Measurement Driven Project Management

2004 CMMI Conference

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Presentation Objectives

Discuss some principles of measurement.

Explain the benefits of implementing data driven project management.

Present a QIC Process Measurement Framework[SM].

Provide some examples of data driven project management metrics.

Discuss some measurement strategies and provide an example project measurement dashboard.

Answer any of your questions.

Agenda

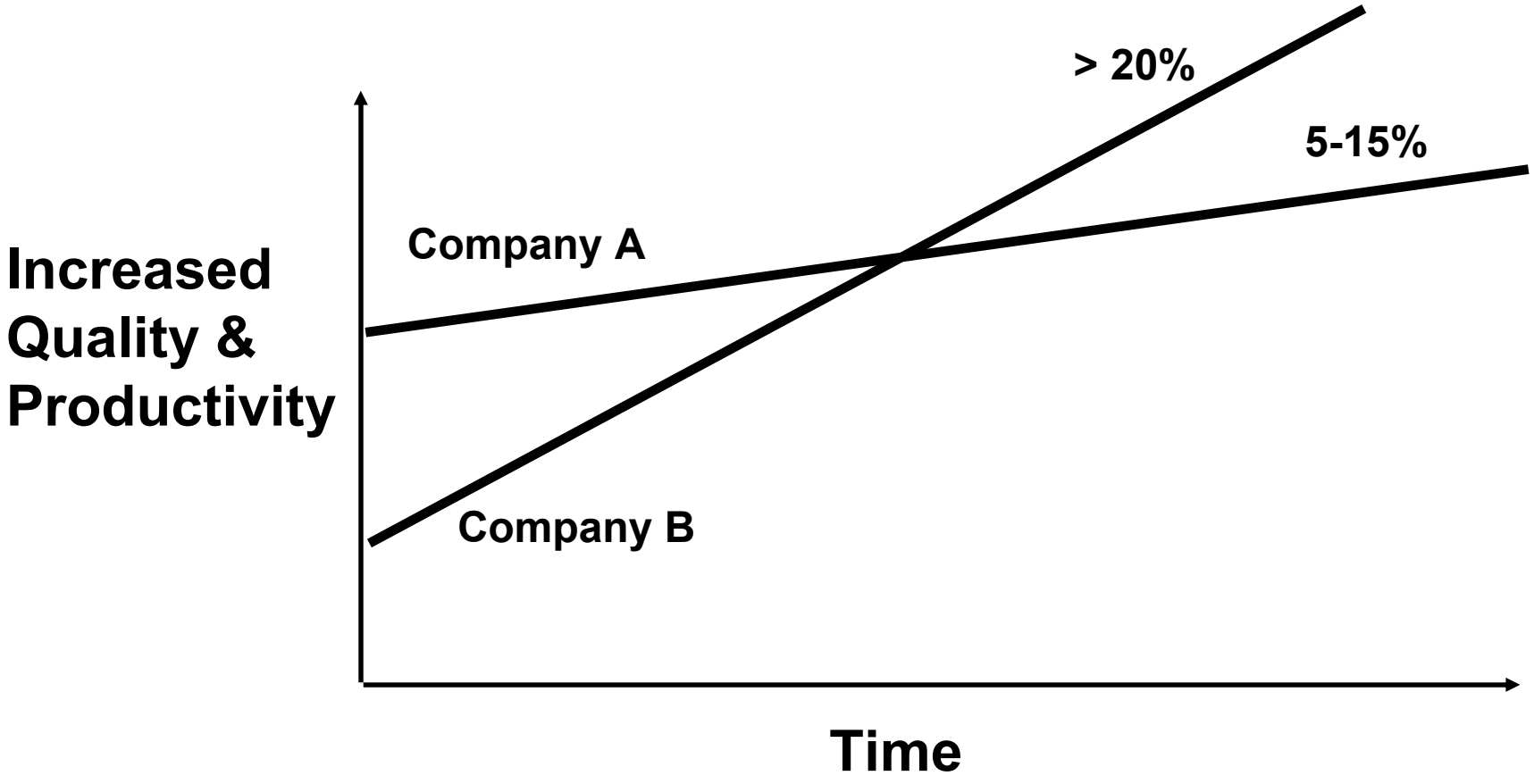
- **Motivation**
- **Data Driven Project Management**
- **QIC Process Measurement Framework℠**
- **Some Measurement Examples**
- **Some Measurement Strategies**
- **Summary**
- **Questions and Answers**

The Principle of Measurement

As Lord Kelvin said a century ago:

"When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science."

