

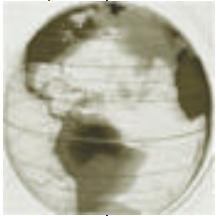


Why is Level 4 So Hard?

Washington DC Area SPIN

November 1, 2000

Jeff Perdue





The Capability Maturity Model

- The CMM describes an evolutionary improvement path for a software organization, from an ad hoc immature process to a high quality mature process
- This path is laid out in 5 levels
- The CMM was developed at Carnegie Mellon University's Software Engineering Institute (SEI), a US government funded center chartered to improve the state of the practice in Software Engineering



CMM References

- The CMM is available as an Addison-Wesley textbook: The Capability Maturity Model: Guidelines for Improving the Software Process, 1995, 441 pages
- The CMM is also available on the web (free) at www.sei.cmu.edu/cmm
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CMM Maturity Levels

Level Number	Level Name	Characteristics
5	Optimizing	Continuously improving processes
4	Managed	Quantitative Control of Product and Process
3	Defined	Management and engineering practices defined at the organization level
2	Repeatable	Basic Project Management established
1	Initial	Ad hoc and often chaotic

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Key Process Areas of the CMM

Level 5 – Defect Prevention,
Technology Change Management,
Process Change Management

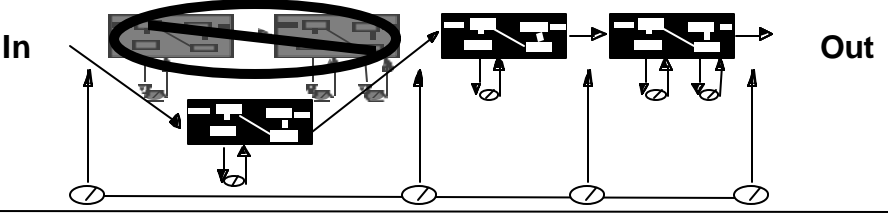
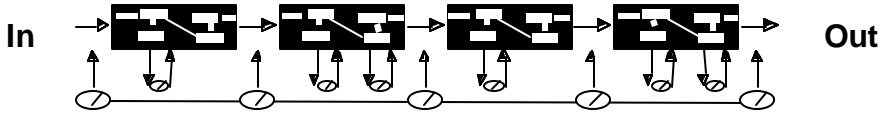
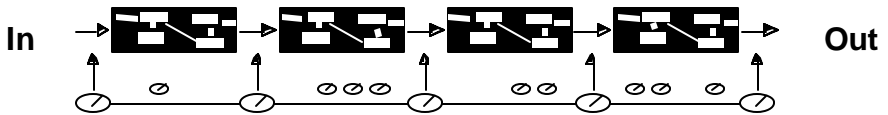
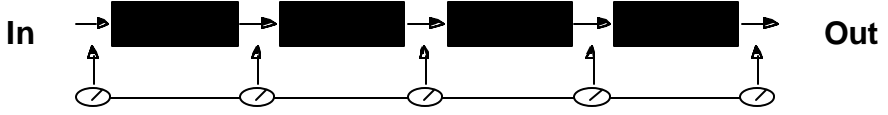

Level 4 – Quantitative Process Management,
Software Quality management

Level 3 – Organization Process Focus, Organization Process Definition,
Training Program, Integrated Software Management, Software
Product Engineering, Intergroup Coordination, Peer Reviews

