



SOFTWARE PRODUCTIVITY CONSORTIUM

Measurement Practices in High Maturity Organizations

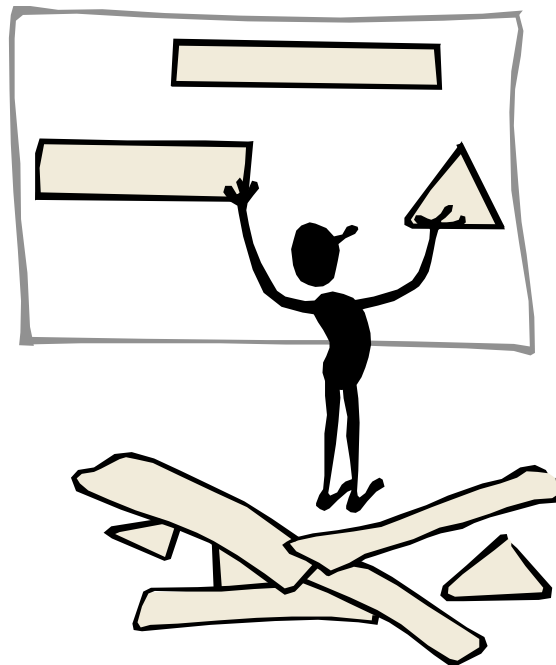
Donald V. Dortenzo
Process Improvement Specialist
703-742-7119
dortenzo@software.org
www.software.org

Topics

- Higher maturity levels context
- Quantitative Management concept
- Relevant analysis at higher levels of process maturity
- Examples
- “Common Problems”
- Summary

Basic Premise of Quality

The quality of products and services is largely determined by the quality of the processes used to provide them.



The CMM[®] for Software

Level	Process Characteristics	Management Visibility
5 Optimizing	Process improvement is institutionalized	
4 Managed	Product and process are quantitatively controlled	
3 Defined	Technical practices are integrated with management practices and institutionalized	
2 Repeatable	Project management practices are institutionalized	
1 Initial	Process is informal and ad hoc	

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Why are Levels 4 & 5 Difficult?

- Organization must set quantitative business goals
 - Levels 2 and 3 focused on **generalized improvement**
 - Levels 4 and 5 results are maximized by **necessary improvements**
- Requires a paradigm shift
 - Levels 2 and 3 achieved through **conformance**
 - Levels 4 and 5 require **initiative** and **creativity**
- Change in management focus
 - Levels 2 and 3 KPAs focus on **project measurement**
 - Levels 4 KPAs introduce **process** and **product measurement**
 - Seek to understand **organization process capability**
- New Skills are required
 - Levels 2 and 3 document **existing** software skills
 - Levels 4 and 5 require **new measurement** and **statistical skills**

Differences in Behavior

At Levels 2 & 3...

- Management reacts
 - Conducts comparative rather than statistical analysis
 - Manages to specifications
 - Does not understand process capability
- Measurement program
 - Data available for analysis
 - Analysis at project level
 - Data quality often still a concern

At Levels 4 & 5...

- Management anticipates
 - Predicts results of critical processes
 - Manages process variation and product quality
 - Evaluates outcomes relative to capability
- Measurement program
 - Data relied on for decision making
 - Data analyzed at organization and project levels

As an Example...

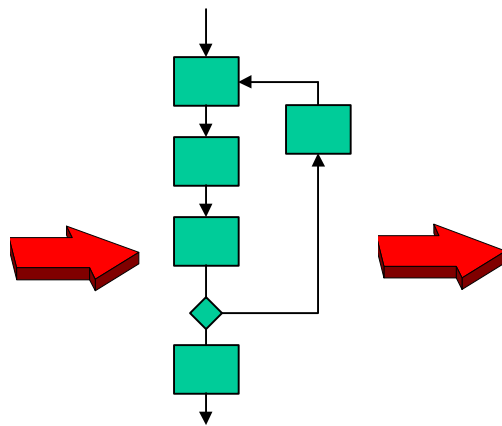
Level 3 Approach

Defined Process

Reqs

Design

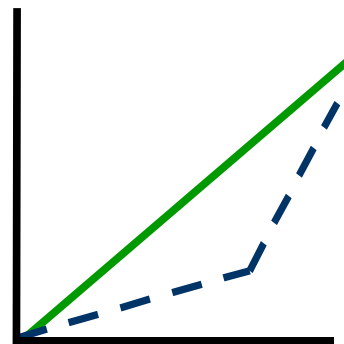
Code



Peer Review
Process

Peer Review
Types

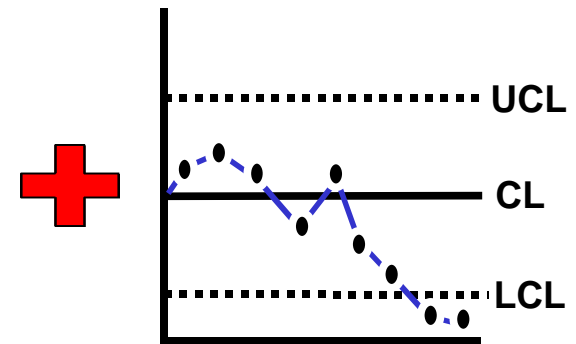
Progress and Status Measures



Are peer
reviews being
accomplished
during coding?

