Measuring the Inspection Process

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Introduction

- Many organizations perform inspections, but many fail to adequately measure the performance of the inspection process, and many more fail to make the most productive use of the inspection data that they collect
- Lack of a good automated data collection and analysis system is often a factor
- Often there is an implicit assumption that any kind of inspection is better than nothing
- Without measurements and pro-active management, the inspection process is likely to under-perform significantly, often adding overhead without significantly improving quality

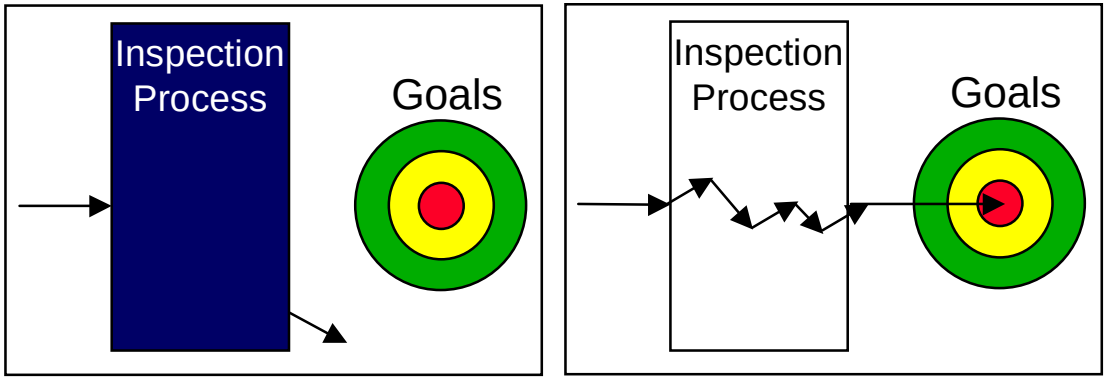
Inspections

- Team activity
  - introduced by Fagan at IBM in 1976 and modified by others (Gilb 1993)
  - performed by author and peers
  - objective is to find and prevent defects in plans, requirements, designs, code, test cases, etc
- Inspections use two mechanisms to detect defects
  - a check for consistency between work products and their source documentation
  - a checklist based on organization level defect data
- Cost effective when measured and actively managed

Inspection Goals

- Reduce development cost and cycle time
- Remove as many defects as possible as
  - early as possible
  - quickly as possible
  - cheaply as possible
- Obtain metrics to drive continuous process improvement through defect prevention
- Manage and continuously improve inspection process
- Disseminate product knowledge and development skills
- Estimate remaining defects in the product

Measurements, Goals, & Management



- Goals stated in terms of measurable quantities
- Measurement key to managing the process and achieving the goals
  - "You can't manage what you can't measure"

Inspection Process

- Activities
  - Planning
  - Kickoff Meeting
  - Preparation (Checking)
  - Review Meeting (Issue Logging)
  - Editing (Defect Fixes)
  - Follow-up Meeting
- Roles
  - Author
  - Moderator
  - Recorder
  - Reviewers
- Checking Mechanisms
  - Source Documents
  - Checklists

Measurements

- Only four basic measurements
  - Effort: the effort required to prepare for, hold, and fix the defects found in the inspection
  - Size: the size of the work product under inspection, often measured in lines of code (LOC)
  - Issues: the number of issues logged at the review meeting
    - Issues are typically potential defects or “questions of intent”
    - Product improvement suggestions are never issues
  - Defects: the number and type of defects, effort required to fix, point of injection and point of removal, description
- Simple and economical to collect in-process with an automated tool
- All other metrics are derived from this basic set

