Performance Measurement in CMMI: A Focus on Variation Among Otherwise Similar Programs

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Today’s Talk

Setting the stage

Our approach & Some Example results

How can you help?

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The talk in a nutshell

A two-fold problem:

- Need for credible evidence of CMMI effect
- Need for better measurement & analysis in our field

A solution ... that addresses both

- Analyze variation & covariation properly
- With a focus on modeling cause & effect statistically
- & with data initially from high maturity organizations

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Why is this Work Important?

Substantial evidence exists

- CMMI-based process improvement can & has led to concomitant improvement in performance outcomes
- Predictably faster, better, cheaper product development & maintenance

Skepticism exists about the value of disciplined adherence to well defined processes ... & CMMI in particular

- As opposed to solutions *de jour*
- That are ***not*** necessarily at odds with processes that satisfy the goals of CMMI best practices – e.g., Agile or Six Sigma methods

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Current State

Case studies

- With quantitative evidence of process improvement & concomitant performance gains
- Typically showing total results over time ... often rolled up over multiple projects

Often accompanied by qualitative affirmations

- Based on experience of those doing the work
- That process improvement is the major source of change

But little explicit discussion of competing explanations

- Whether or how they were considered
- Leading to accusations of spurious correlation

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What's Missing?

Generalizable comparative analyses are needed

- On performance outcomes of ***differences*** in process enactment
- Under ***varying*** organizational circumstances & product characteristics
  - ***that may affect variation in both successful process enactment & performance outcomes***

With more attention to:

- Issues of data integrity & validity of comparisons across organizational units
- Choice of appropriate multivariate statistical techniques
  - To instantiate process performance models
  - Looking at common cause of process effects mediated by project context

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Understanding Variation & Causal Thinking

There almost ***always*** is variation

- In product quality, project & organizational performance
- How processes are enacted
  - The existence of defined processes
  - Adherence/compliance with them
  - & how well the processes are enacted ... the “goodness” issue
- & the other factors that may effect both process & performance outcomes

Looking only at total results

- May mask important differences at the project level ... where most of the development work actually takes place

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Overview

Work with larger enterprises

- Comprised of multiple projects, contractual programs, & other constituent organizational units
- That already have &/or are evolving common measures of performance
- Along with complimentary measures of process enactment, organizational & product attributes

An important way to provide:

- More generalizable, comparative analyses explaining variation
- In both successful process enactment & the performance outcomes that the processes are meant to achieve

Especially important *in lieu* of shared measures that enable wider state of the practice & benchmarking analyses

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Analyzing Covariation

Analyses of joint distributions among two or more variables can be very helpful

- Better insight into reasons for anomalies& inconsistencies in process enactment and performance outcomes
- More informed conjectures about opportunities for improvement
- Enhancing root cause analysis ... benchmarking if you will, e.g.,
  - BAE Minneapolis examines details of inspection process enactment, e.g., code size per review, team skill makeup, frequency of inspections
  - Proactively before refining process definitions as well as to monitor compliance with existing processes
  - Similar monitoring at Motorola Software Group (MSG)

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Work with Motorola Software Group

MSG performance & project context data definitions are well defined.

- However, process capability needs to be measured more consistently & analyzed more explicitly

Process compliance/adherence ***is*** measured & monitored at MSG.

- Used regularly in quantitative project management & causal analysis
- & used regularly in piloting & deploying new processes & technologies

However, ***covariation*** with performance & other factors could be analyzed more proactively in explicit process performance models.

- Shared “how-to" process measures are crucial for using benchmarks to identify promising benchmarking opportunities
- Data as tightly coupled as possible to CMMI-based "what" process measures also important for internal Motorola purposes

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Cost of Quality at Motorola Software Group (MSG)

Cost of Quality (COQ) at MSG includes effort spent on...

- Review / Inspection
- Test development & execution
- Quality auditing, training, other process Improvement & problem prevention

Cost of Poor Quality (COPQ) includes...