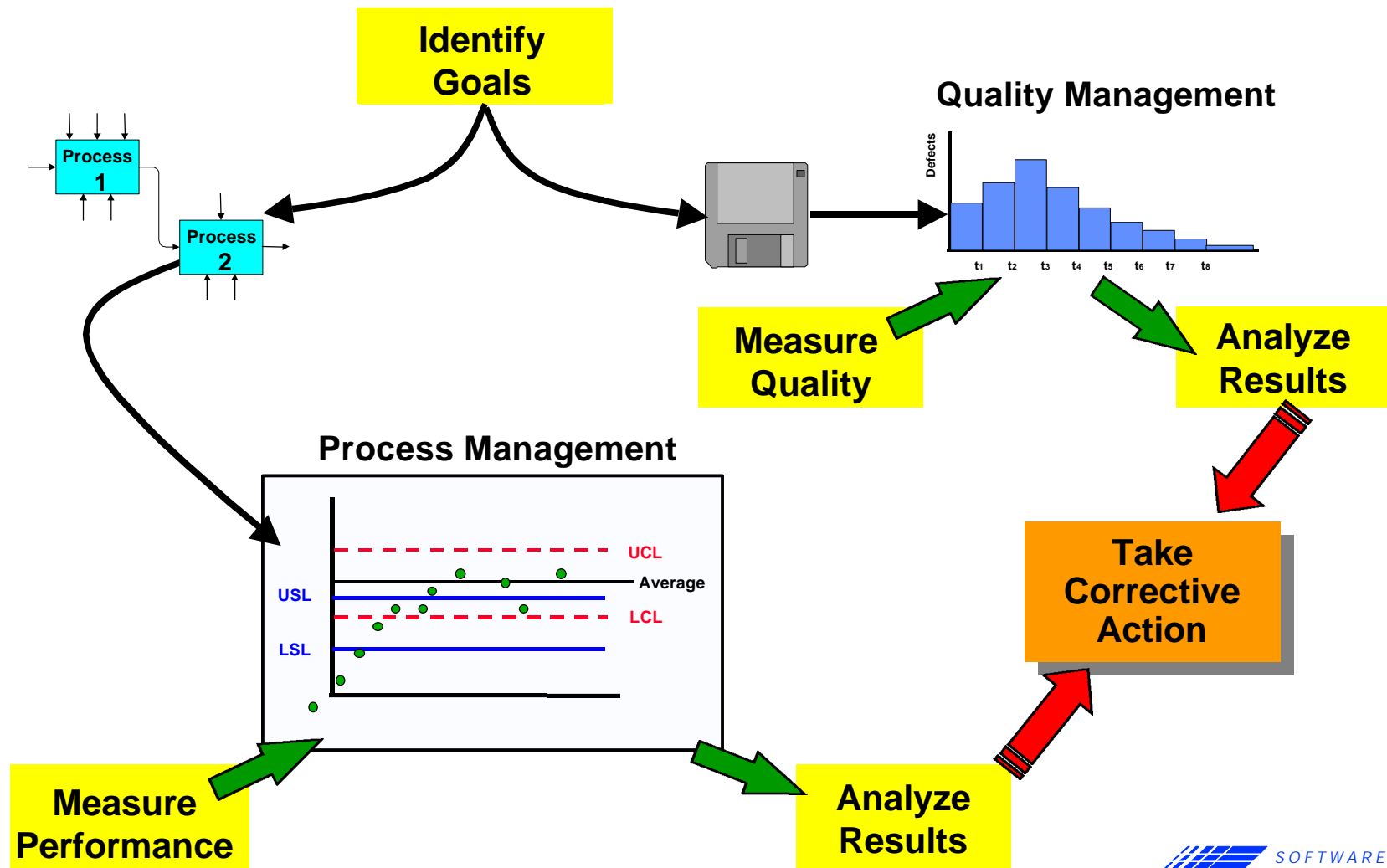
Level 4 Approach

Process Performance Measures



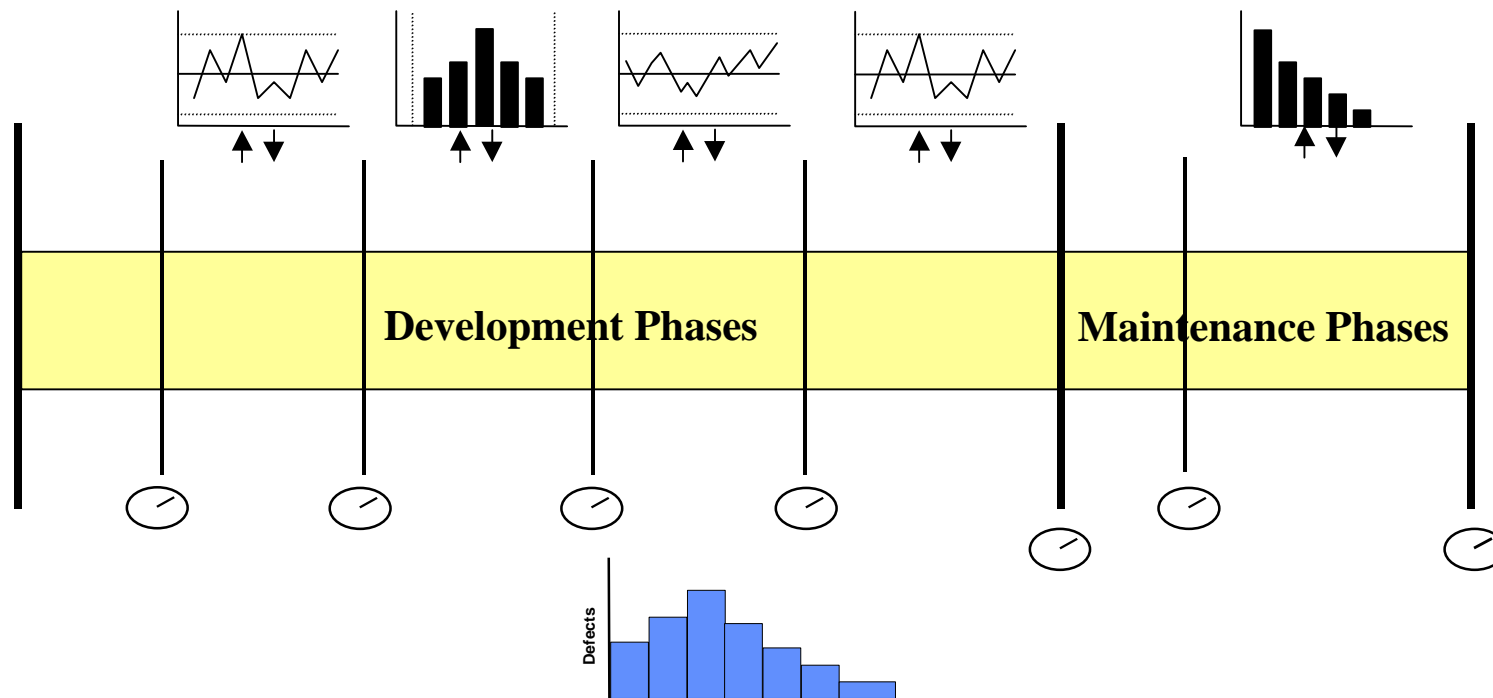
How does peer the
review process work?
How does it compare
to other projects?

