You must be at least this tall to ride: How standards help improve your organization's software quality

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MITRE is a not-for-profit organization that operates research and development centers sponsored by the federal government.

We operate FFRDCs—federally funded research and development centers—which are unique organizations that assist the United States government with:

- Scientific research and analysis
- Development and acquisition
- Systems engineering and integration

We also have an independent research program that explores new and expanded uses of technologies to solve our sponsors' problems.

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Moreover, because we operate multiple FFRDCs, we foster a culture of knowledge sharing. We apply what we learn from addressing one sponsor's challenges to similar issues faced by other federal agencies. This means when sponsors engage with us, they have access to all the minds of MITRE.
I work directly with the OSD Software Assurance Community of Practice and the DHS Software and Supply Chain Assurance Community of Practice

I run MITRE’s Software Quality Assurance Evaluation Teams
– We’ve evaluated over 230 Million Lines of Code
– Unclassified through TS SCI
– Covered 120+ Languages
– Are a Subject Matter Expert (SME) in-the-loop evaluation team for both the Source Code and the Documentation
– We use multiple COTS static, and dynamic, code analyzers as reference input to the SMEs
– We highlight the Good in the Code/Documentation equally with highlighting areas that require improvement – All non-trivial software can be improved
We hold these truths to be self-evident*

Where is your data on that?

* Declaration of Independence
What do you say after 100+ evaluations?
After 84 MSLOC?
In over a dozen languages?

Whew!

More Data Please
What Does 100+ evaluations tell us?
Corpus divided into 4 quartiles

Standard Deviation curves based on Maintainability and Reliability of the corpus

HC SVNT

DRACONES

Here are Dragons

Quality is too high, Focus on Functionality

The Goldilocks Zone, Good balance of Quality and Functionality

The Pink Zone where Quality needs minor improvement

The Blue Zone where Quality needs significant improvement

Each colored quartile is calculated from 108 Government applications scanned under similar conditions.

Dot size is proportional to Technical Debt.

Code Wash Light  Code Wash  SOAE

Low <-------------- Confidence Level ------------> High

Software Quality Assurance Evaluation

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Out of Recorded Scores
Minimum Quartile – Quality Needs Major Improvement
Lower Quartile – Quality Needs Minor Improvement
Goldilocks Zone
Quality is Good – Goldilocks Zone
Quality is Too High – Focus on Functionality

Connects separate scores for the same source code base.
The Data comprising the Corpus
Maintainability

- Complexity: 23%
- Architecture: 11%
- Programming Practices: 22%
- Naming Conventions: 11%
- Documentation: 22%
- Size: 11%
CISQ Conforms/Supplements ISO 25000 standards

- ISO/IEC 25010 defines a software product quality model of 8 quality characteristics
- CISQ conforms to ISO/IEC 25010 quality characteristic definitions
- ISO/IEC 25023 defines measures, but not automatable or at the source code level
- CISQ supplements ISO/IEC 25023 with automatable source code level measures

ISO/IEC 25010 — Software Product Quality

CISQ automated structural quality measures are highlighted in blue

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True or False?

- 79% of the software vulnerabilities that exist in the wild start off as quality issues in the code during the development phase of the Software Development Life Cycle.

- It costs $1 to fix a bug in the Development Phase, $100 to fix it in the Test Phase, and $1,000 to fix it in the field.

- The dependent libraries I use can be vulnerable even if I do not use the vulnerable functions.
True or False?

- As Code Size (Software Lines of Code : SLOC) increases the software becomes harder to maintain.
- As Maintainability increases (becomes easier to maintain) Reliability increases (becomes more reliable).
- As Maintainability and Reliability increase so does Scalability.
- Scanning source code does not improve the quality of the source code.
- 80% of the cost of a project over its entire lifecycle is expended in the Maintenance Phase.
True or False?

- Agile Development Methodology is better than Waterfall
- Java is the best language to use for DoD programs.
- Technical Debt is just bad
The Envelope Please?
79% of the software vulnerabilities . . .

79% of the software vulnerabilities that exist in the wild start off as quality issues in the code during the development phase of the Software Development Life Cycle.

True, so far...