Evolutionary vs. Revolutionary Quality Improvement



- Adapted from *Juran on Leadership for Quality*, Juran, 1989

Some Best-In-Class Benchmarks

METRIC	WORLD-CLASS BENCHMARK
Costs of Poor Quality	Reduced from 33% to under 10%
Defect Removal Efficiency	70-90% total defects removed before test
Post-Release Defect Rate	Six Sigma (3.4 defects per Million Parts)
Productivity	Doubled (e.g., in 5 years)
Return on Investment	5:1 - 10:1 ROI
Schedule / Cycle Time	Cut in half (e.g., in 5 years)

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Problem Statement

80% of all improvement efforts have no measurable results.

Most projects have limited or poor metrics to help them manage their projects.

The most common metrics are schedule and budget (which are usually inadequate).

Most organizations keep changing the schedule and budget, so that the original estimates are lost.

If an organization achieves their N+1 schedule, is that really a success?

Project Management and Metrics

Most projects estimate:

- Schedule (e.g., dates)
- Effort (e.g., hours)
- Cost (e.g., $)

Many projects do not estimate:

- Size (i.e., how big is the project?)
- Defects (e.g., what is the needed quality of the product)?

Some PMI PMBOK Metrics

Planned Value (PV) = BCWS (Planned Effort)

Earned Value (EV) = BCWP (Earned Planned Effort)

Actual Value (AV) = ACWP (Actual Effort)

Schedule Performance Index (SPI) = EV/PV (ratio or %)

Cost Performance Index (CPI) = EV/AV (ratio or %)

Schedule Variance (SV) = EV - PV (in hours or cost)

Cost Variance (CV) = EV - AV (in hours or cost)

- **Reference: "A Guide to the Project Management Body of Knowledge", Project Management Institute, 2000.**

Why Size?

Size is "how big is the project"?

For example, what is a size metric for building a house?

- **Total square feet**
- **Total Finished/Unfinished square feet**
- **Foundation size**
- **Number of rooms (large, medium, small)**

Projects with unclear or changing requirements can double in size.

Projects can track on schedule, effort, and cost, and still be in trouble.

Why Defects?

Defects help answer the question, "what is the quality of the project's product"?

One major defect that reaches a customer can cause the project to lose money (e.g., lawsuit).

Defects can be estimated and tracked during a project.

Quality shipped to the customer can be accurately predicted ahead of time.

Measuring defects is a great way to do process improvement and defect prevention.

Why Size and Defects?

Without size, organizations don't know:

- **How big are our projects?**
- **Estimating may be off**
- **Productivity = size/effort**

Without defects and size, organizations don't know their quality:

- **Defect density = defects/size**
  - **(During project execution)**
- **Product defect rate = defects/size**
  - **(After shipping the product to the customer)**

Data Driven Project Management

Using data driven project management, projects should measure (at a minimum):

- **Cost**
- **Defects**
- **Effort**
- **Schedule**
- **Size**

Benefits include being able to measure:

- **Performance**
- **Productivity**
- **Quality**
- **ROI**

A data driven "project management dashboard" helps projects to ensure they are on track.

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Goal/Question/Metric Paradigm

PART	DESCRIPTION
Goal	Every metric must be directed towards a measurable goal. The idea here is that there must be a good reason to be collecting the data.
Question	Every goal should be answered by one or more key questions. The question should be stated so that a metric(s) can clearly answer it.
Metric	The metric must be a quantitative entity that answers a specific question, which in turn addresses a goal or part of a goal.

- Adapted from "V. R. Basili and D. M. Weiss, "A Methodology for Collecting Valid Software Engineering Data", IEEE Transactions on Software Engineering, vol. SE-10, no. 3, November 1984, pp. 728-738.

Analogy: Managing for Finance

Managing for Finance	Managing for Quality
Financial Planning: Setting business goals; budgeting	**Quality Planning:** Setting quality goals; Estimating
Financial Control: Cost control; actual vs. planned	**Quality Control:** Planned vs. actual quality goals; taking action on difference
Financial Improvement: Cost reduction; mergers; acquisitions	**Quality Improvement:** Waste and rework reduction; eliminate & prevent defects

- Adapted from "Juran on Leadership for Quality: An Executive Handbook", Juran, 1989.

Project Core Measures

Unit of Measure	Characteristics
Counts of physical lines of code	Size, progress, reuse
Counts of staff hours expended	Effort, cost, resource allocations
Calendar dates	Schedule
Counts of software problems and defects	Quality, readiness for delivery, improvement trends

Reference: Carleton, et al., "Software Measurement for DoD Systems: Recommendations for Initial Core Measures", CMU/SEI-92-TR-19.

QIC Process Measurement Framework℠

GOALS	KEY QUESTIONS	METRICS	*DC	*DS
PLAN		Cost, defects, effort, size, schedule, etc.		
CONTROL		Cost, defects, effort, size, schedule, etc.		
IMPROVE		Cost, defects, effort, size, schedule, etc.		