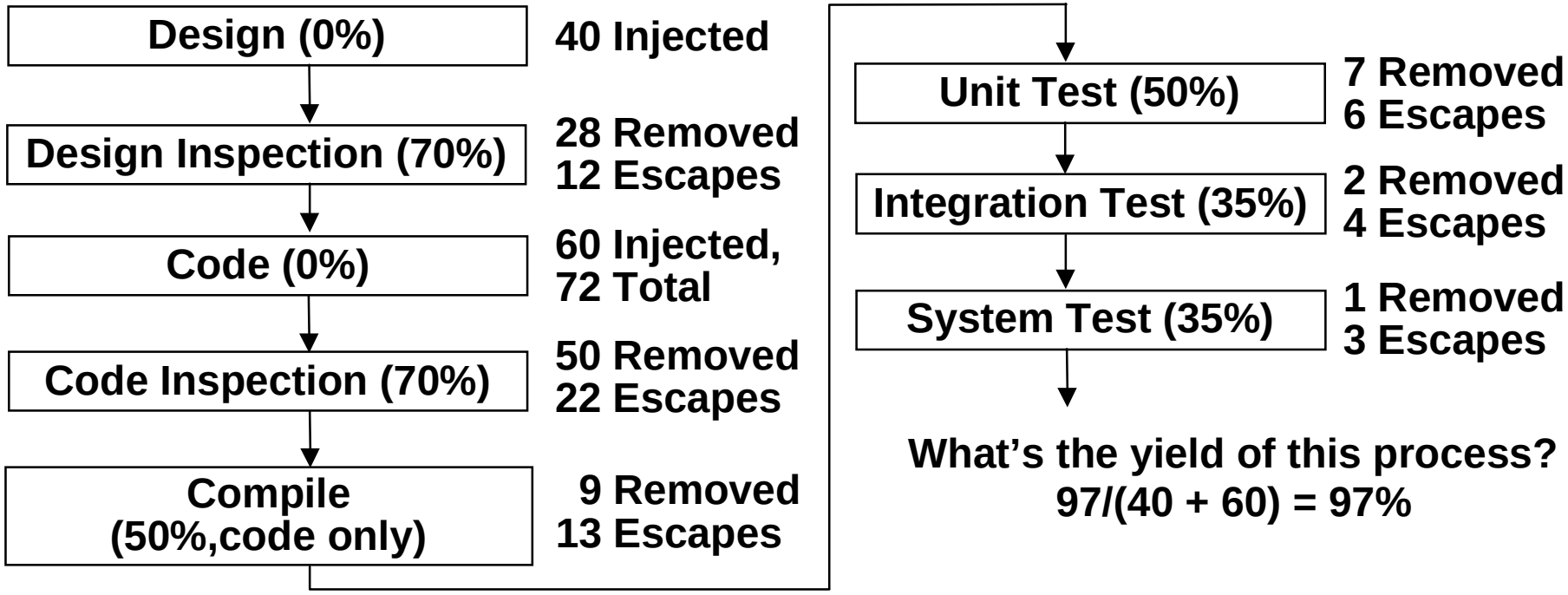
Inspection Measures

Product Size	Size of the product
Team Size	Number of people on the inspection team
Issues	Number of issues noted
Defects	Number of defects corrected
Effort	Effort spent in each activity
Review Rate	Product Size/Preparation Effort
Issue Rate	Issues/Preparation Effort
Review Duration	Length of Review Meeting
Issues Logged	Number of unique issues logged
Logging Rate	Issues Logged/Review Meeting Duration
Issue Density	Issues Logged/Product Size
Defect Density	Defects/Product Size
Defects/Issue	Defect Density/Issue Density
Defect Removal Rate	Defects/Total Effort
Leverage	Defect Removal Rate/ Test Defect Removal Rate

Guidelines

Product Size	Large products are very hard to inspect
Team Size	Large teams are rarely cost-effective
Effort	People can rarely stay focused for more than a couple of hours
Review Rate	100 - 200 LOCs/hr is usually good
Review Duration	1 hour is a good target
Issues Logged	Number of unique issues logged
Logging Rate	1 - 2 minute per issue is good
Defect Density	Controlled by the development process
Defects/Issue	0.5 is not unusual
Leverage	> 1 for cost effective inspections

Yields and Quality Management



Managing with Entry & Exit Criteria

- Define explicit entry and exit criteria for each process step
  - Activity doesn't start unless the entry criteria are satisfied
  - Activity doesn't complete unless the exit criteria are satisfied
- Can be qualitative or quantitative
  - qualitative criteria typically require some activity be complete or some intermediate product be available
  - quantitative criteria typically require that a measured value associated with an inspection process goal fall within a range of values that represents typical or targeted performance
  - establishing quantitative exit criteria is a key part of planning the inspection
- Failure to meet entry or exit criteria requires a corrective action by the moderator

Quantitative Entry/Exit Criteria

- Planning: moderator
  - spot checks product and rejects if it issue density is too high
  - estimates and set targets for: average checking effort, average review rate, average issue rate, expected number of issues logged, issue density, issue logging rate, the number of defects in the product after inspection
- Kickoff Meeting
  - team sets goals for average checking effort, average review rate, average issue rate, and issue logging rate
- Preparation - each reviewer
  - plans checking time, review rate, expected number of issues found, issue density, and issue rate and checks for consistency with team goals
  - verifies that actuals are consistent with planned values and team goals (exit)

Quantitative Entry/Exit Criteria - 2

- Review Meeting - moderator
  - verifies checking times, review rates, issues per reviewer, and issue rates meet the goals established at the Kickoff Meeting (entry)
  - checks that issue logging rate against goal set up during the Kickoff meeting (exit)
  - checks that issue density and review rate meeting the planning goals (exit)
  - checks that remaining number of defects in the product has been estimated and meets planning goals (exit)
- Follow-up Meeting - moderator
  - verifies defect density meets inspection goals and the number of defects removed and the estimated number of defects remaining are consistent with the project quality plan (exit)
  - estimates the inspection ROI (exit)