Quantitative Management Concept



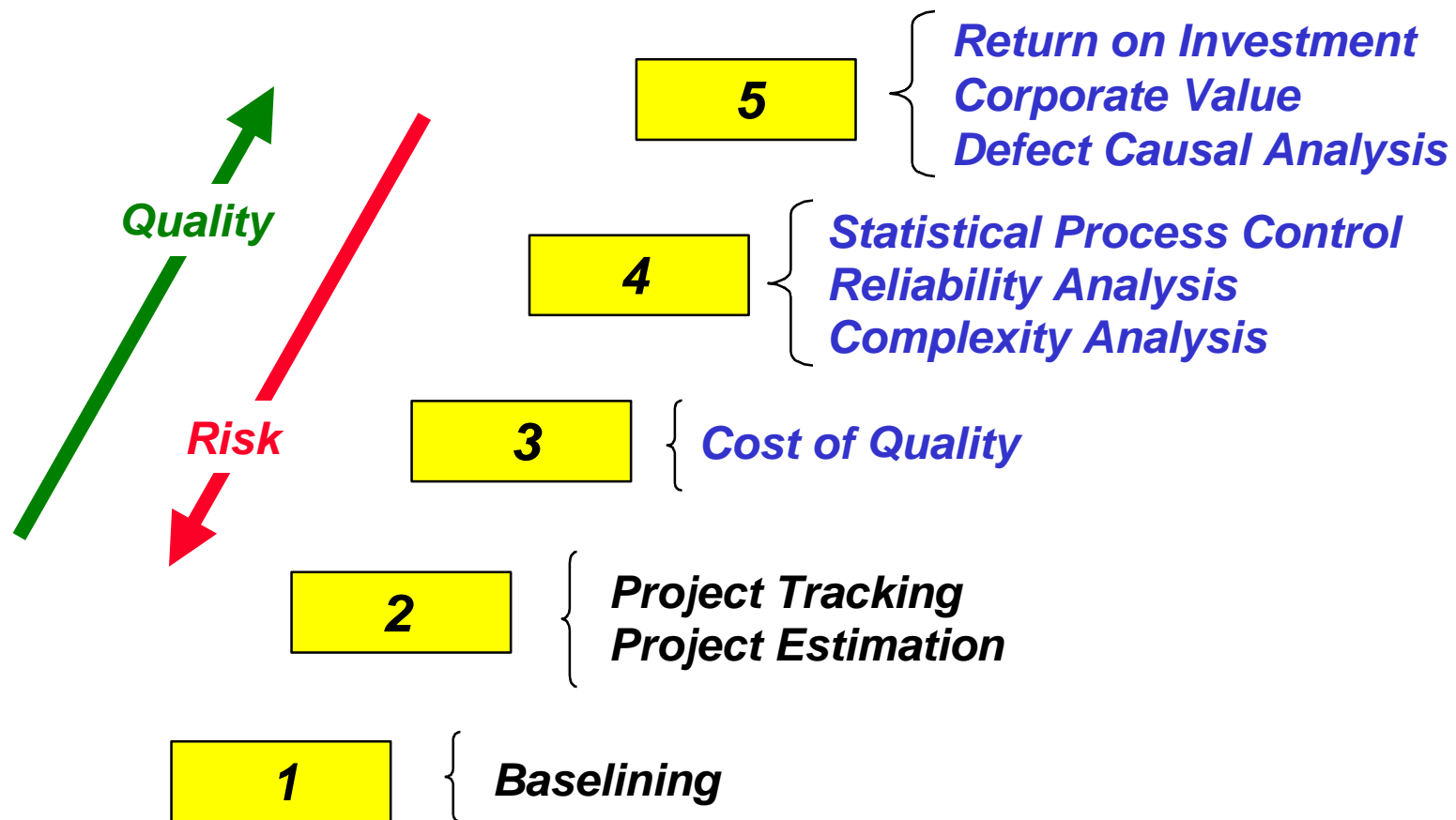
Applied Across the Life Cycle

*Critical process performance measured
in process, during process execution*

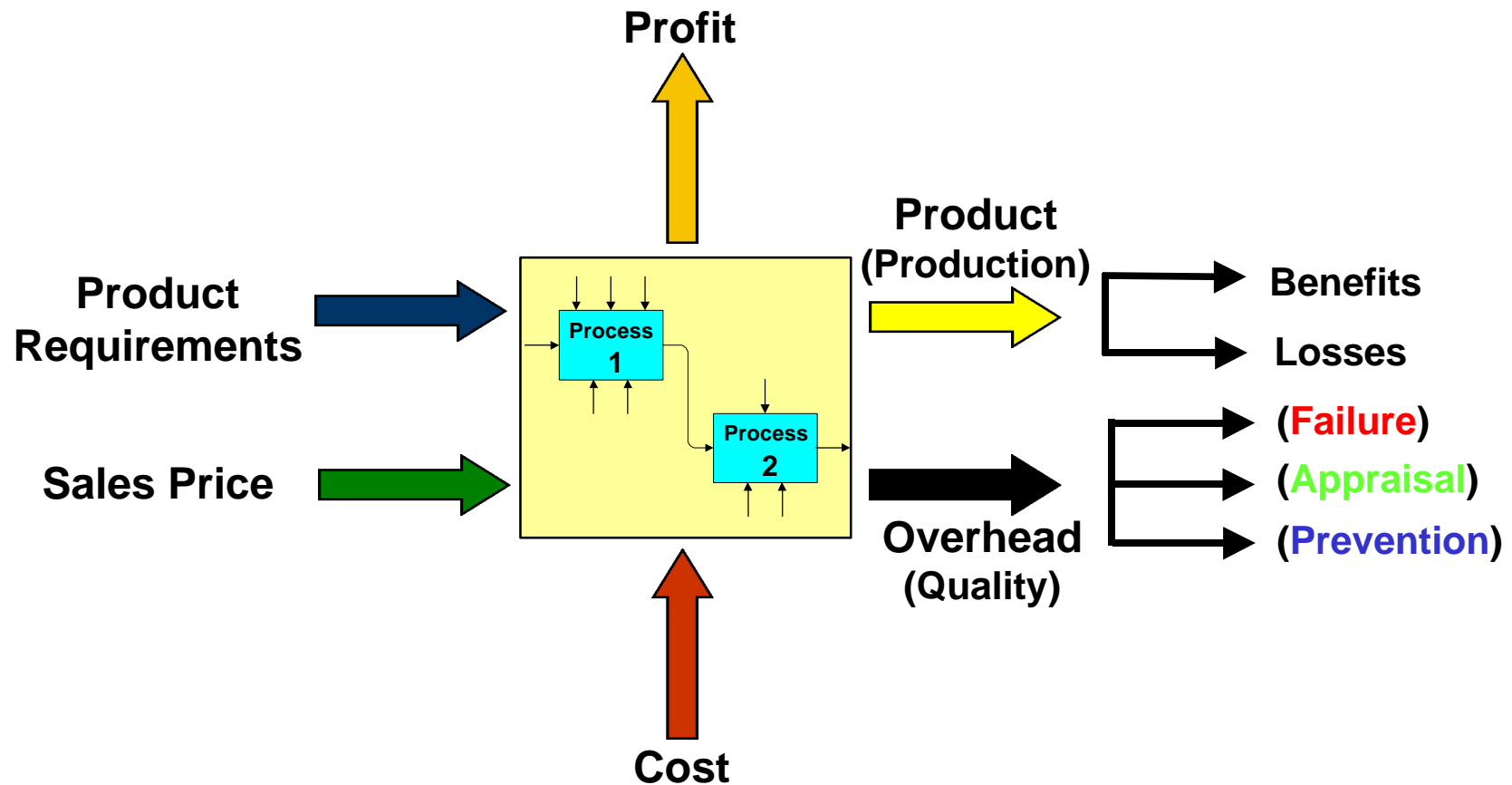


*Product quality characteristics measured
at product transition points*

