Updating the Quality Profile

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Topics

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BACKGROUND

Quality Journey

Watts Humphrey defined the quality journey as follows

1. **Test and fix.**
2. **Inspect.**
3. **Partial measurement.**
4. **Quality ownership.**
5. **Personal measurement.**
6. **Design.**
7. **Defect prevention.**
8. **User-based measurement.**

- The challenge is to get teams past step 1, to step 4 and beyond. For this, we need measures the team can use.

The Quality Plan

	Time			Defects Injected			Defects Removed		
	Plan	Actual	Actual %	Plan	Actual	Actual %	Plan	Actual	Actual %
Planning	16:32	8:09	2.47%	0	0	0%	0	0	0%
Research and Investigation	0:00	0:00	0%	0	0	0%	0	0	0%
Requirements	41:34	10:45	3.25%	10.4	2	3%	0	0	0%
Detailed Design	57:44	26:24	7.99%	28.9	16	25%	0	0	0%
Detailed Design Review	7:00	3:47	1.15%	0	0	0%	19.6	7	11%
Detailed Design Inspection	9:52	7:07	2.15%	0	0	0%	9.81	2	3%
Code	201:34	66:49	20.20%	202	39	62%	0	3	5%
Code Review	42:06	9:16	2.81%	0	0	0%	148	22	35%
Static Analysis	0:00	0:00	0%	0	0	0%	31.7	0	0%
Unit Test	103:30	70:29	21.30%	0	1	2%	25.4	21	33%
Refactoring	0:00	0:00	0%	0	0	0%	0	0	0%
Code Inspection	33:17	23:21	7.07%	0	0	0%	3.17	4	6%
Integration Test	179:14	45:17	13.70%	0	5	8%	1.5	4	6%
System Test	111:00	0:00	0%	0	0	0%	0	0	0%
Retrospective	20:19	2:09	0.65%	0	0	0%	0	0	0%
Total	823:42	273:33		241	63		239	63	