* DC = Data Collection; DS = Data Storage

- Reference: "A Process Measurement Framework That Works", Olson, Timothy G., 1997 SEPG

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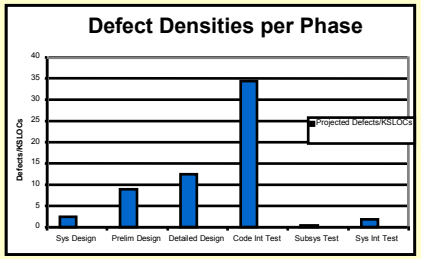
Example: Project Data

PLAN

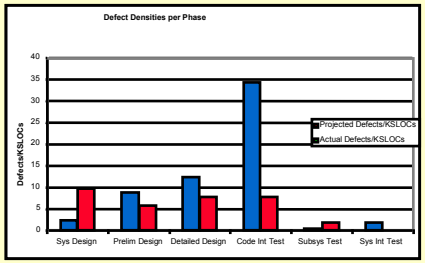
Goal - Planning	Question	Metric	Collect
Accurate estimates based on historical data within ± X%. Example: Plan and estimate within ± 15% of actuals.	How many defects per phase will be generated in new products?	Defect Density Software Size	Inspection database



Quantitative Goals: Setting goals to Plan, Control, & Improve defect removal

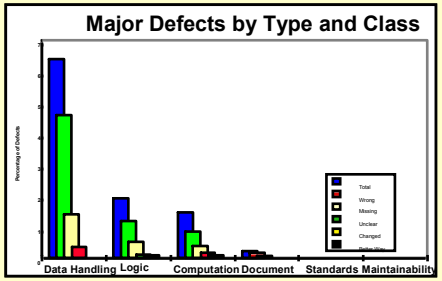
Defect Removal Curve: Setting defect removal curve per development phase

CONTROL



Defect Removal Curve: Actual vs planned; Taking action when set limits are exceeded