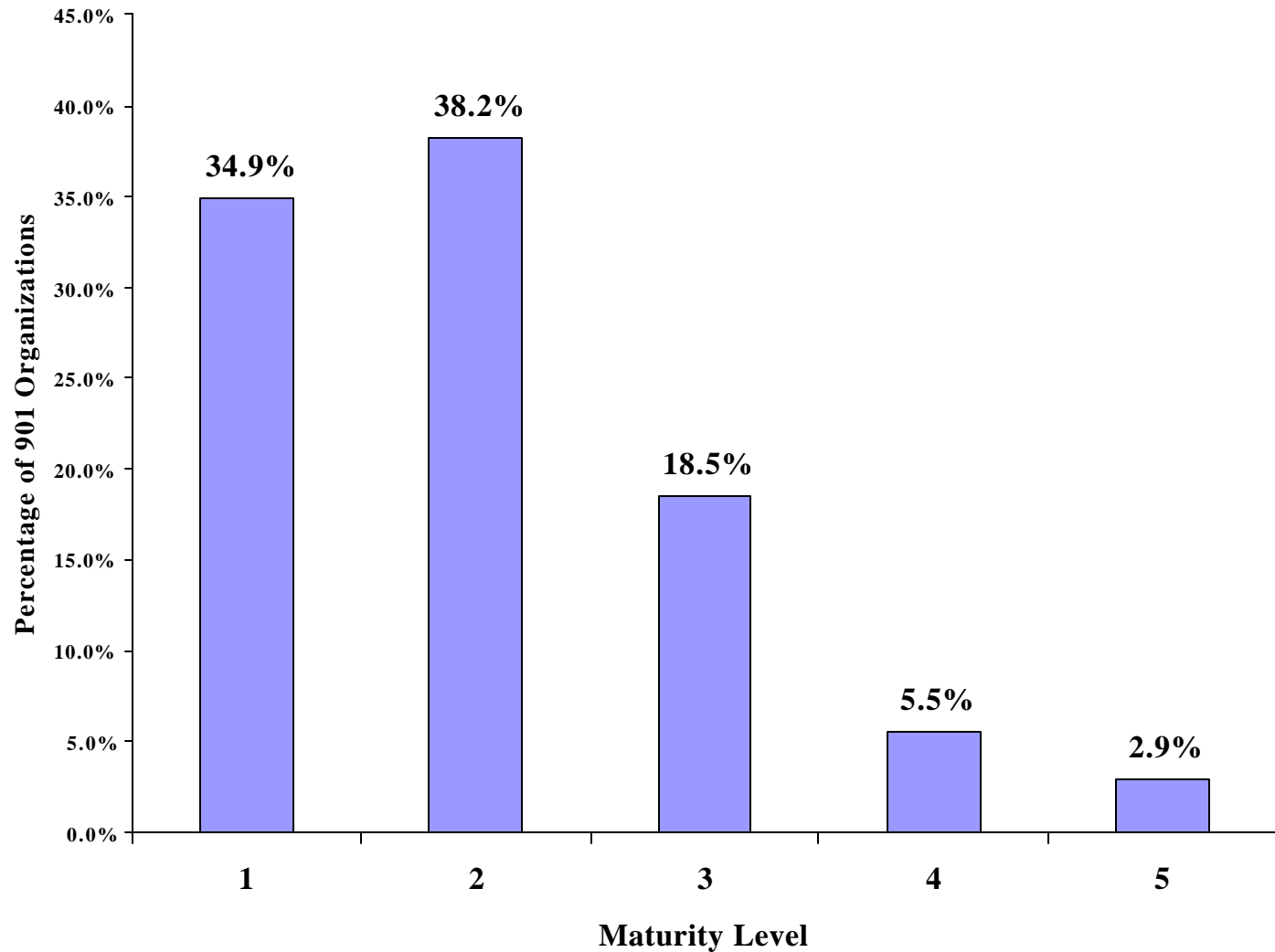
Level 2 – Requirements Management, Software Project Planning,
Software Project Tracking and Oversight, Software Subcontract
Management, Software Quality Assurance, Software Configuration
Management

Metrics by Level

Managing Software Risks with World-Class Customers

Level	Metrics	Management Visibility
5 Optimizing	Continuous Improvement	
4 Managed	Organizational, task level (implies a common set of tasks)	
3 Defined	Organizational, sub-phase level (implies a common set of sub-phase activities)	
2 Repeatable	Simple, phase oriented, determined, collected, and used by the project	
1 Initial	Undetermined	

SEI Assessment Maturity Profile



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Data from 1996 - June 2000

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33 Organizations with Self Published Maturity Levels of 4