Analysis of Measures at Higher Levels of Maturity



Cost of Quality Analysis



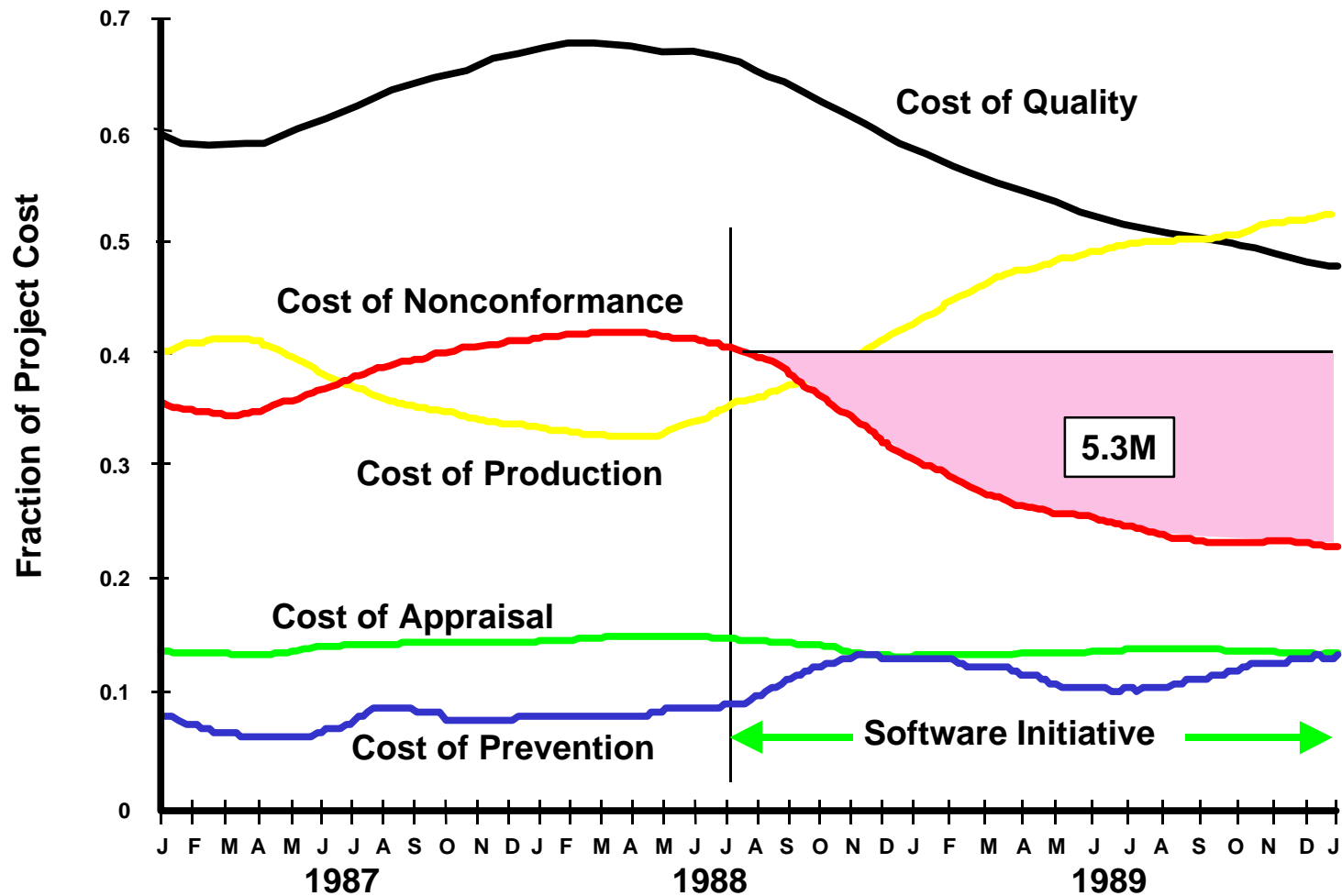
Cost of Quality Factors

Failure Costs: Effort spent fixing non-conformances (i.e., rework)

Appraisal Costs: Effort spent finding non-conformances (i.e., inspections and testing)