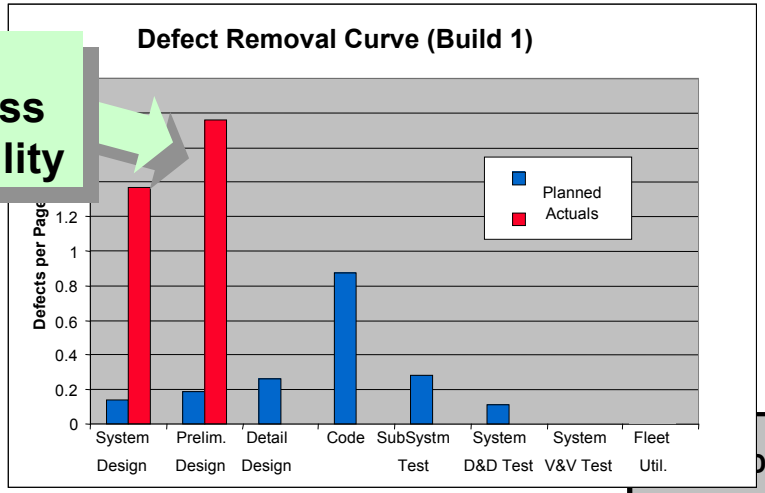
IMPROVE



Defect Prevention: Pareto and root cause analysis of common defects

Control: Project Quality Tracking

New Process Capability

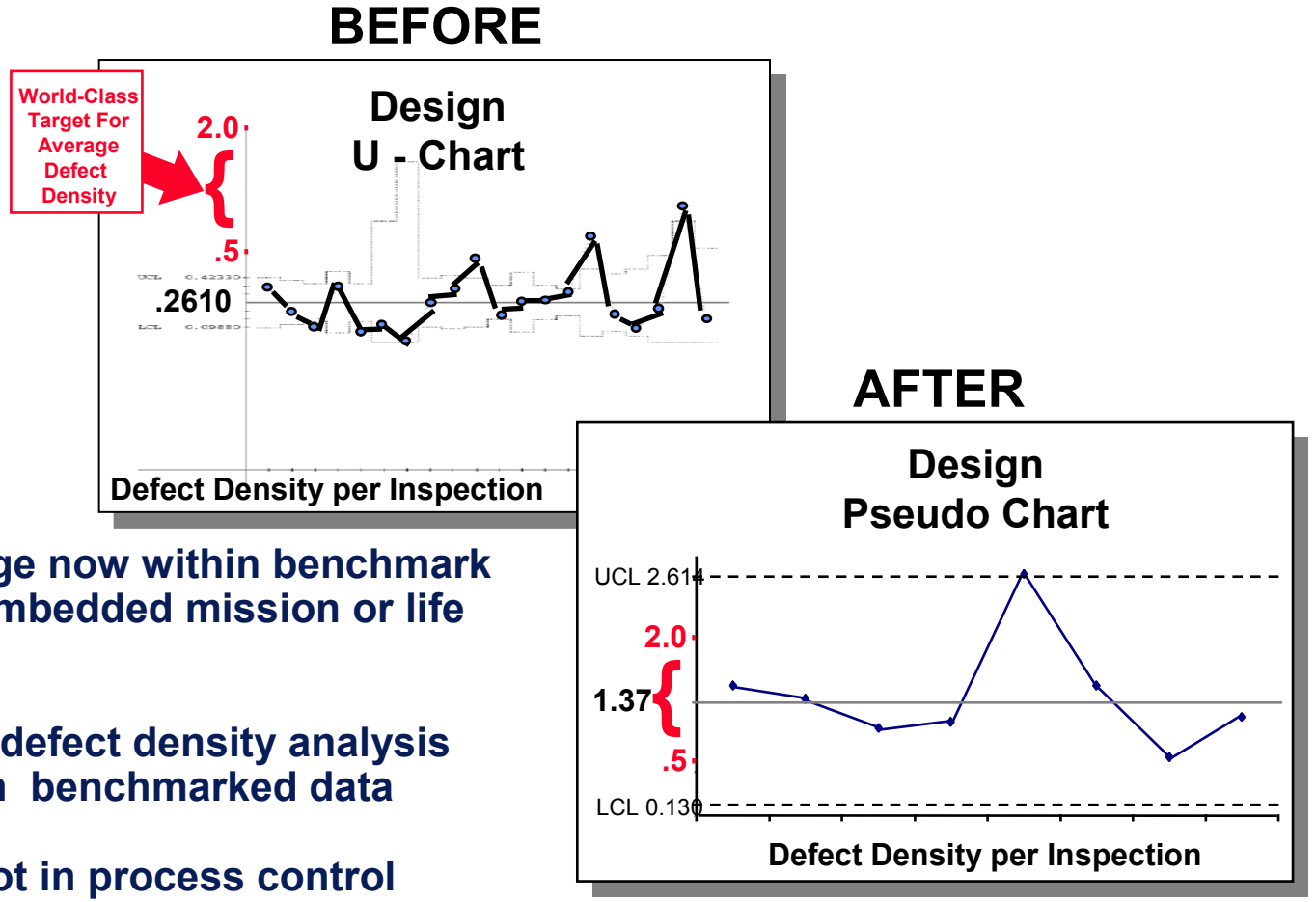


D 1	Defect Removal(Pages) Planned	Actual	Control Limits Set	Within Limits?
Project Start-Up				
System Design	0.14	1.37	15%	978.5%
Preliminary Design	0.19	1.76	15%	926.3%
Detailed Design	0.26	0	15%	0%
Code	0.87	0	15%	0%
Sub-System Int. Test	0.112	0	15%	0%

Track defect removal taking corrective action when acceptable limits exceeded

- Adapted from Beeson, Dennis D. and Olson, Timothy G. , "Instrumenting Software Projects: A Case Study of Real World Projects", SEPG 2001.

SPC of Product Defect Removal



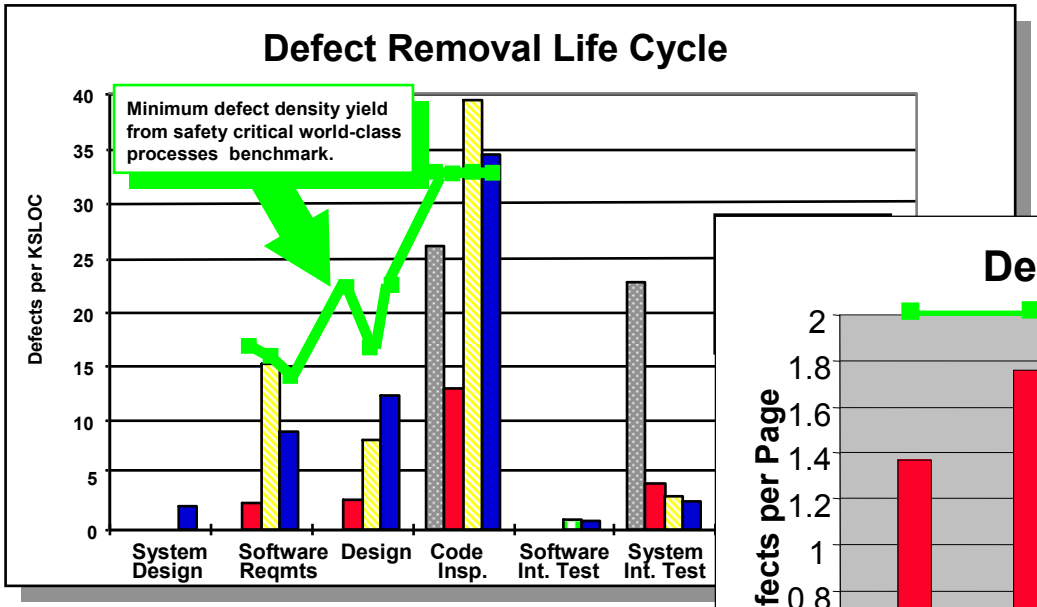
- Defect density average now within benchmark inspection data for embedded mission or life critical software
- Preparation rate and defect density analysis show rates are within benchmarked data
- Defect density still not in process control