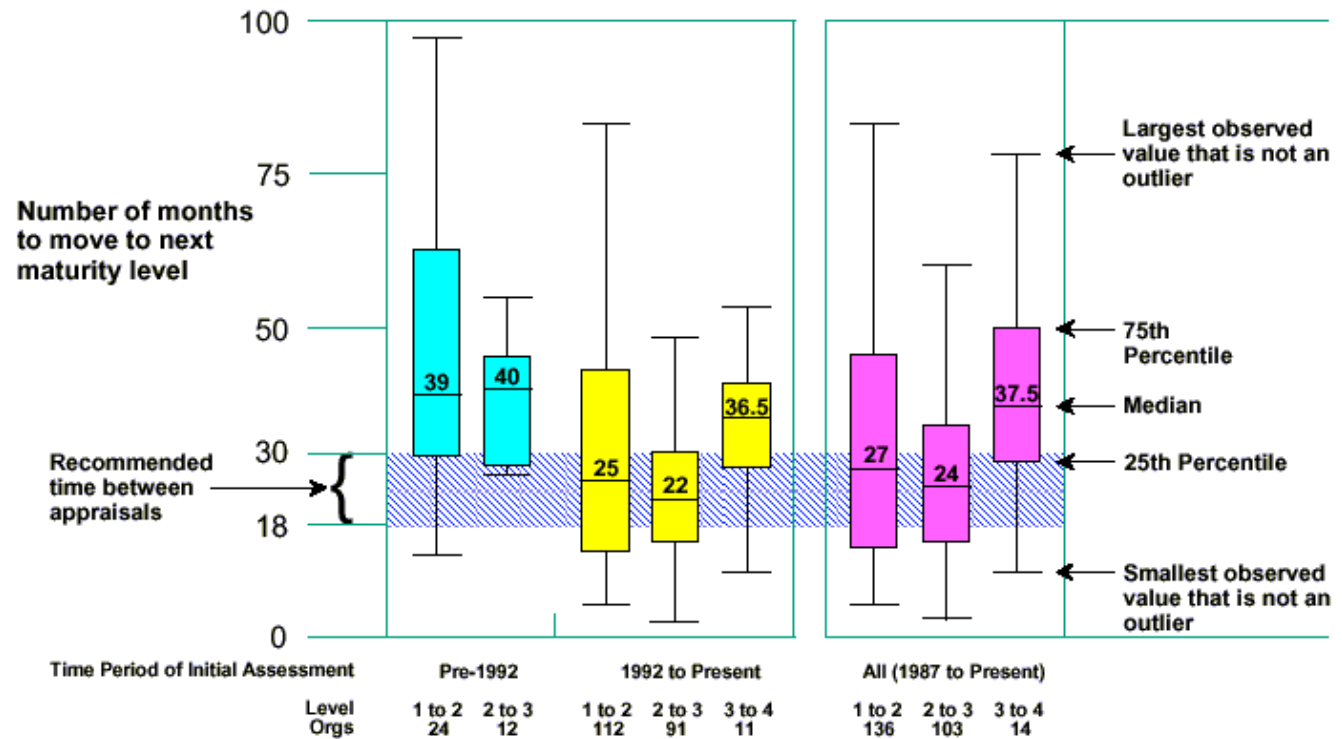
- Loral Federal Systems, CITIL (Citicorp Information Technology Industries Limited), Oklahoma City Air Logistics Center Directorate of Aircraft Managment Software Division Test Software and Industrial Plant Equipment Branches, Honeywell India Software Operation, Wipro Infotech Group Global R&D Division, Citibank Citicorp Overseas Software Ltd. Division, Telos Corp. Software Engineering Center Fire Support Lawton Ok, Lockheed Martin Federal Systems Gaithersburg, Lockheed Martin Ocean Radar & Sensor Systems, Infosys Technologies Limited, Computer Sciences Corporation's Integrated Systems Division, DSQ, Litton Guidance & Control Systems, Cognizant Technology Solutions, Tata Consulting Services (TCS) India SEEPZ Division, BFL Software Limited, Tata Elxsi Limited, HCL Perot Systems A-10/11 Sector 3 Noida India, Mastek Limited Mumbai, Hexaware InfoSystems Limited Mumbai & Chennai Centers, Northrop Grumman ESSS Baltimore Operations , Origin Information Technology India Ltd., Lockheed Martin Naval Electronics & Surveillance Systems Moorestown, Lockheed Martin Air Traffic Management, Lockheed Martin Management & Data Systems King of Prussia PA, Lockheed Martin Aeronautics Company Fort Worth, Hughes Software Systems Limited New Delhi and Bangalore Centers, Northrop Grumman Integrated Systems and Aerostructures, Silverline Technologies Limited Mumbai India and Chennai India, TCS-Ahmedabad Branch, Tata Interactive Systems Division of Tata Industries Ltd. Mumbai India, Lockheed Martin Information Systems, Siemens Information Systems Limited (SISL) Software Development