Prevention Costs: Effort spent to avoid non-conformances (i.e., building in quality)

COQA Example (1)



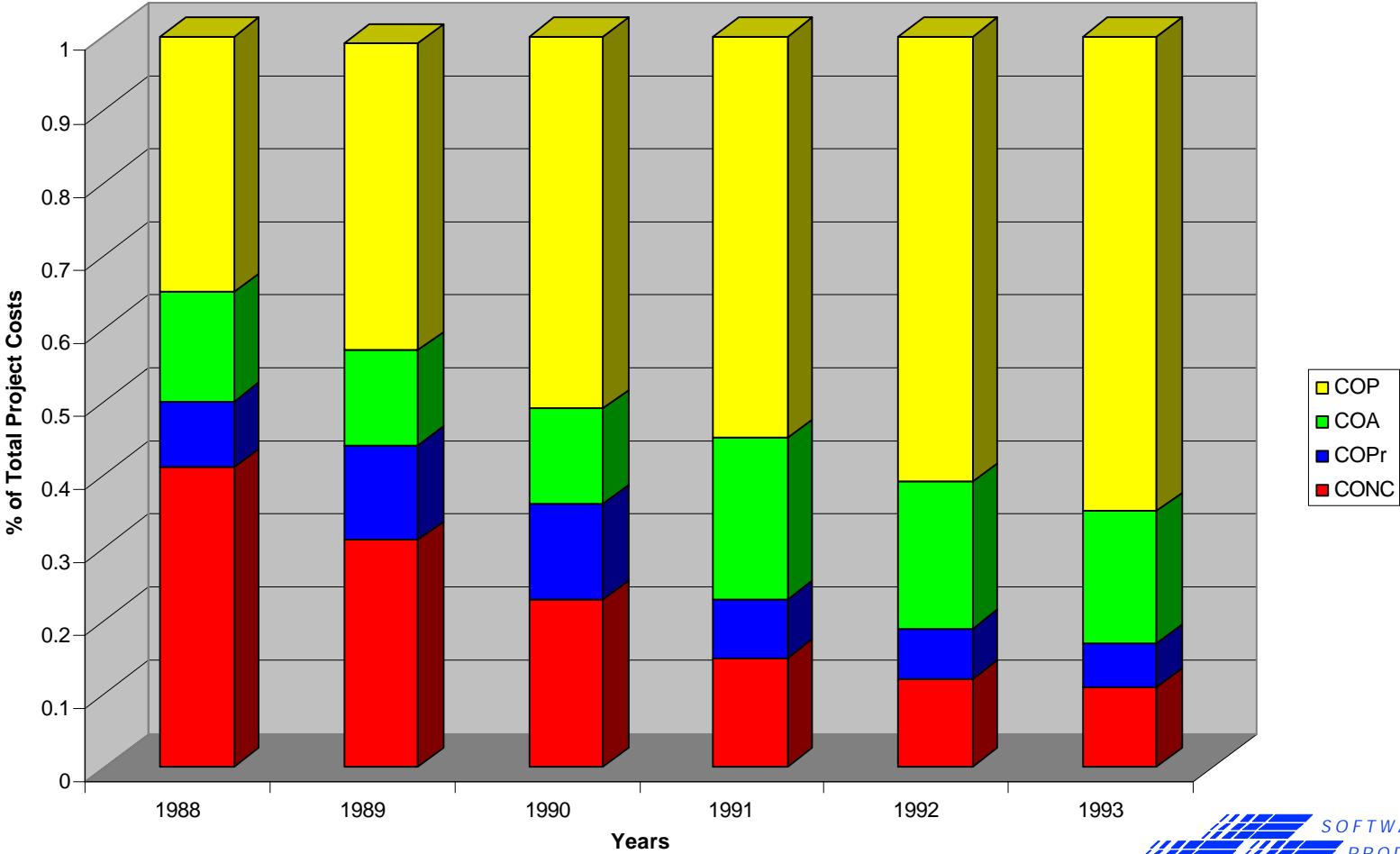
Source: R. Dion, "Quantifying the Benefit of Software Process Improvement," presented at AIAA Software Process Improvement Workshop (November 1990).

