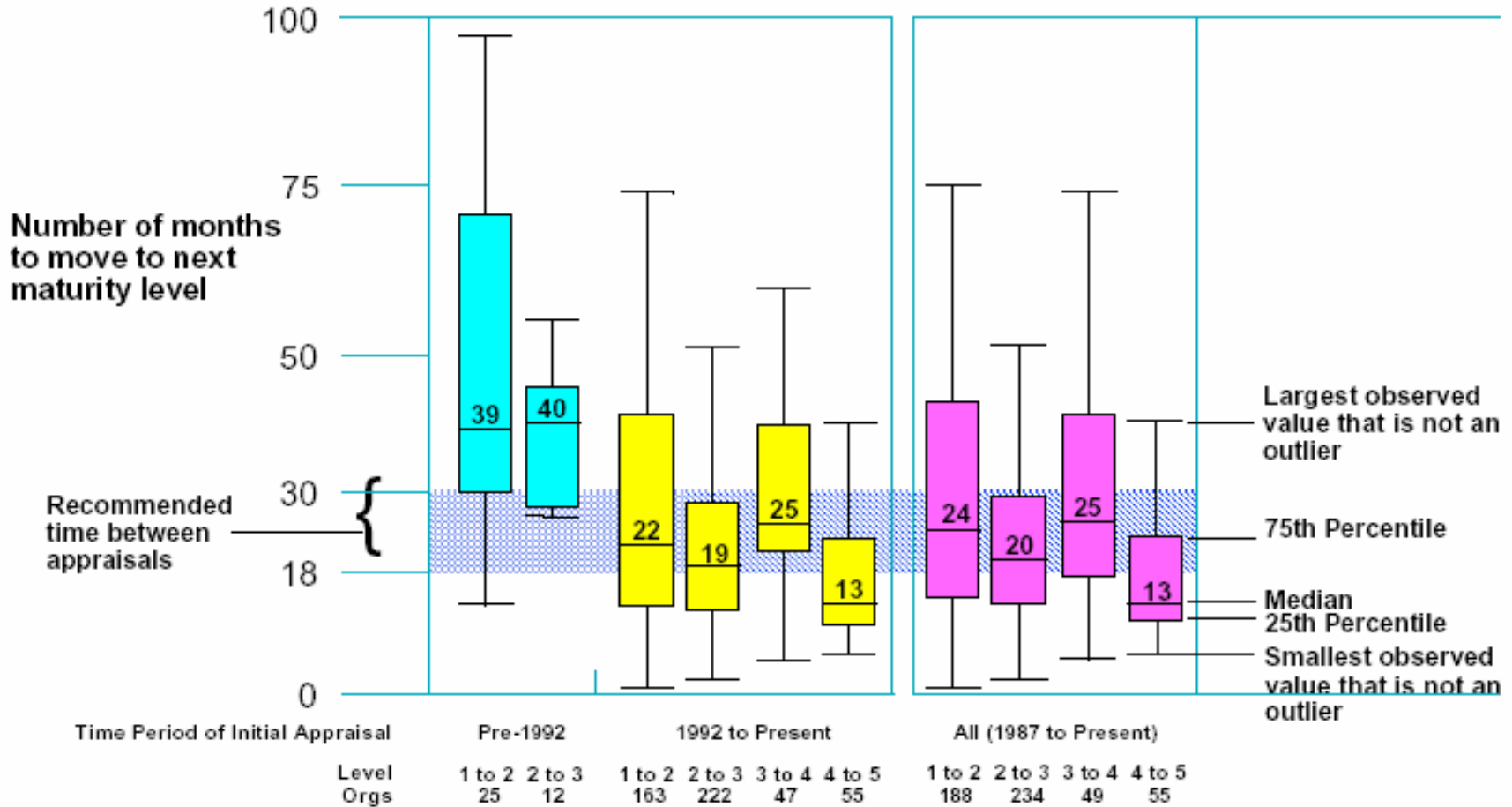


Based on most recent assessment, since 1992, of 533 organizations



SW-CMM March 2004

Time to Move Up



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How Not to Waste Millions on CMMI®

**Improvement Programs:
Scope, Assessments, Approaches**

Be Clear on Your Goals

- Compliance – get the badge
- Performance – get the internal ROI
- Combination
 - Which is necessary, which optional?
 - In what timeframe?
 - What scope?



Scope: The Critical Decision

- Compliance:
 - Can choose org'l scope (must be coherent)
 - Judged by weakest link
- Performance:
 - Look for coherent set of problems
 - Look for consistent “culture”
 - Avoid rivalries (perceived differences)
 - Existing levels and disparities
- Trade-off: minimize duplication vs useless results



Scope

- CMMI Scope
 - Which levels, which process areas?
 - SAM? IPPD? SA?
- Beware looking at ML3 if you're ML1



Assessments

- Range of expense, thoroughness, disruption, education, buy-in
- SCAMPISM A – very broad, very deep, very disruptive, great buy-in, great education
 - Very well-defined method, SEI approved
- SCAMPI C – very quick, minimal disruption, no buy-in, little education, no corroboration
 - Varies between assessors, SEI outline
- Many variations in between



Assessments: SCAMPI A

- SCAMPI A is required to “get the badge”
- Requires assessment team, training, on-site collection of evidence, interviews
- Often 100+ hours on-site, plus training time and reports
- Compliance-oriented
- Usually not appropriate to start an improvement program: overkill or damaging



Performance-Driven Improvement Program™

- Start with Executive Buy-In
 - Know what's involved, commit
- Identify what problems will be addressed
 - Some form of self-assessment is best
 - Ask the people who do the work!
 - Use the CMMI to organize the inquiry and responses (*Use an expert!!!*)
- Develop action plan to address the problems
- Design, pilot & deploy solutions



Design Principle: Risk-Appropriate

- Constant's Principle:
 - *Rigour should match Risk*
- Risk: \$, hours, reputation, market window
- Rigour: process chosen, verification of compliance, handling of deviations
- However: at ML1 primary risk is following a process, any process!!



Compliance-Driven Improvement Program

- Use SCAMPI C to identify gaps to compliance
- Optionally use Performance-Driven Improvement Program to insure changes provide value
- Plug gaps
- SCAMPI A to get the badge



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How Not to Waste Millions on CMMI®

Special Cases

Evaluating Potential Suppliers

- Exclusion from tendering vs risk management
- Check assessment:
 - SCAMPI A or CBA IPI?
 - Authorized lead assessor?
 - When?
 - What scope?
 - Major organizational changes?
 - Report, presentation, ADS



Managing Suppliers

- Guidance in the model
- Process Areas and practices
- Supplier Agreement Management (SAM) ML2
- CMMI SE/SW/SS: Supplier Sourcing
 - Integrated Supplier Management (ISM) ML3
 - “Discipline Amplifications” in other PAs



Special Cases: Very Large

- Scope carefully; watch for culture
- Build “pull” rather than “push”
- Re-use assessment results to avoid cost of multiple assessments
- A central process group must be very careful
 - Facilitate, don't dictate
 - May need divisional process groups
 - Solve projects' problems



Special Cases: Very Small

- Solve the problem, don't "install the practice"
- Make the solution risk-appropriate
- Use more informal solutions
 - Training slides
 - Emails
 - Senior management oversight
 - *Sometimes* early opportunity for standardization



Avoid Pitfalls

- Variable executive monitoring
- Premature standardization (Level 3)
- Over-elaborate procedures
- Ignoring “risk-appropriateness”
- Over-the-wall process development
- Ignoring company history
- CMMI-focused improvement



Further Information

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