Source: www.sei.cmu.edu/sema/pub_ml.html



Carnegie Mellon University
Software Engineering Institute

Time to Move Up



24

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Process Maturity Profile of the Software Community 2000 Update - SEI/MA 8.00

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Maturity Levels Are Cultural Norms

- Maturity level are described in the model by Key Process Areas containing Goals and Key Practices, however the critical attributes of organizations that have achieved a specific maturity level are a set of “Cultural Norms” that are firmly established – it’s the way we do things here, even if we think no one will know
- The purpose of Key Process Areas and Key Practices is to guide an organization toward these Cultural Norms – which is also called institutionalizing the process



Level 2 – Repeatable Culture

- Level 2 is focused on Managing Software Projects
- Its core Key Process Area is Software Project Planning
- Planning and tracking are core competencies of level 2 organizations



Level 3 – Defined Culture

- Level 3 is focused on Organization wide process definition and management
- Its core Key Process Area is Organization Process Definition
- All Projects use a (possibly tailored) version of the Organization's Standard Software Process



Level 4 – Managed Culture

- Level 4 is focused on Quantitative Management
- Its core Key Process Area is Quantitative Process Management
- There is a strong knowledge of statistics and quantitative management techniques throughout a level 4 organization
- Note: Level 2 and Level 3 organizations measure (even most Level 1 organizations measure some things)



Level 4 Key Process Areas

- Quantitative Process Management
- Software Quality Management



Quantitative Process Management

- The process performance of each project's defined software process is controlled quantitatively
- Statistical Process Control is used on some process measures
 - other measures may use level 3 methods (thresholds) or level 2 methods (significant deviations)
- The process capability of the organization's standard process is known in quantitative terms
- Quantitative and statistical techniques are widely known and used where appropriate



Quantitative Process Management - 2

- For each software project, the specific measurement data to be collected, the intended use and analysis of each measurement, and the process points at which they will be collected, are all precisely defined (AC 4.2)
- Each software project's defined process measurement data is collected and analyzed (AC 5.2)
- Acceptable limits for each project's measurements are defined (AC 5.5)
- Adjustments are made to bring the actual process performance in line with each project's defined acceptable limits (AC5.7)



Quantitative Process Management - 3

- Reports documenting the results of software projects' quantitative process management activities prepared and distributed to project staff, management and the software quality assurance group, in accordance with their needs (AC6)
- Each project's quantitative process management activities performed in accordance with a documented plan (AC 2)
- The process performance baseline for each project is integrated as appropriate into the process capability baseline of the organization's standard software process? (AC 7.2)