- Rework & related failure correction throughout the life cycle

Both expressed as percentages of overall effort spent for product development

Results presented here examine ***test development & execution***

- Proactive drill-downs
- Initial results from 2002 ... N = 46 projects

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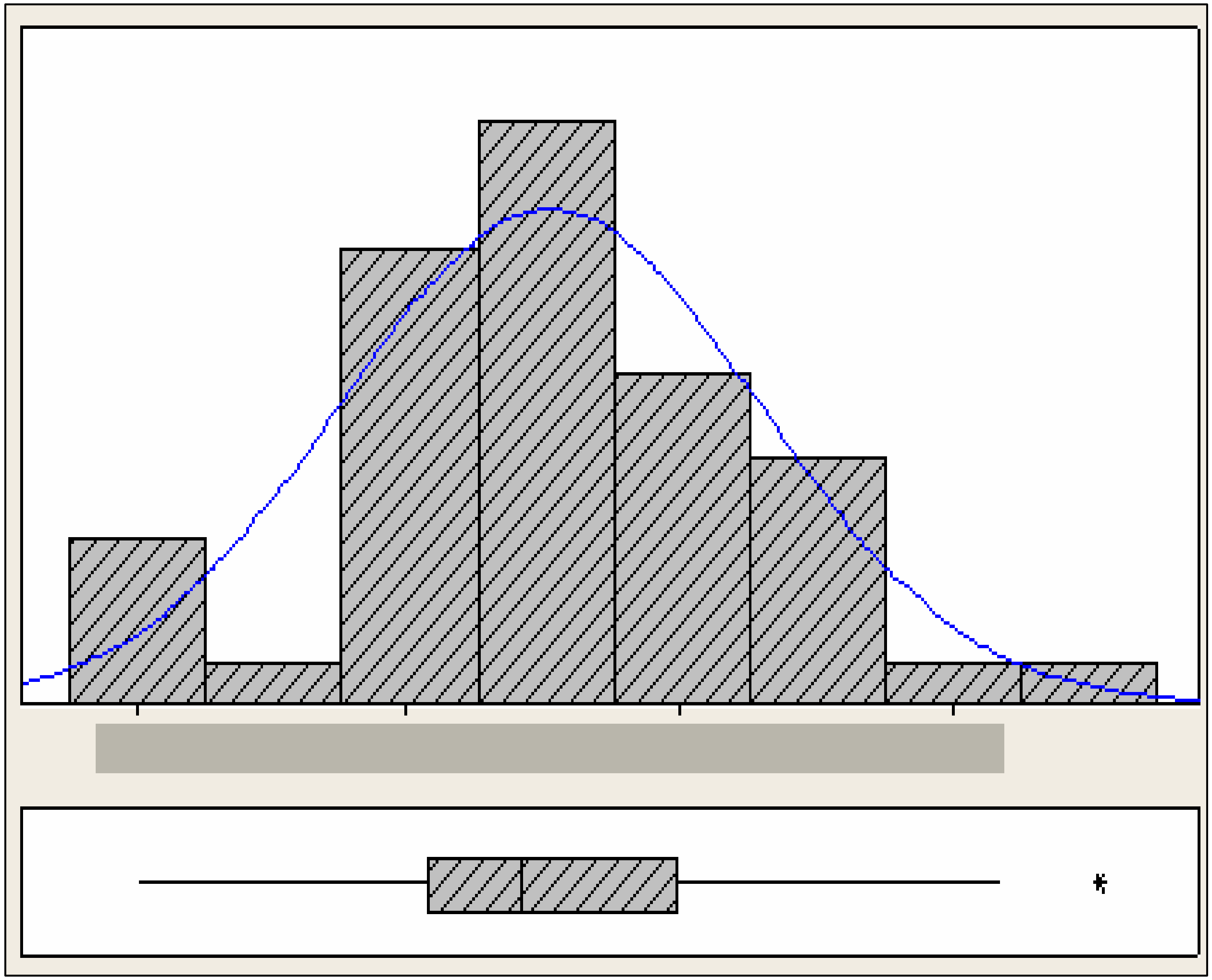
Variation in Cost of Quality for Test Appraisal