Estimating the Escapes

- Always estimate the number of defects that have "escaped" the inspection process
  - $N_{escapes} = N_{total} - N_{found}$
- Ways to estimate the total number of defects:
  - Count the number of issues that were classified as potential defects
    - Assume the number found equals the number remaining – this is equivalent to assuming an inspection yield of 50%
    - If there are statistics on the average inspection yield, divide the number of defects found by the average yield
  - Use population sampling techniques

Population Sampling Techniques

- Provides a rough estimate of escapes
- Problem: Estimate the number of fish in a pond.
- Solution:
  - Take a sample, tag the fish and release them
  - Take a second sample, under similar conditions, and count the number of tagged fish
  - Estimate the population based on the fractional number of tagged fish
- Example:
  - Suppose the first sample has 20 fish
  - Suppose the next sample also has 20 fish, 4 of which are tagged (20%) from the first sample
  - This implies, all things being equal, a sample contains 20% of the fish population, so the estimated population is 100 fish (20 fish / 20%)

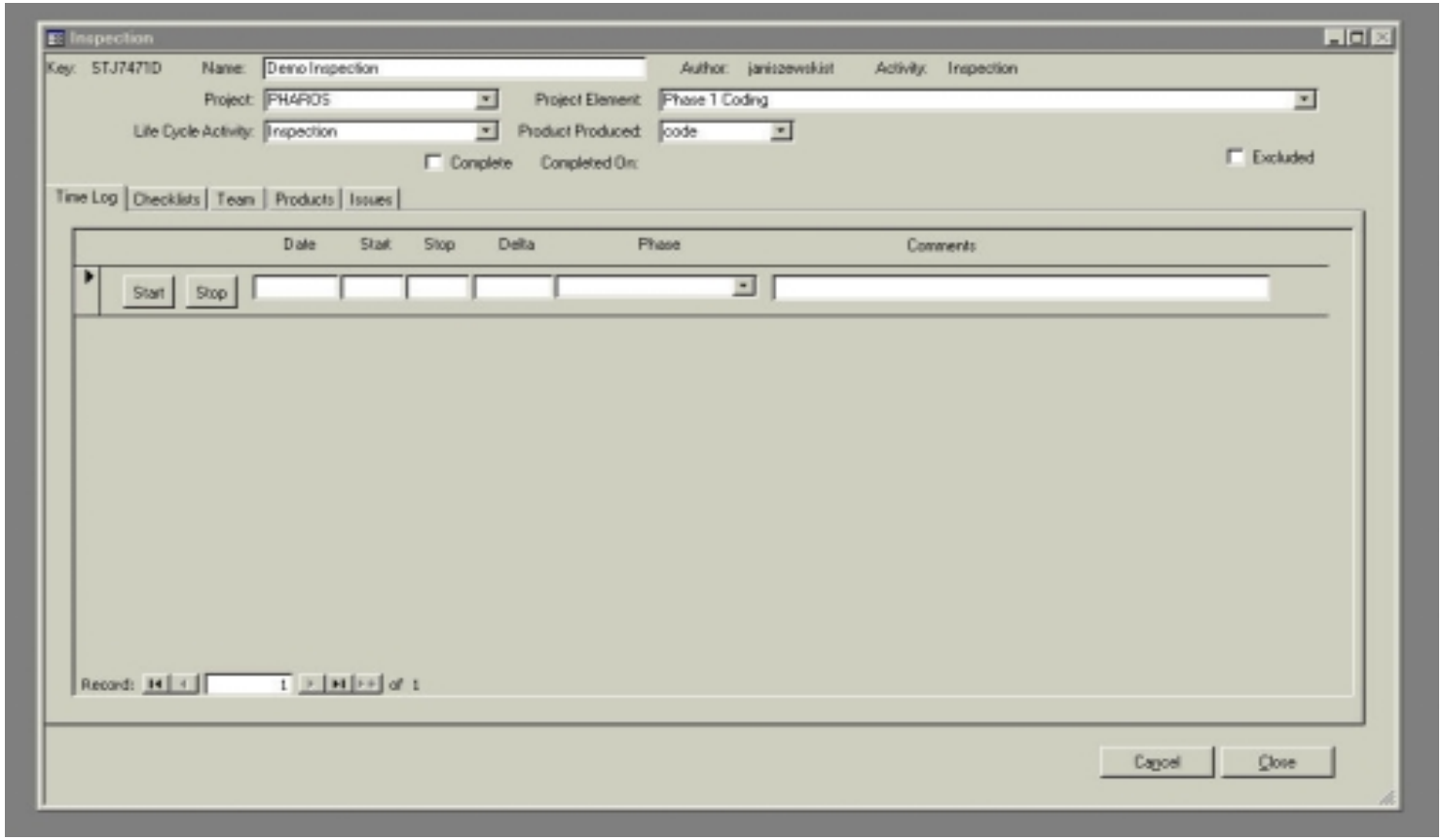
Application to Inspections

- Use two independent reviewers with the same skill level
- Each will find some common defects, and some unique defects
- Use the percentage of common defects to estimate the overall defect population
- Subtract the number of defects found to estimate the number of escapes