Analysis indicates Quantitative Management & Inspection Processes have increased preparation rate and improved defect removal

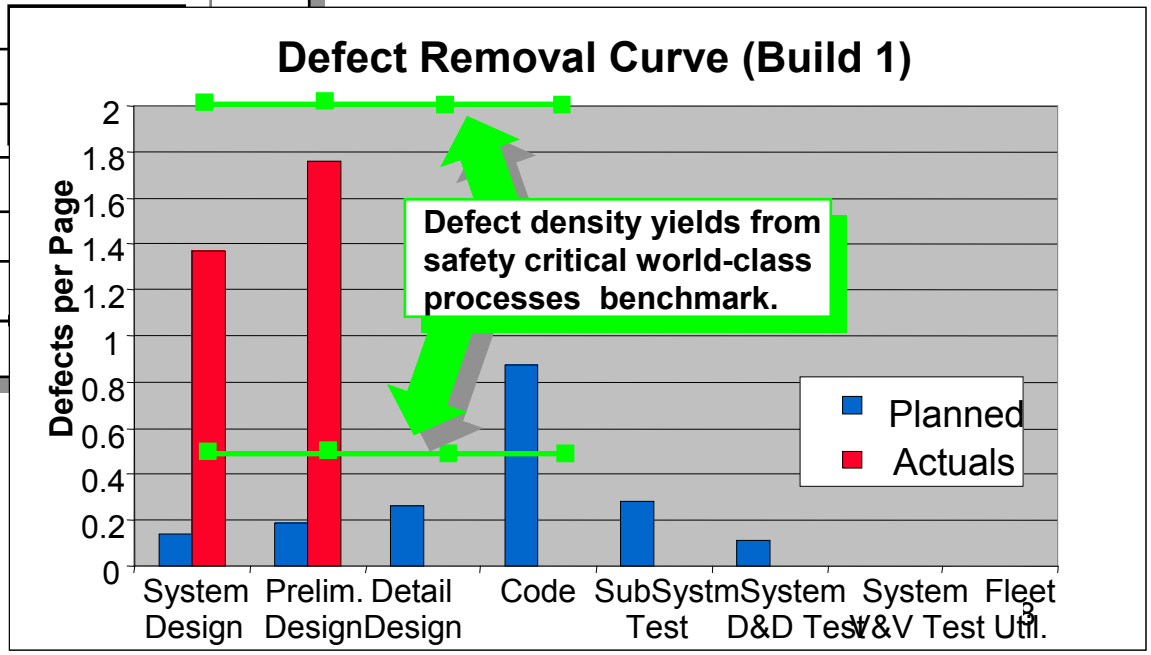
• Adapted from Beeson, Dennis D. and Olson, Timothy G. , "Instrumenting Software Projects: A Case Study of Real World Projects", SEPG 2001.

Improvement: Benchmarking

Before



After



Benchmarks indicated Requirements and Design inspections could yield highest ROI from process improvement

• Adapted from Beeson, Dennis D. and Olson, Timothy G. , "Instrumenting Software Projects: A Case Study of Real World Projects", SEPG 2001.