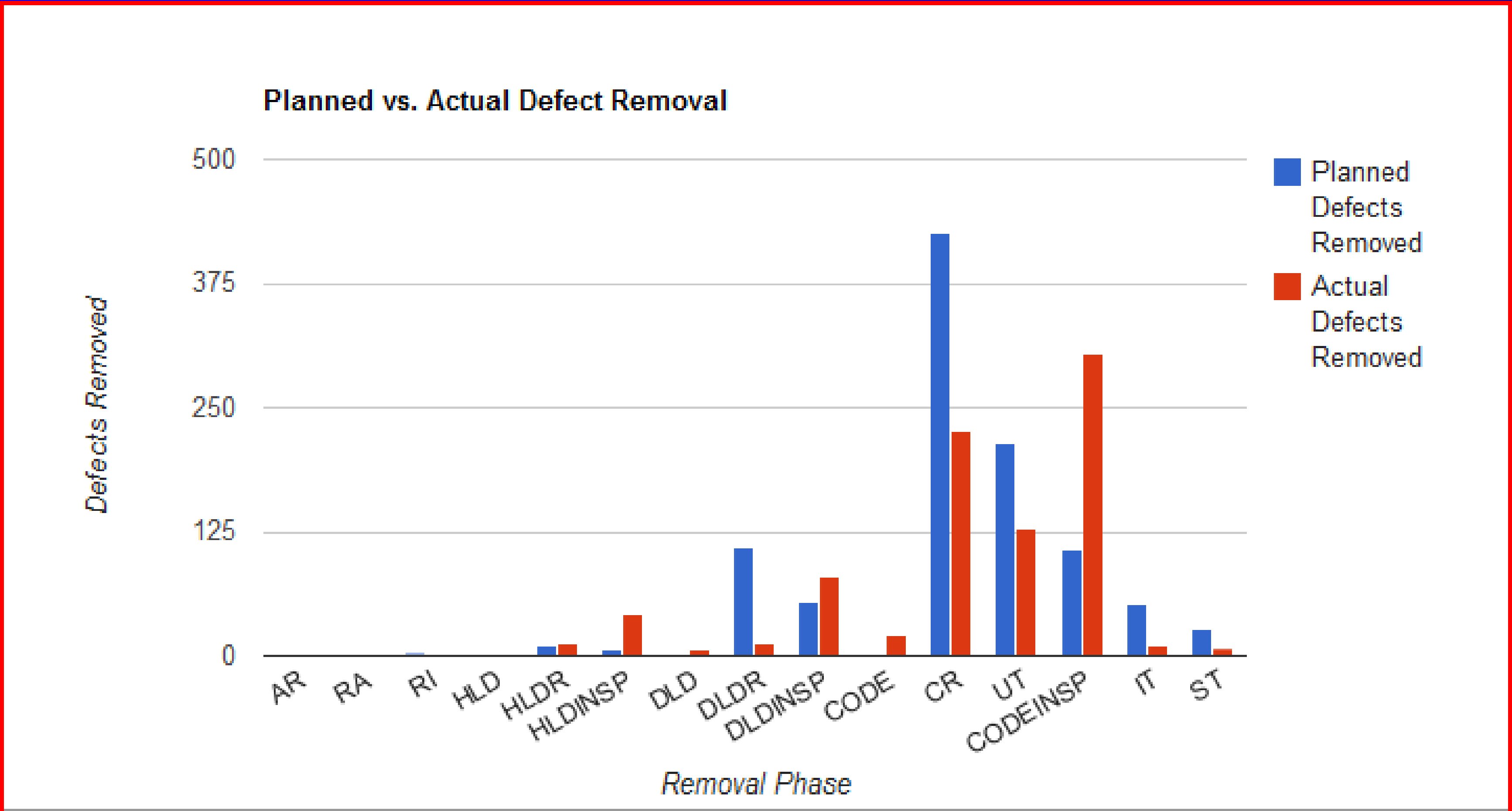
The Problem

- It is difficult to determine the weekly quality status when looking at total planned defects (based on total planned effort).
  – What if all tasks have not been completed yet?
  – What if actual time is much less than planned?
  – What if actual time is much greater than planned?
- Instead, base the quality plan on to-date actual effort on completed tasks

Updated Quality Plan

Phase	Planned Defects Removed	Actual Defects Removed	Actual Effort for Completed Tasks	Planned Defects Injected	Planned Yield
AR	0.00	0	5.32	0.67	0%
RA	0.00	0	5.23	1.31	0%
RI	0.99	0	0.48		50%
HLD	0.00	0	168.89	21.11	0%
HLDR	11.05	12	39.17		50%
HLDINSP	5.52	41	75.61		50%
DLD	0.00	5	428.26	214.13	0%
DLDR	109.83	13	70.83		50%
DLDINSP	54.91	79	266.72		50%
CODE	0.00	20	799.27	799.27	0%
CR	427.09	226	295.17		50%
UT	213.55	129	462.27		50%
CODEINSP	106.77	304	274.72		50%
IT	53.39	10	147.34		50%
ST	26.69	7	53		50%

Defects Injected and Removed



Updated Injection and Removal Rates

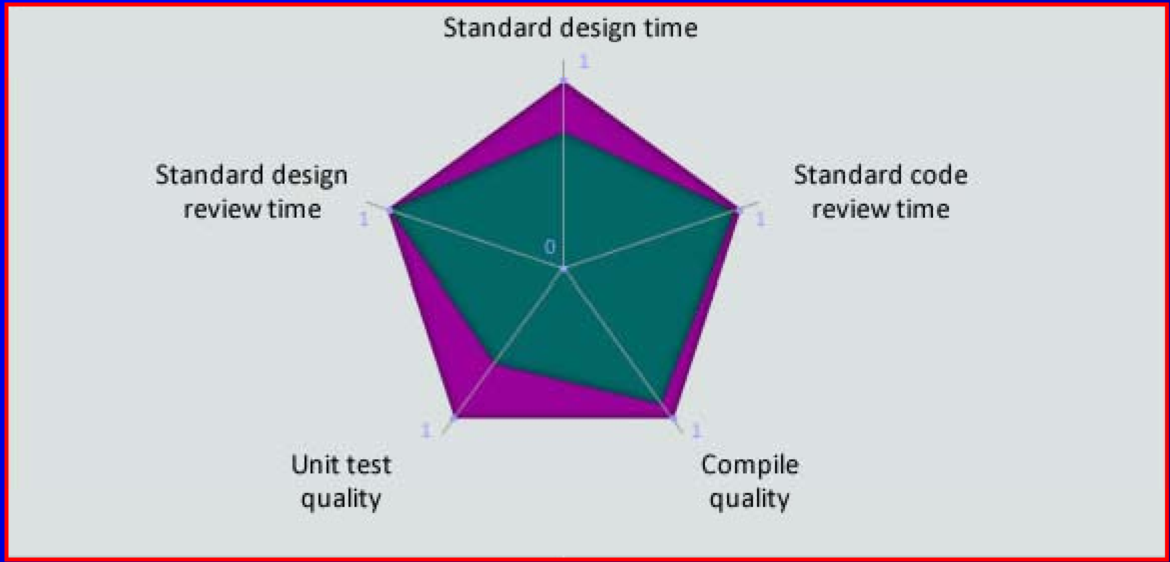
Based on data on over 100 completed projects, with no Compile phase tracking.