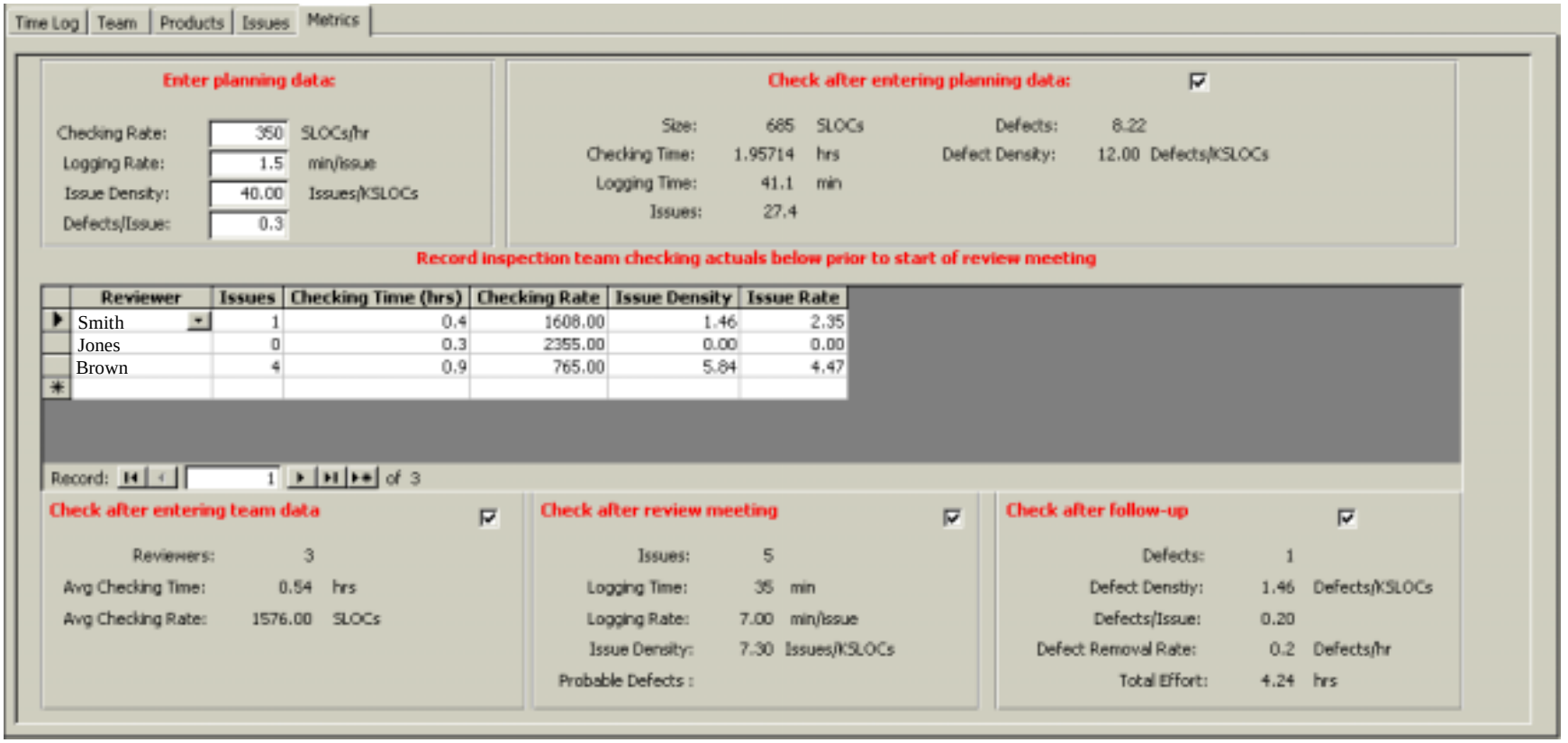
Automation

- Automated data collection and analysis is integral to effectively managing an inspection process
  - objective management is impossible without measurement
  - collecting data on paper forms results in a “write-only” data base
- To avoid most data collection errors, data should be collected “in-process” in real time
- Data should be stored in an on-line database
  - avoid need to aggregate data implicit in most spreadsheet based approaches
  - provide real-time decision support capability
  - provide process performance analysis and process control functionality
  - provide security mechanisms for data confidentiality