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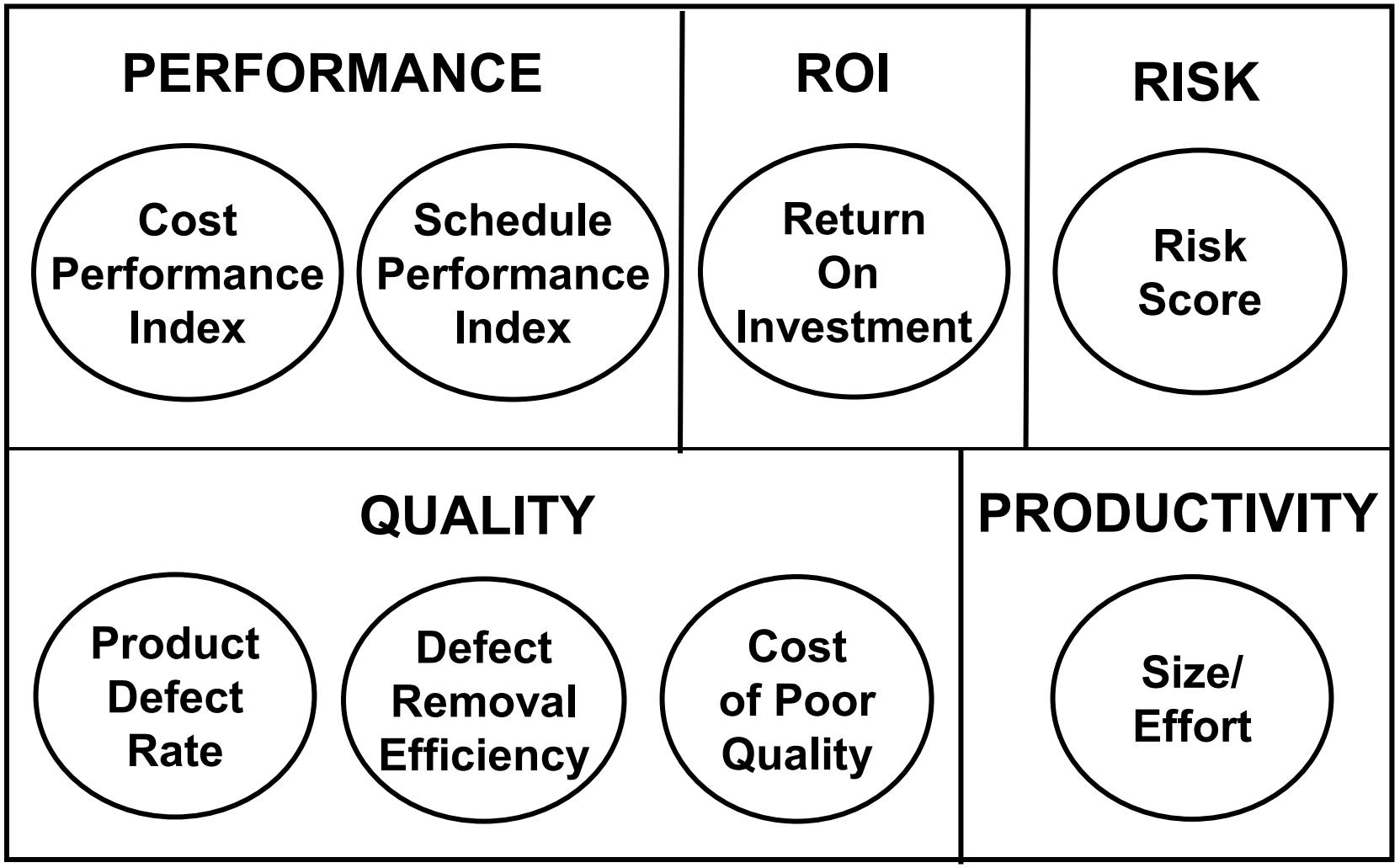
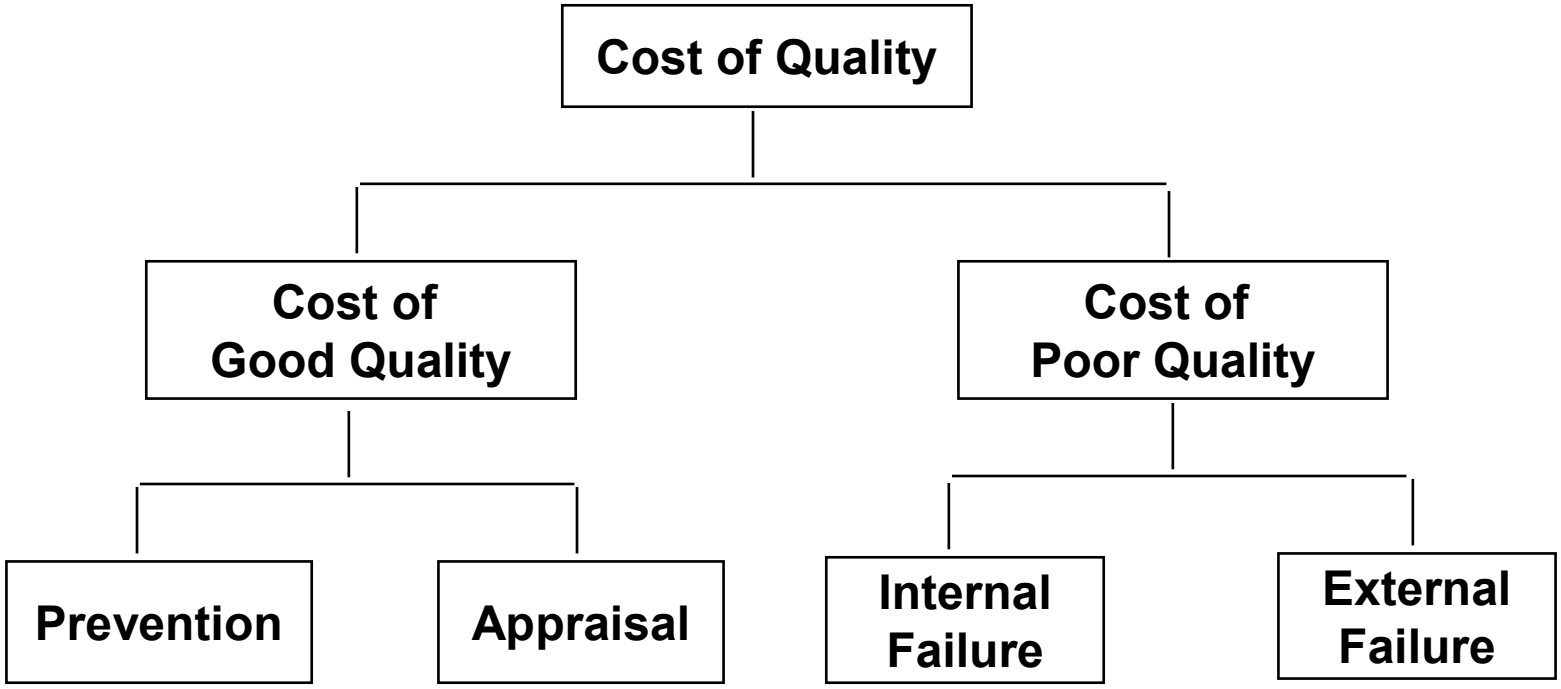
Project Metrics