Results from MSG China Center

- N = 46
- Actual values of data distribution (not shown here) are quite good by our sense of "industry standards"
- Still, there are variations that MSG wishes to reduce further
- **A critical factor for COQ reduction**



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Differences by Domain

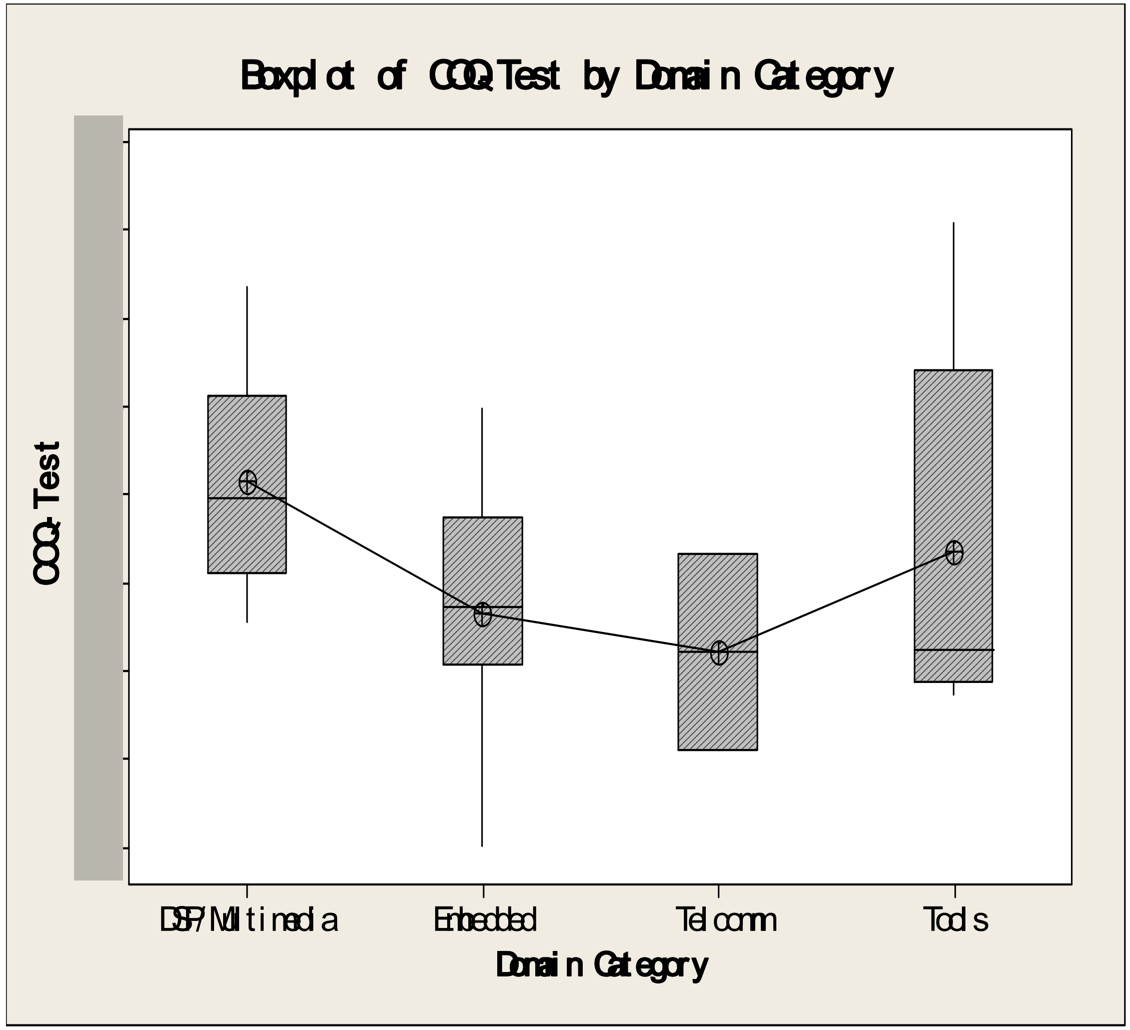
DSP/Multimedia projects have higher COQ-test