Sample Forms



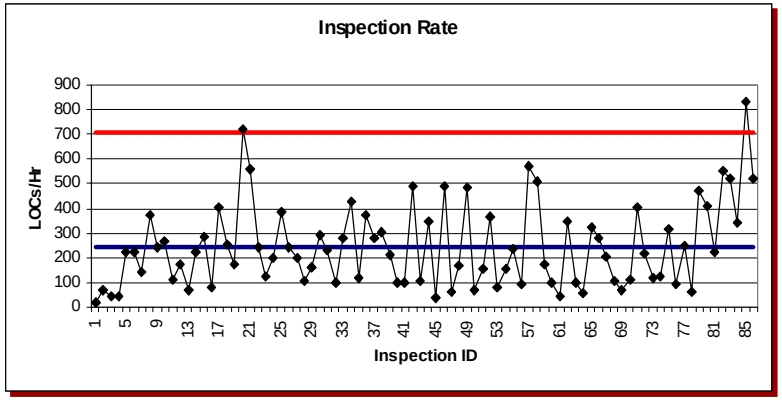
Real Time Decision Support

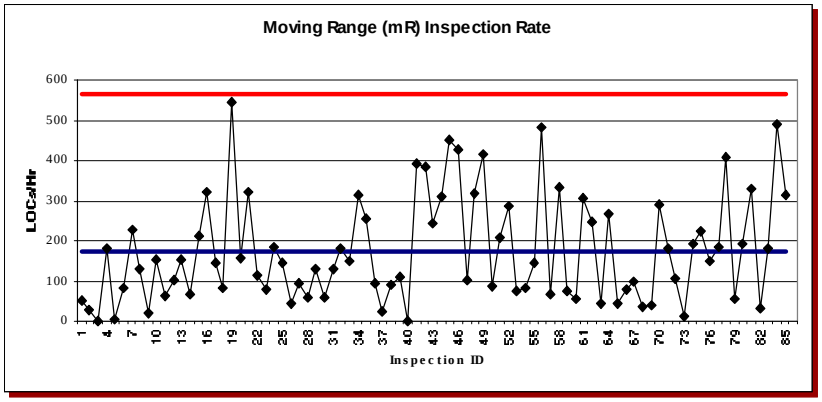


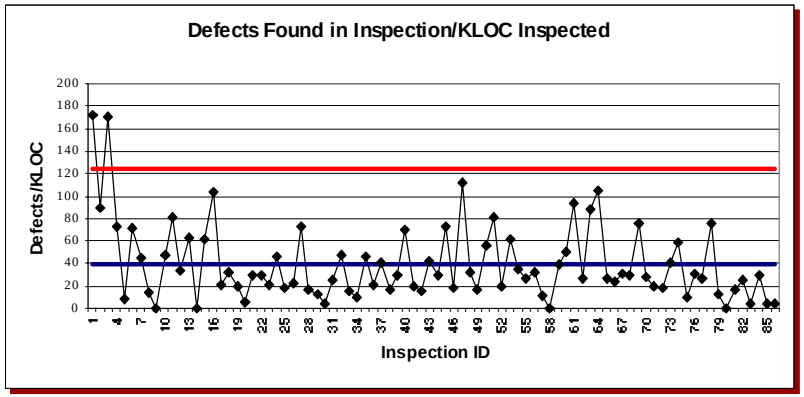
Data Recording Overhead

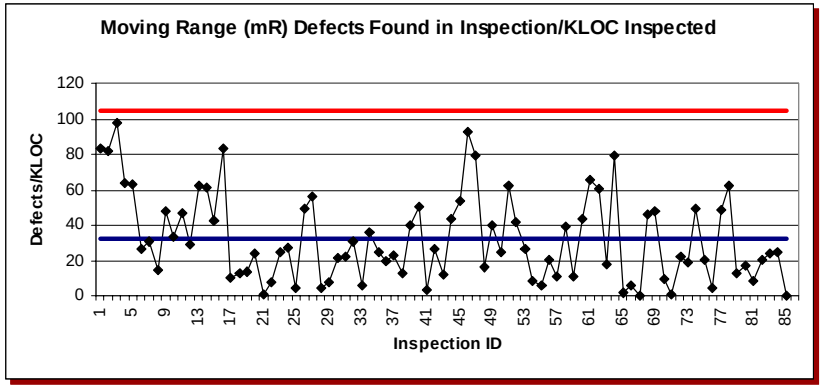
- Time log entry requires about 15 sec
  - Assuming three reviewers, 5 log entries each, 15 entries for the meetings, and 5 entries by the author yields about 35 x 15/60 ≈ 9 min
- Defect log entry requires about 30 sec
  - assuming a 400 LOC product with about 20 defect yields 20 x 30/60 ≈ 10 min
- Issue log entry requires about 30 sec
  - assuming 40 issues yields 40 x 30/60 ≈ 20 minutes
- Total data recording overhead ≈ 40 minutes
- Total effort, assuming 200 LOC/hr inspection rate & 2 min/issue yields 3 x 400/200 + 40 x 2 /60 ≈ 7.5 hours, at least 8.5 if you allow for kickoff, editing, and follow-up
- Data recording overhead 40/(8.5*60) ≈ 8%