	Projects	Size	Effort	Cost	Schedule	Defects
Plate Full	1. 2. 3. . . . N					
Backlog	N+1 ...					

Example Metrics Dashboard

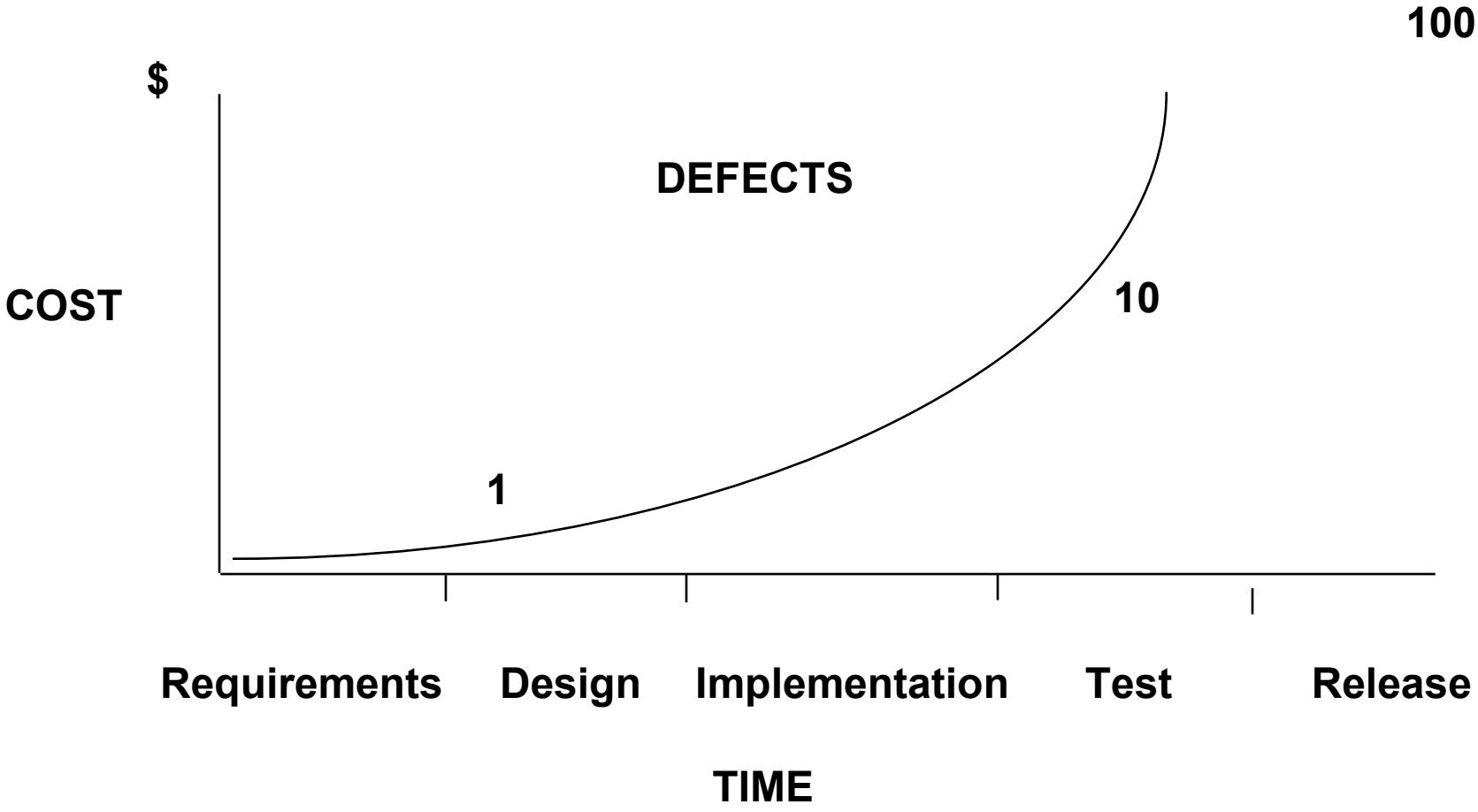


Major COQ Categories

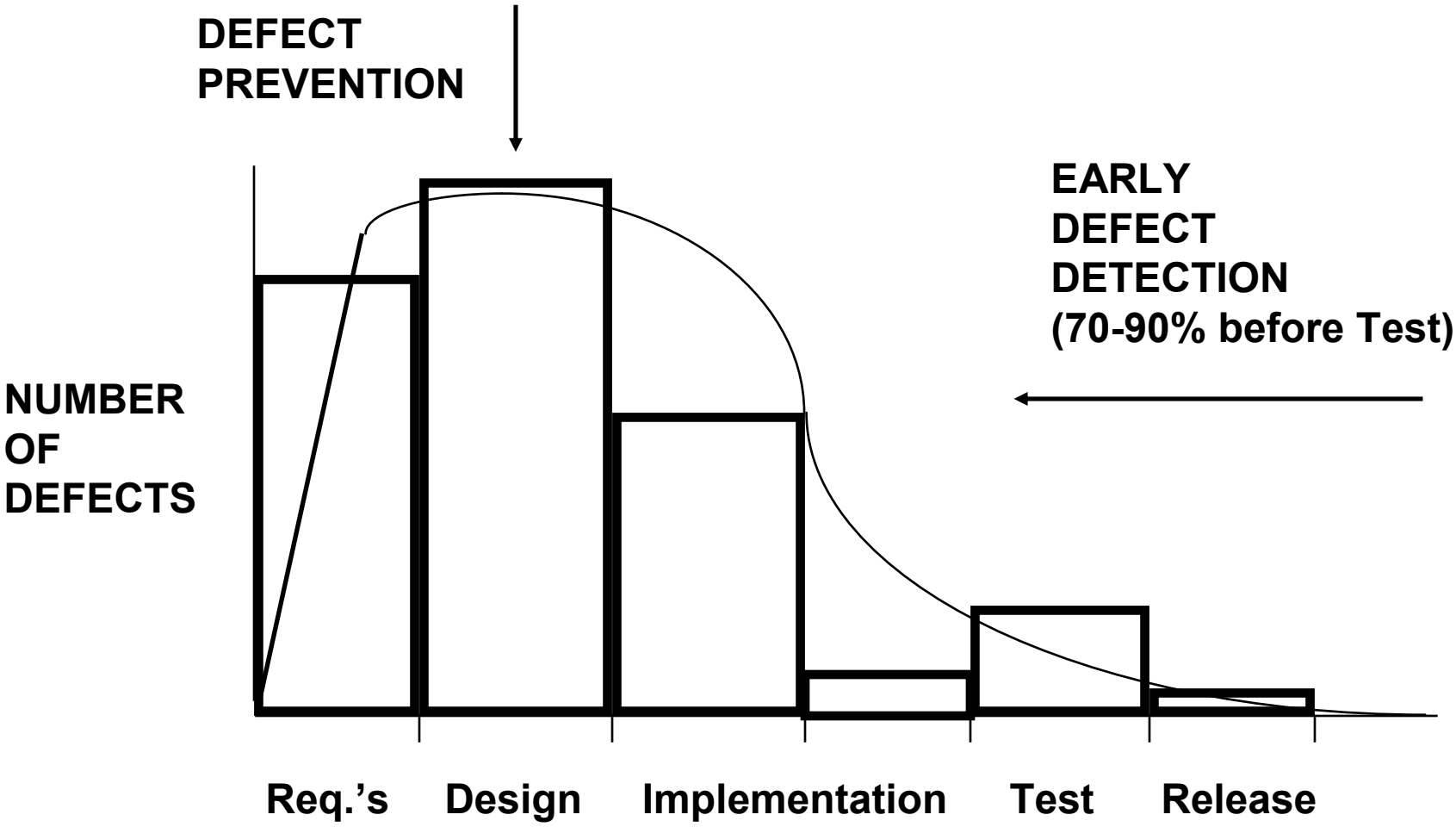


How Much Do Defects Cost?

Defects cost less to fix when detected earlier in the process



Best-in-Class Strategies



- Slide adapted from Olson, "A Software Quality Strategy for Demonstrating Early ROI", SSQ Journal, May 1995.

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Most improvement efforts have no measurable results.

Many projects do not estimate size and defects and have poor visibility into productivity and quality.

Data driven project management can provide a "metrics dashboard":

- **Performance**
- **Productivity**
- **Quality**
- **Risk**
- **ROI**

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