- Most Assembly projects fall here
- Some porting & optimization-oriented development projects, with high performance requirements
- & some product-oriented projects

Embedded vary more

Ns:

- 10 DSP Multimedia
- 29 Embedded
- 2 Telecom; 5 Tools



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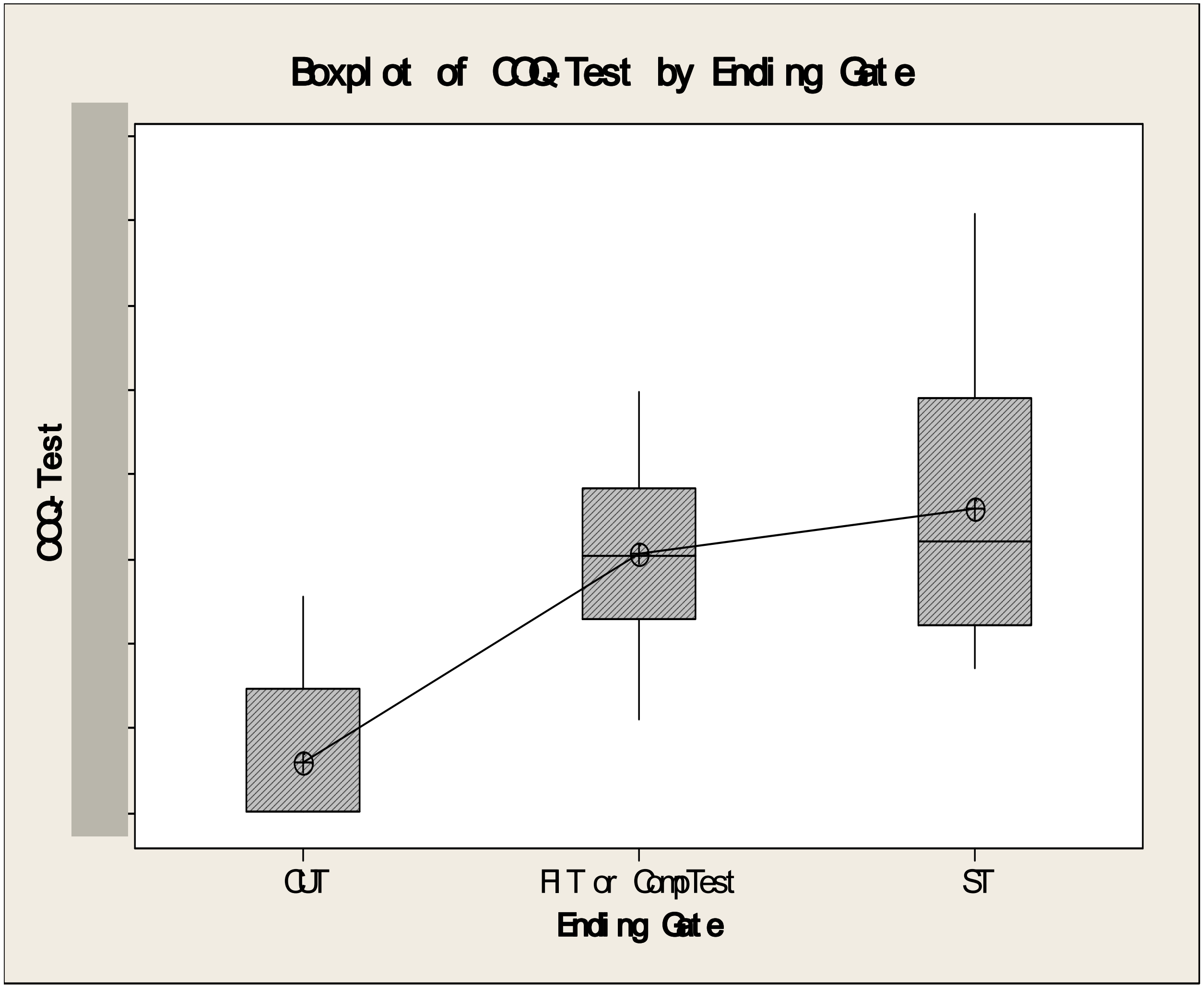
Differences by Motorola "End Gates"