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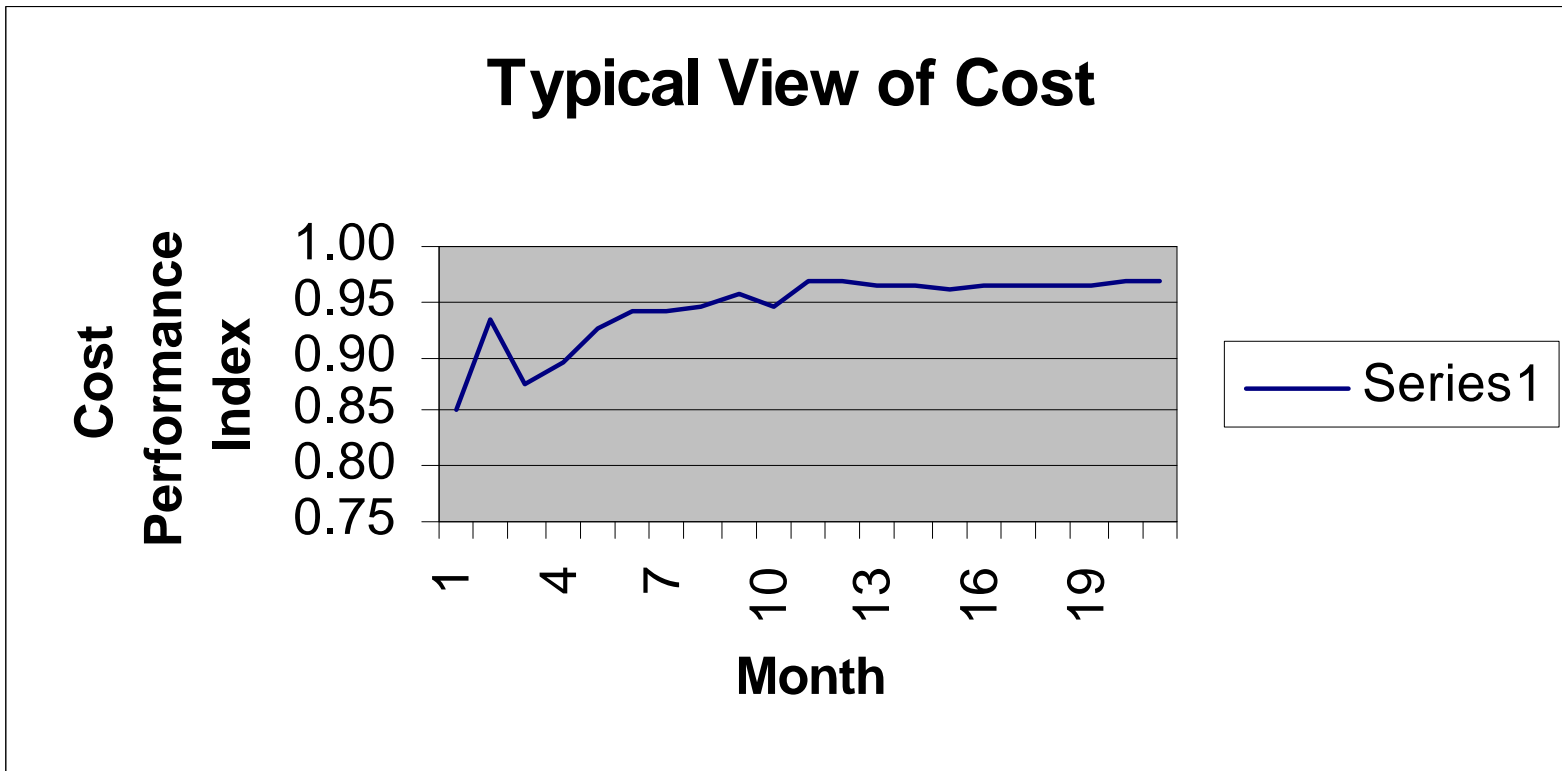


COQA Example (2)