Phase	**Injection Rates (defects/hour)**
High-level Design	0.125
Detailed Design	0.5
Code	1.0

The Quality Profile

Measure	Meaning	Ideal criteria
Standard Design time	The ratio of Design time to Code time.	Design time ≥ Code time
Standard Design Review time	The ratio of Design Review time to Design time.	Design Review time ≥ 50 percent of Design time.
Standard Code Review time	The ratio of Code Review time to Code time.	Code Review time ≥ 50 percent of Code time.
Compile quality	The density of defects found during Compile.	< 10 defects/KLOC
Unit Test quality	The density of defects found during Test.	< 5 defects/KLOC

Process Quality Index



- Values of 1 are shown at the outermost edge of the profile; poorer values are proportionately closer to the center of the profile diagram.
- PQI is the product of the values of all five vertices of the quality profile.
- PQI greater than 0.4 is an indicator of a zero-defect component.

Issues

- Design : Code ratio does not take into account High-Level Design
- Design : Design Review and Code : Code Review do not consider impact of inspections
- Unit test defect density is difficult to measure in automated test environments
- No one wants to track compile defects (and a lot of modern development environments don’t include this step)

Appraisal to Development Ratio

Appraisal to Development Ratio (A/D R) is defined as

$$\frac{\text{(time in personal review + time in team inspection)}}{\text{(time in personal review + time in team inspection + time in development)}}$$

Analysis of over 300 components shows an A/D R of > .35 is an indicator of high quality.

Code and Design A/D R

Replace the Standard Design Review Time and Standard Code Review Time indices with

- Standard Code Appraisal Time

$$\frac{\text{(time in personal code review + time in team code inspection)}}{\text{(time in personal code review + time in team code inspection + time in coding)}}$$

- Standard Design Appraisal Time

$$\frac{\text{(time in personal design review + time in team design inspection)}}{\text{(time in personal design review + time in team design inspection + time in design)}}$$

Unit Test

- Recent studies have shown a positive correlation between test code coverage and software reliability.
  - The larger the size of the program, the more positive the correlation
  - The more complex the program, the more positive the correlation
- Replace Unit Test Quality measure from Unit Test Defect Density to Unit Test Code Coverage
  - >80% and
  - Consider Block, Decision, and All –Uses coverage

Static Analysis

- Replace the Compile Defect Density index with Static Analysis
  - The benchmark is difficult
  - Before inspection?
  - During build?
  - Defect logging?
- Suggest a {1,0} measure
- Limited data suggests warning density of < 2 warnings / KLOC

An Example

CheckId	Warning	Reason
CA1052	CA1052: Static holder types should be sealed	This warning can be suppressed in the case where a base class is designed to be inherited, but only contains static methods.
CA1711	CA1711: Identifiers should not have incorrect suffix	This warning should be fixed, with the following exceptions: • A 'Permission' type enumeration can end with 'Permission'.
CA1801	CA1801: Review unused parameters	Uncalled private code may be necessary for WCF Data Members. Suppress warning in this situation.
CA1811	CA1811: Avoid uncalled private code	Uncalled private code may be necessary for WCF Data Members. Suppress warning in this situation.

High-Level Design

- When working with teams doing Architecture Centric Engineering (ACE), High-Level Design is a critical step.
  - Limited data, but results point to 1:1:1 HLD:DLD:CODE ratio.
  - Suggest changing Standard Design Time index to reflect this ratio

Suggested Update to Quality Profile

Measure	Meaning	Ideal criteria
Standard Design Time	The ratio of HLD to DLD to Code time	HLD time >= DLD time >= Code time
Standard Design Appraisal Time	The ratio of Design Appraisal time to (Design Appraisal time + Design time	A/D Ratio Design >= .35
Standard Code Appraisal Time	The ratio of Code Appraisal time to (Code Appraisal time + Code time	A/D Ratio Code >= .35
Unit Test Coverage	Code coverage	>= 80%
Static Analysis Usage	Static analysis rules customized and all warnings resolved	1 (as opposed to 0 when not done) < 2 warnings/KLOC

References

- Del Frate, F.; Garg, P.; Mathur, A.P.; Pasquini, A.; , "On the correlation between code coverage and software reliability ," *Software Reliability Engineering, 1995. Proceedings., Sixth International Symposium on* , vol., no., pp.124-132, 24-27 Oct 1995
  doi: 10.1109/ISSRE.1995.497650
  URL: http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=497650&isnumber=10649
- Krishnamurthy, S.; Mathur, A;, "On Predicting Reliability of Modules Using Code Coverage" *ACM, August 1996*