Open Loop Process Run Charts



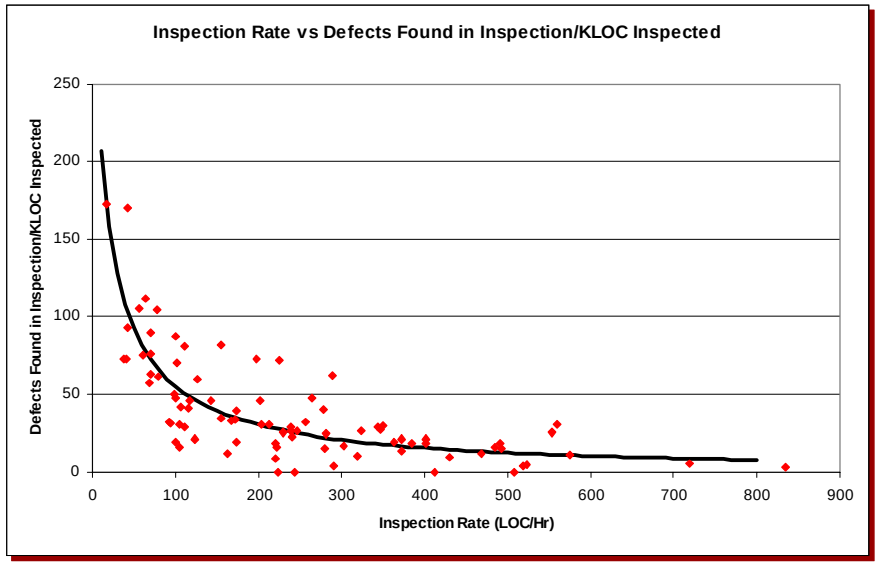






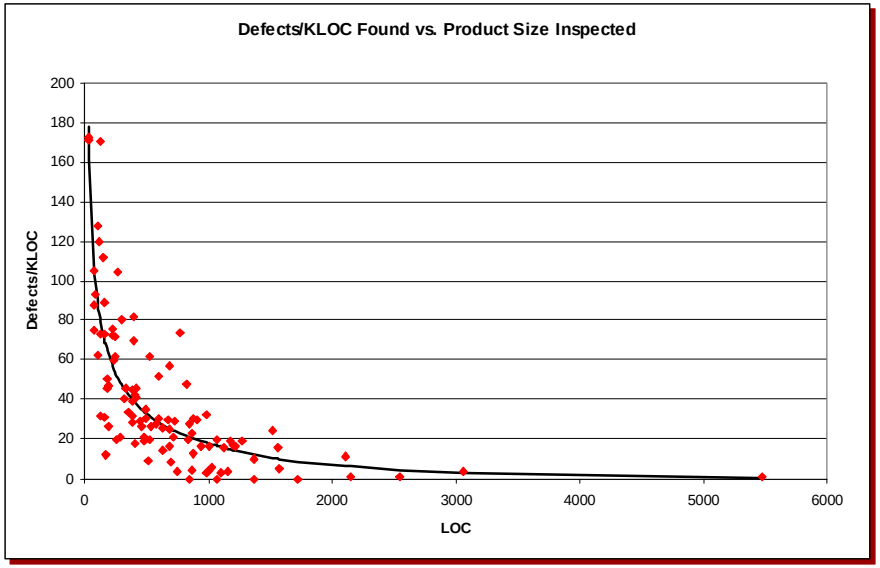
- Average review rate 244 LOCs/Hr
- Average defect density 39 Defects/KLOC
- Average removal rate 6/Hr

Correlation Analysis



- $r^2 = 0.67$
- $y = 1000/(0.1x + 3)$
- Target rate ~200 LOC/Hr

- **$r^2 = 0.68$**
- **$y = 1000\exp(-x/2000)/ (x)1/2$**
- **Target size < 500 LOCs**