Reduction in COQ



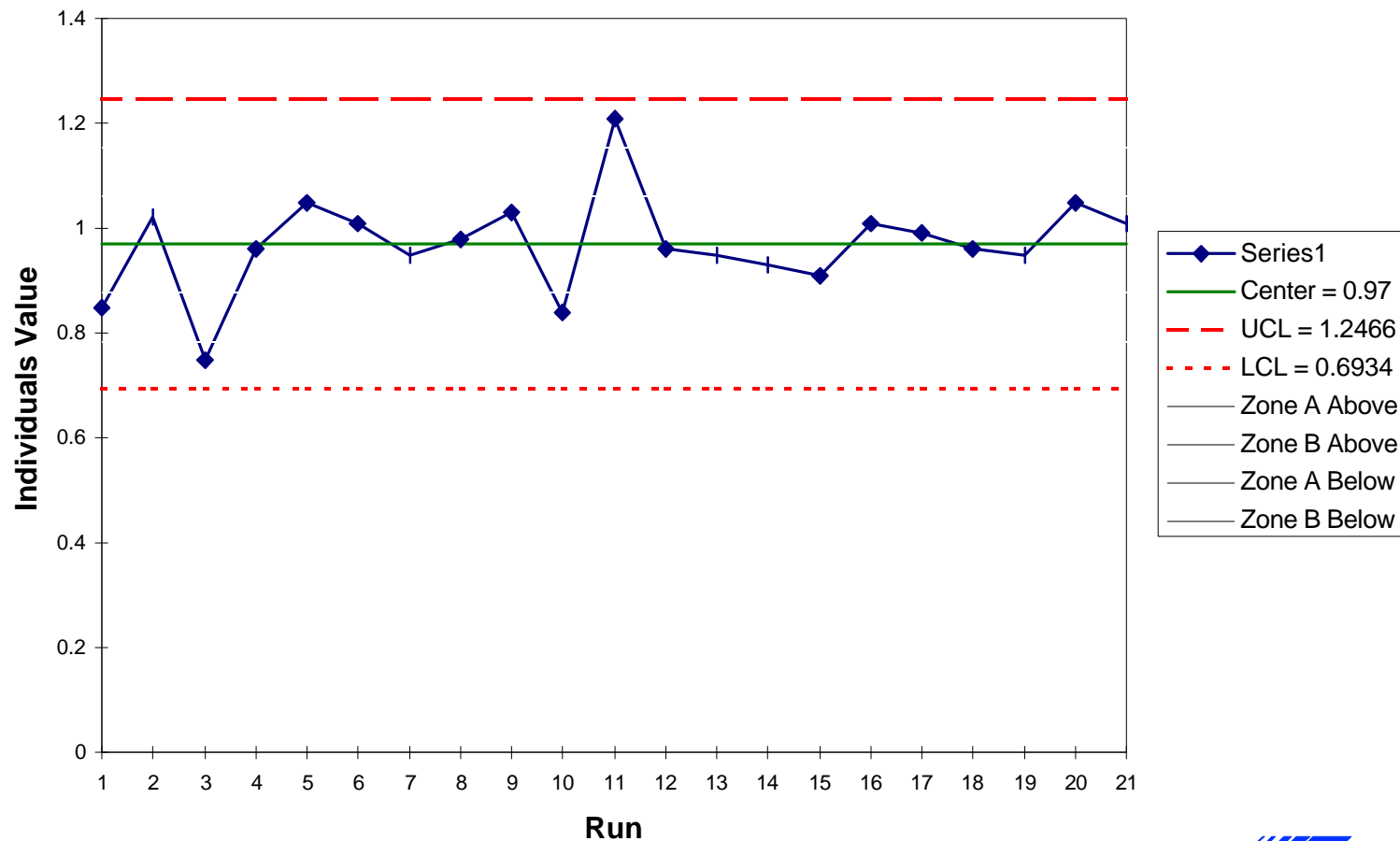
Monthly CPI Example



$$\text{Cost Performance Index} = \frac{\text{Budgeted Cost of Work Performed}}{\text{Actual Cost of Work Performed}}$$