- A review of 350 CWEs identified the root cause of 276 CWEs was a quality issue in the code that should have been contained in the Development Phase of the SDLC
- There are over 1000 CWEs
- Our data has not been fully analyzed, yet (we are at 35%)
- DAU claims 84% . . . I have not seen where they get this number from
Security Feature

XSS
(CWE-79)
Exploit
(CAPEC-86)

SQL Injection
(CWE-89)
Exploit
(CAPEC-66)
It costs $1 to fix a bug . . .

It costs $1 to fix a bug in the Development Phase, $100 to fix it in the Test Phase, and $1,000 to fix it in the field.

Actually, according to Caper’s Jones*

- Typical data for cost per defect varies from study to study but resembles the following pattern circa 2013:
  - Defects found during requirements = $250
  - Defects found during design = $500
  - Defects found during coding and testing = $1,250
  - Defects found after release = $5,000

- While such claims are often true mathematically, there are three hidden problems with cost per defect that are usually not discussed in the software literature:
  1. Cost per defect penalizes quality and is always cheapest where the greatest numbers of bugs are found.
  2. Because more bugs are found at the beginning of development than at the end, the increase in cost per defect is artificial. Actual time and motion studies of defect repairs show little variance from end to end.
  3. Even if calculated correctly, cost per defect does not measure the true economic value of improved software quality. Over and above the costs of finding and fixing bugs, high quality leads to shorter development schedules and overall reductions in development costs. These savings are not included in cost per defect calculations, so the metric understates the true value of quality by several hundred percent.

- The cost per defect metric has such serious shortcomings for economic studies of software quality that a case might be made for considering this metric to be a form of professional malpractice for economic analysis of software quality

The dependent libraries I use can be vulnerable even if I do not use the vulnerable functions.

True, BUT . . . Do you really want to accept that risk?

- If there is executable code in your deliverable, it can be executed even if you do not call that function
SLOC vs Maintainability

As Code Size (Software Lines of Code : SLOC) increases the software becomes harder to maintain

- True
SLOC vs Maintainability

Correlation Coefficient = -0.1104

# Data Points = 82

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Java SLOC vs Reliability

Java is the best language to use for DoD programs

- False
SLOC Java vs Reliability

Correlation Coefficient = -0.2178

SLOC Java

Exponential Trend Line

Polynomial, order 2, Trend Line

Reliability

# Data Points = 38

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Java SLOC vs Maintainability

Java is the best language to use for DoD programs

- False
WHY does the Maintainability go up when Java SLOC goes up?
Why Maintainability Increases as Java SLOC increases

1. There are only 38 samples in the corpus. But that should be statistically significant

2. You must look at the Java code to better understand this abnormal trend

3. Looking at the Java code, within the DoD, we see that most of the Java code is used to tie together various libraries and frameworks

4. We have gotten very good at writing Glue-Code in Java

5. Consider that Java Libraries are chock full of knowns vulnerabilities, well....
We Need More Data!

- I have asked CAST Software if they will share with me their database of Java code scanned within the DoD to add additional data points to this graph to see if it settles into an expected indicator that as SLOC increases that Maintainability decreases.
Maintainability vs Reliability

As Maintainability increases (becomes easier to maintain)
Reliability increases (becomes more reliable)

- True
Maintainability + Reliability vs Scalability

As Maintainability and Reliability increase so does Scalability

- Unknown
- Why?
  - What is the industry accepted definition of Scalability in software?
Scanning vs Quality

Scanning source code improves the quality of the source code

- False

Yes, it is a trick question
80% of the cost of a project over its entire lifecycle is expended in the Maintenance Phase

- True
Technical Debt is Just Bad

- No argument here
Technical Debt vs Reliability

Correlation Coefficient = -0.6007

Exponential Trend Line

# Data Points = 82

Polynomial, order 2, Trend Line
Agile vs the CVE Count

Wait!

While Agile started then, it has nothing to do with the number of vulnerabilities discovered AND fixed!

We can say that during the reign of Agile we found and fixed more vulnerabilities, but that had nothing to do with Agile …

During the reign of Agile the Vulnerability rate significantly increased!
What is Next?

- Collect more data

- Publish a paper on the data we have and again when we have more data
Questions?