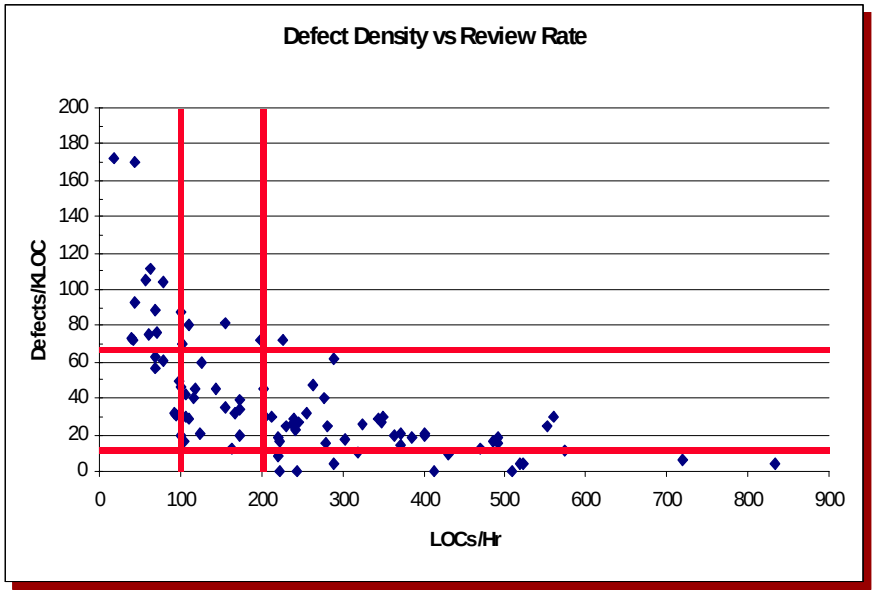
Inspection Action Plan

Slow Review Rate & Many Defects

Is the product really buggy?
Was the review really effective?
Was the review cost efficient?

Fast Review Rate & Many Defects

The product **IS** buggy.
Return to author for rework
Ask someone else to rewrite



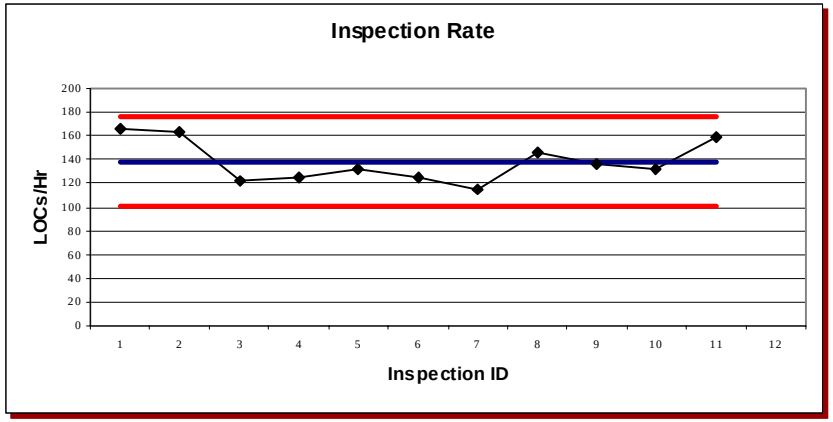
Slow Review Rate & Few Defects

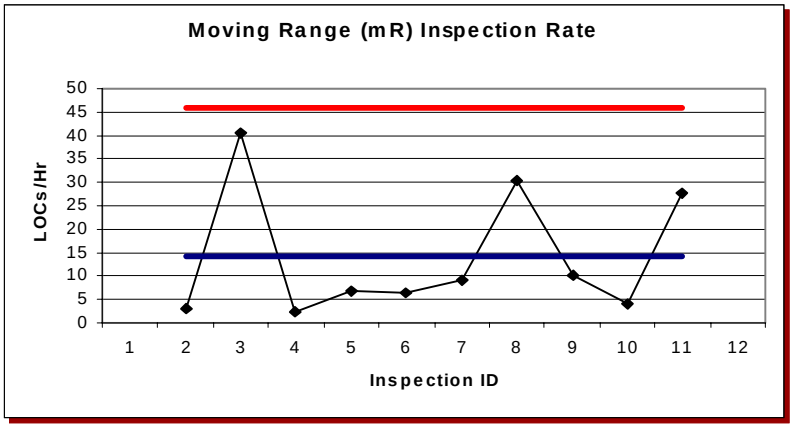
Is the product really good?
Was the review really ineffective?
Was the review cost efficient?