Projects ending at System Test often have higher COQ-Test

Ns:

- 5 Code & Unit Test (CUT)
- 20 Component Test & Feature Integration Test (FIT)
- 21 System Test (ST)



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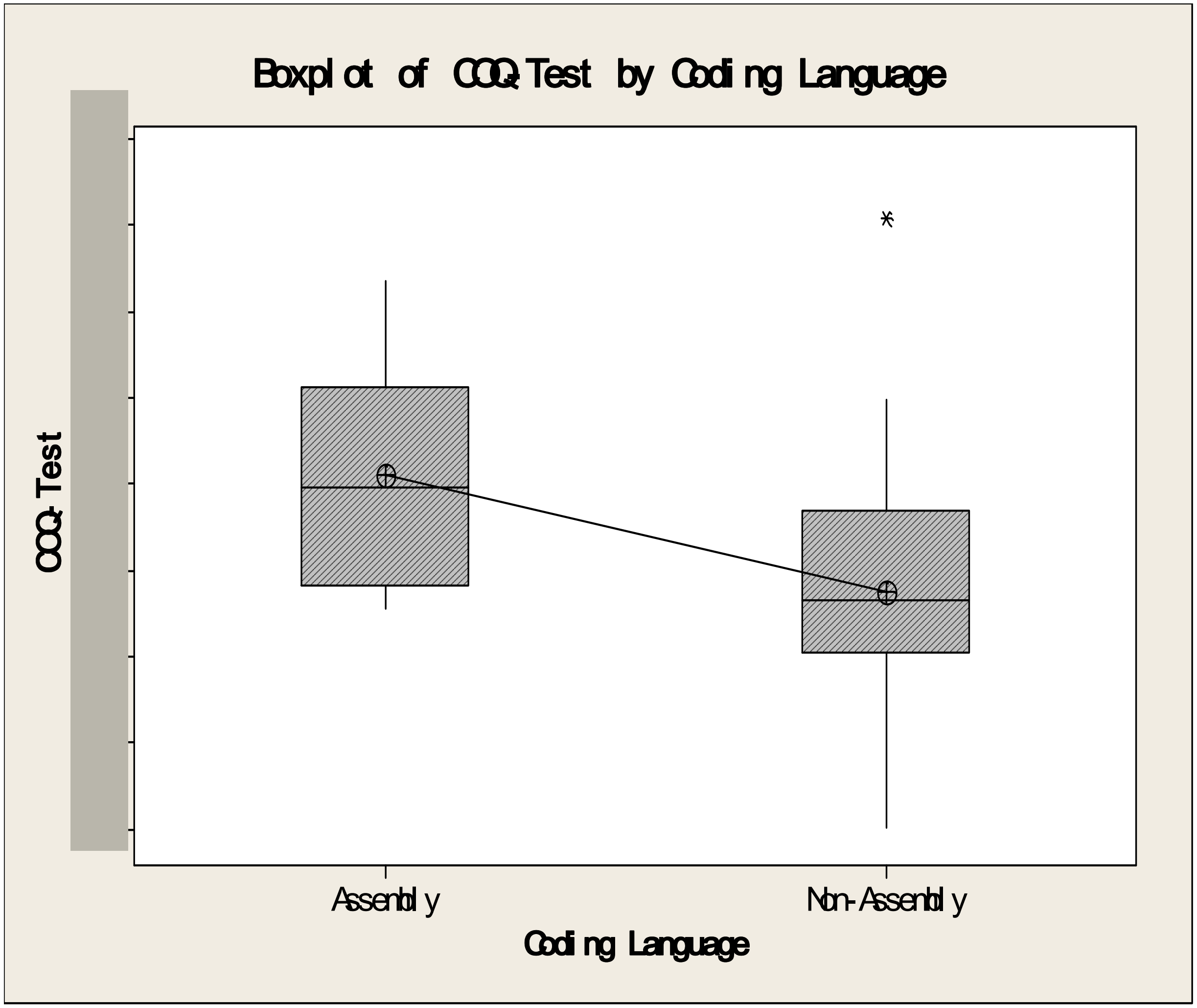
Differences by Coding Language