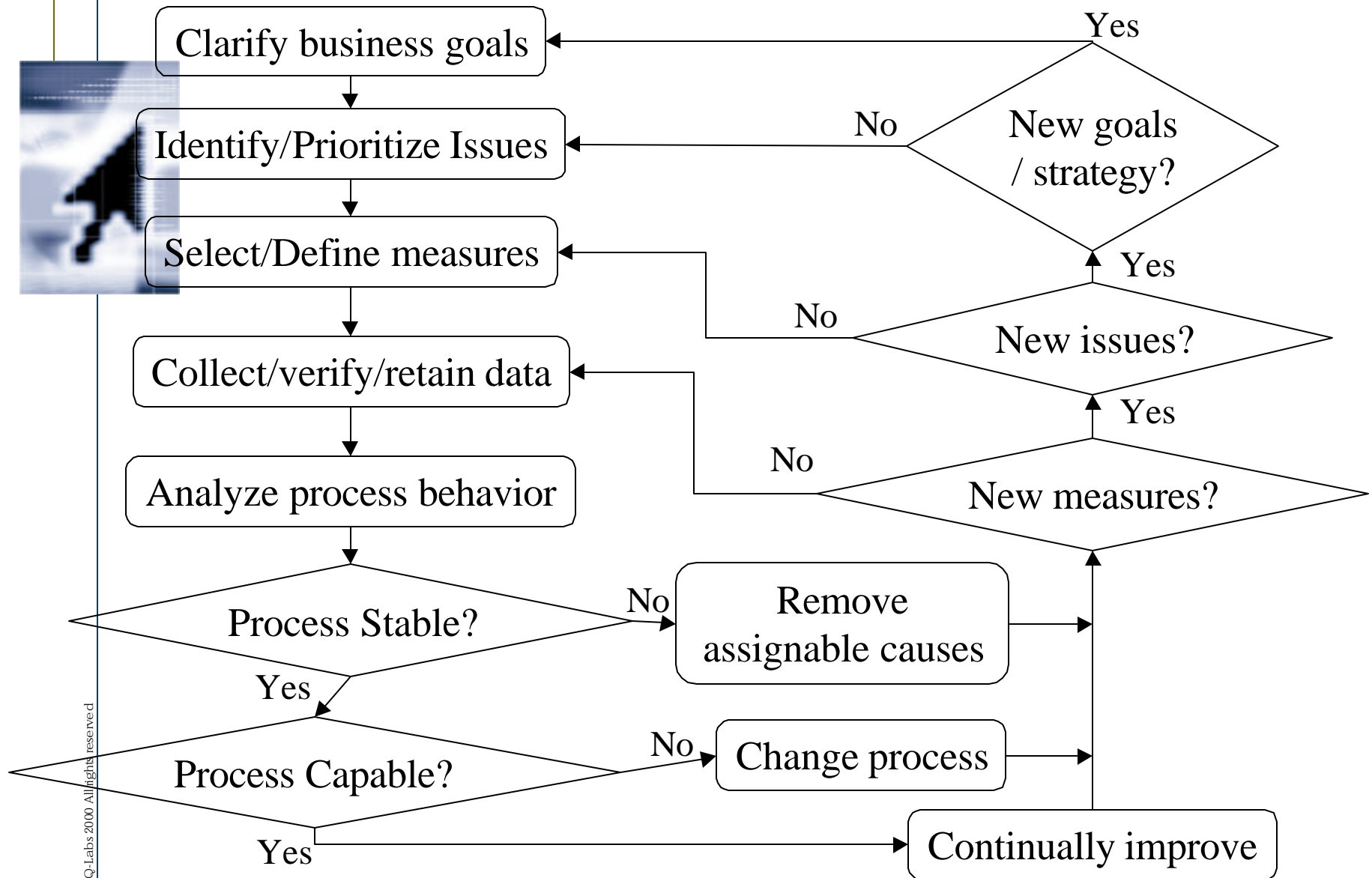


Quantitative Process Management - 4

- The process capability of the organization's standard software process is documented quantitatively (AC 7.3)
- Process capability trends in the organization's standard software process are examined to predict likely problems and identify opportunities for improvement (AC 7.4)
- Changes to the organization's standard software process are tracked and analyzed to assess their effects on the organization's process capability baseline (AC 7.7)

SPC Framework

Managing Software Risks with World-Class Customers



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Clarify Business Goals

- Quantitative methods are a powerful technique for changing the behaviour of an organization
- How do you know that the changes your process improvement encourages will be desirable in your marketplace?
- This is the reason for the initial focus on business goals - without a business justified set of objectives for improvement, the default objectives of the improvement model or consultants may drive your “improvement” program