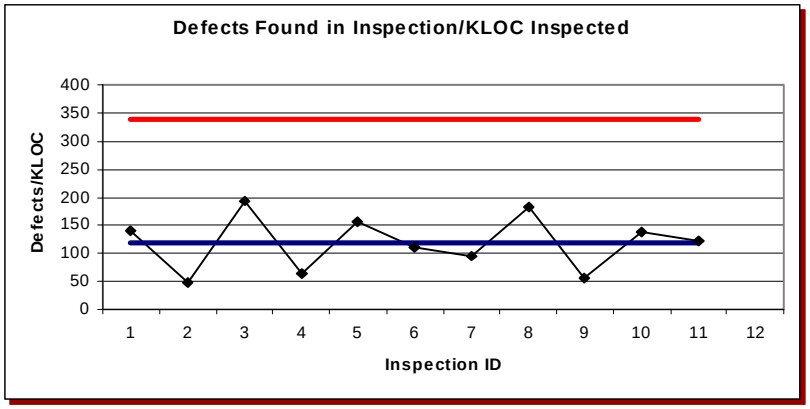
Fast Review Rate & Few Defects

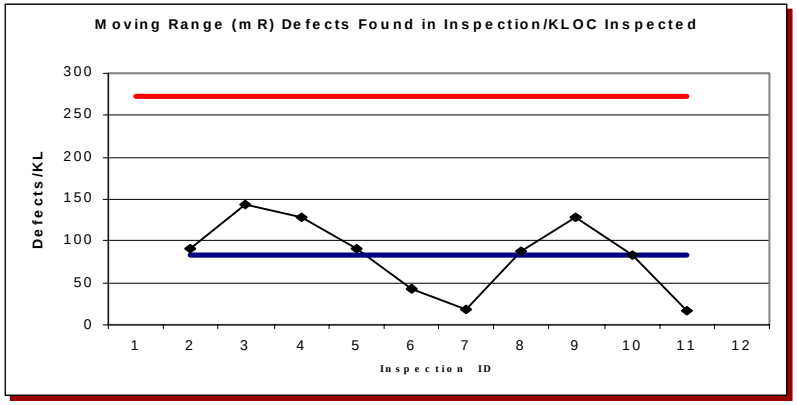
~~Is the product really good?~~
Re-review at a slower rate
Use the checklist

Closed Loop Run Charts









- Major decrease in variation
- Average Review Rate 138 LOCs/hr
- Average Defect Density 118 Defects/KLOC
- Average Defect Removal Rate 15/hr

Calculating Return on Investment - 1

- Training, tool and activity cost are directly measured
- Savings = difference in cost between finding a defect in review and finding it later in the process

	Defects leaked from prev phase	New Defects Injected	Phase Yield	Defects Contained	Defects Leaked	Defect Removal Cost	Total Removal Cost (hrs)
Design	0.0	40	0%	0.0	40.0	n/a	0.00
Design Bench Check	40.0	0	0%	0.0	40.0	10 mins	0.00
Design Inspection	40.0	0	0%	0.0	40.0	30 mins	0.00
Code	40.0	60	0%	0.0	100.0	n/a	0.00
Code Bench Check	100.0	0	0%	0.0	100.0	5 mins	0.00
Compile	100.0	0	50%	50.0	50.0	1 min	0.83
Code Inspection	50.0	0	0%	0.0	50.0	15 mins	0.00
Unit Test	50.0	0	50%	25.0	25.0	15 mins	6.25
Integration Test	25.0	0	35%	8.8	16.3	18 hrs	157.0
System Test	16.3	0	35%	5.7	10.6	18 hrs	102.0
							267

- Without inspections, defects cost 267 hrs/KLOC

Calculating Return on Investment - 2

	Defects leaked from prev phase	New Defects Injected	Phase Yield	Defects Contained	Defects Leaked	Defect Removal Cost	Total Removal Cost (hrs)
Design	0.0	40	0%	0.0	40.0	n/a	0.00
Design Bench Check	40.0	0	50%	20.0	20.0	10 mins	3.33
Design Inspection	20.0	0	50%	10.0	10.0	30 mins	5.00
Code	10.0	60	0%	0.0	70.0	n/a	0.00
Code Bench Check	70.0	0	70%	49.0	21.0	5 mins	4.08
Compile	21.0	0	50%	10.5	10.5	1 min	0.18
Code Inspection	10.5	0	60%	6.3	4.2	15 mins	1.58
Unit Test	4.2	0	50%	2.1	2.1	15 mins	0.53
Integration Test	2.1	0	35%	0.7	1.4	18 hrs	13.23
System Test	1.4	0	35%	0.5	0.9	18 hrs	8.60
							37

- With inspections,
  - Cost of holding the inspections is about 40 hours
  - The cost of defect removal drops to 37 hours.
- Net savings is 267 – (40+37) = 190 hours

References

Software Inspection, Tom Gilb and Dorothy Graham, Addison-Wesley 1993

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