Major effects on test effort & COQ-Test

- Projects coded in assembly significantly more costly to test

Ns:

- 10 Assembly
- 26 Non assembly



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Explaining the Variation

Factors that vary jointly with COQ-test – Adjusted $R^2 = .67; p < .0001$

- Motorola end gates (Code & unit test; feature & component test; or system test)
- Delta Code Size in KLOC
- Domain (Multimedia, embedded, tools & telecom)
- Coding language (assembly versus non-assembly)
- Base Code size in thousand assembly-equivalent lines of code (KAELOC)

Other factors examined – weak relationships, not significant

- Project Lifecycle (full or partial)
- In Process Faults (IPF) ... Post Release Defects (PRD)
- COQ for review/inspection ... Total Document Size (pages)

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Some Actions Taken

1. Encourage test automation
   - Especially for product-oriented projects
2. Develop organizational integration & system test guidelines
   - To reduce test development effort
3. Encourage project test case reuse & automation
   - Especially for long term projects
4. Enhance analysis of escaped defects
   - Develop causal analysis guidelines
   - Introduce causal analysis methods such as ODC
5. Optimize regression test strategy
   - Introduce fault prediction tool
6. Better sharing of practices & lessons learned among projects.

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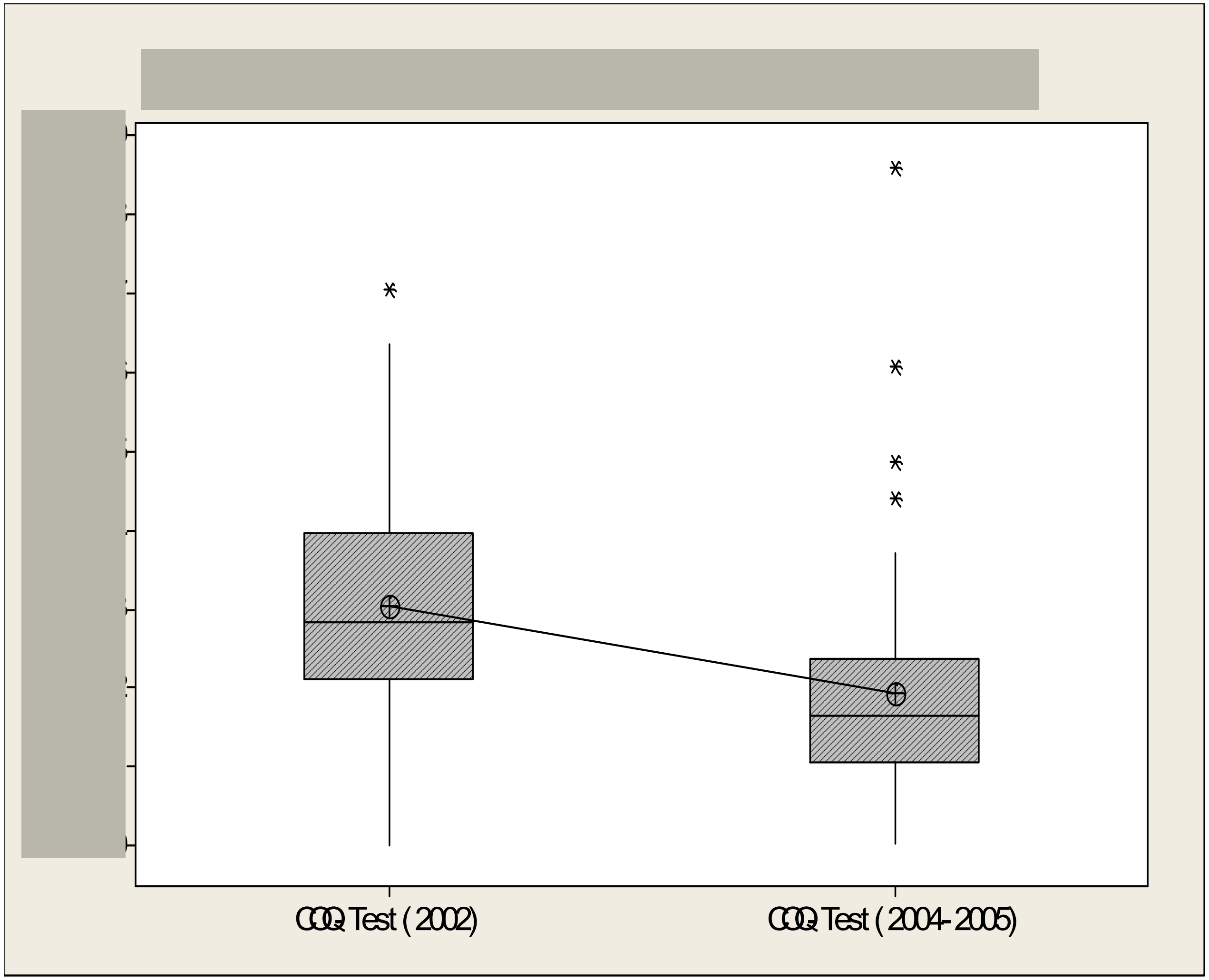
Effects of Process Change

Improvement actions reduced COQ-test cost

Ns:

- 56 in 2002
- 75 in 2004-2005
- P = .002



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Other Standard MSG Performance Measures

Phase Containment Effectiveness

- The proportion of faults that are found at the first check point after they were introduced
- Updated incrementally by phase to monitor & control pertinent processes

In-Process Faults

- Number of faults found before completion of the project’s final phase prior to release Customer Satisfaction

First Estimation Accuracy

Cycle Time Reduction Rate

Post-Release Defect Rate

Customer Satisfaction

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Participate in Our Work & Contribute Your Own

We are always on the lookout for serious collaborators for:

- Enterprise Wide Performance Benchmarking studies
- The other work described today
- Any other ideas you may wish to pursue

Share your experiences with us & the wider systems & software community

- Submit a brief article for *DACS Software Tech News*
  - Next issue ~September 2007
  - Quantitative case studies welcome ... comparisons of variations among projects/programs preferred
- Also plan to edit an issue (perhaps issues) of *Software Process Improvement and Practice*

Please see me here in Golden about these & other opportunities

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The Value Proposition

What's in it for our collaborators?

- Additional insight into their performance & its drivers
- Continuous improvement of their measurement processes
- Improvement of their internal benchmarking capabilities

What's in it for us?

- Better understanding & evidence regarding the effects of process improvement on project performance
- An enhanced ability to provide useful results for the larger software & systems engineering communities
- Learning through collaborative work with capable organizations & individuals who are not us

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Thank You for Your Attention!

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