Clarify Business Goals - 2

- The business goals serve to explain to the organization why the improvement program is being implemented
- They focus subsequent development of specific issues to be tracked and measures to be collected
- They must be communicated to the whole organization - to serve as a constant check for implementation problems

Potential Business Goals



- Reduce defects shipped to customers
- Deliver products on the committed dates
- Reduce the cost of building software
- Increase the productivity of software staff
- Bring products to market faster
- Lower customer support costs
- Competitive pressures
- Customer required it
- Improve customer satisfaction scores
- Improve product reviews



Software Quality Management

- Measurable goals for software product quality are defined
 - often defect based
 - other “ilities” may be important too
- Progress toward achieving the quality goals is quantified and managed
 - projects take corrective actions when quality goals are not being met
- There is a quality plan documenting quality needs of the customer, end users, and organization



Software Quality Management - 2

- For each software project, the activities to measure and manage software product quality are planned (AC1)
- The characteristics of each software product's quality (for example, functionality, reliability, usability, maintainability, performance) are identified (AC3.1)
- Measurements used to quantify the characteristics of each software product's quality are identified (AC3.2)
- For each project's identified product quality measurements, measurable numeric values are selected as quality goals (AC3.3)



Software Quality Management - 3

- The capability of each software project's defined process to satisfy the software quality goals is assessed and documented (AC1.3)
- For each software project, appropriate corrective actions are taken when actual measured quality is below project quality goals (AC4.4)
- Project's defined software processes are adjusted when appropriate to meet software quality goals (AC 4.1 & 4.4)
- Software projects in your organization routinely meet their quantitative quality goals (Co1)

Risks, Barriers and Lessons Learned - 1



- Institutionalization
 - Level 2 & 3 KPAs must be stabilized
 - You need enough time/data for valid trends
 - Nonalignment of measurements to business goals
 - The measurements may be interesting, but do they really impact the business positively?
 - Process for process sake is a sure-fire way to false starts
- Recognition that this is another cultural change - a paradigm shift
 - Identify champions to lead, give them support and resources to succeed
 - Target efforts where initial payoff likelihood is high
 - Pilot efforts, trumpet successes and train on lessons learned
 - Some people will struggle - help them along - training is STILL critical!

Risks, Barriers and Lessons Learned - 2



- Common mistakes:
 - Lots of metrics, little analysis
 - Metrics for metrics sake (what is important to the business?!)
 - Tool-centric approach
 - Lost balance between project and organizational goals (good tailoring will help overcome this)
 - Making decisions based on bad data
 - Using data incorrectly (e.g. to penalize personnel or projects)
 - Measuring what you can - not what makes sense
- Make individual changes to processes, followed by analysis of this changes impact.



How do you recognize Level 4?

- **Verify Levels 2 & 3 first!**
- **Look for predictability and control of products and processes**
- **Study the measurement database and review the graphs**
- **Look for widespread understanding of measurement and statistical techniques (Institutionalization!)**
- **Verify the absence of “write-only” data**
- **Verify that data integrity and appropriate use criteria has been established and followed**
- **Listen for management and staff to raise questions that: look forward, pose what ifs, are systemically-oriented**



So Why is Level 4 So Hard?

- Another culture change
- Widespread understanding of quantitative management and statistics is needed
- The CMM doesn't explain it very well
- Limited published examples
- Weaknesses in level 2 and 3 implementations will cause problems
- Confusion on how to assess



Seek Professional Help

- When managing based on statistical techniques (especially when using control charts) there are many factors to consider in choosing the correct techniques to apply (e.g. what type of control chart would be most applicable, is this variables or attributes data, etc.)
- These factors can most correctly and efficiently be addressed by professional statisticians
- Of course a statistician may not know anything about your business or processes – so a collaborative effort is required



SPC For Software Reference

- There are many good texts on statistics and statistical process control
- Unfortunately most of them have nothing to do with software
- The new book by William Florac and Anita Carleton, “Measuring the Software Process – Statistical Process Control for Software Process Improvement” is an excellent, software specific reference
- The SPC Framework discussion in this presentation is based on this book



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