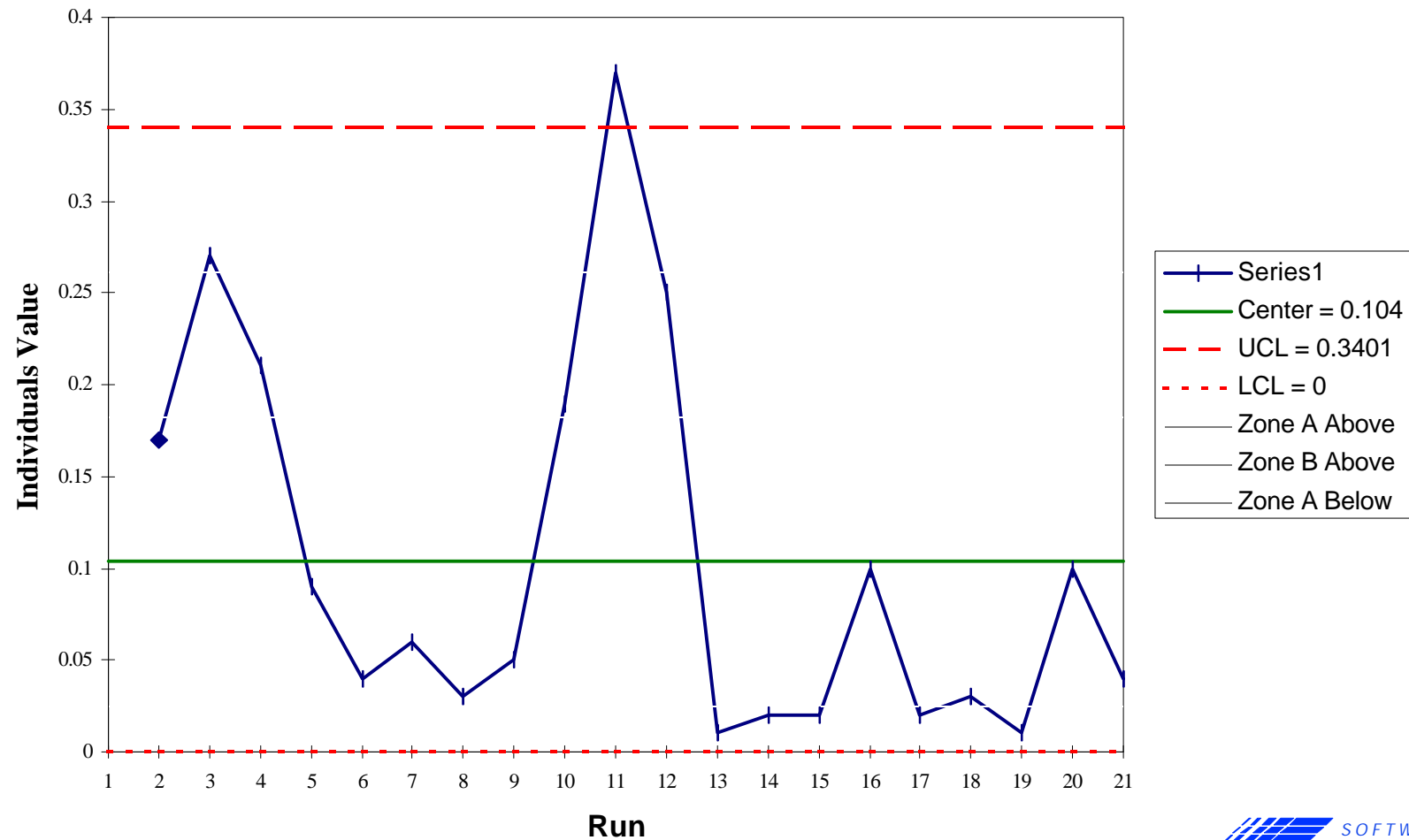
Individuals Chart for Monthly CPI

Individuals chart with Shewhart Control Limits






Range Chart for Monthly CPI

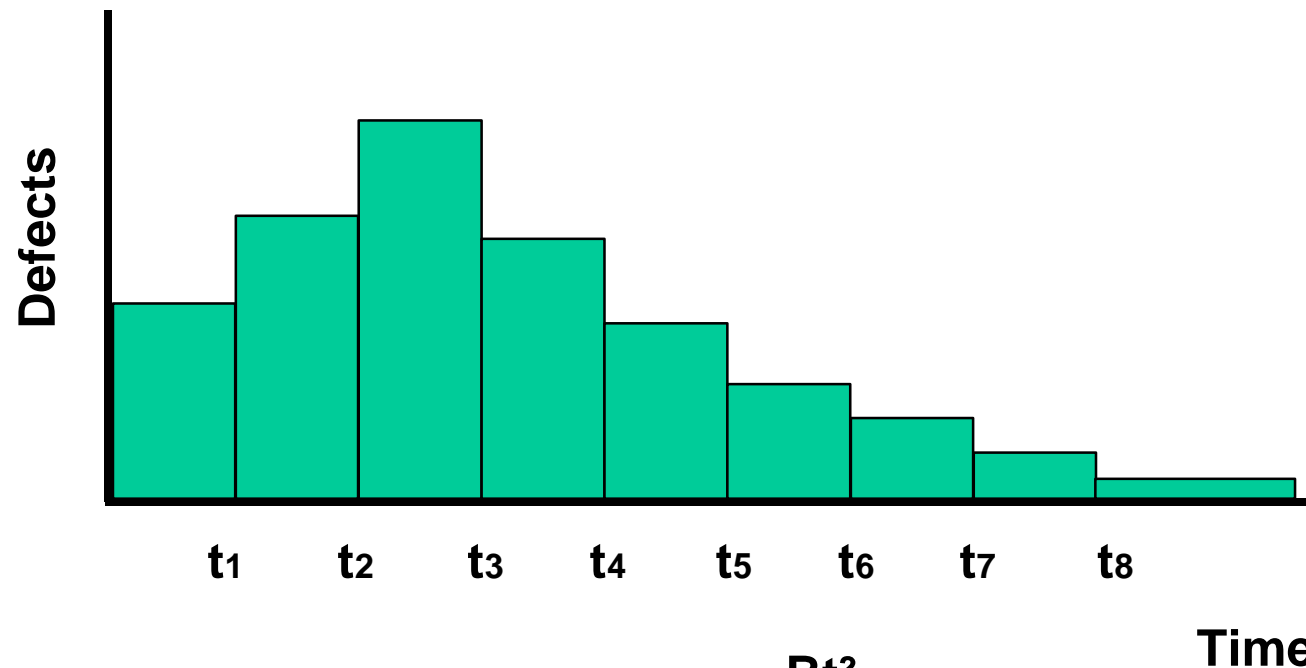
Range chart with Shewhart Control Limits



Quality Models

- Choice of models depends on prioritization of quality goals
 - Functionality  Defect Model
 - Maintainability  Complexity Model
 - Reliability  MTTF Model
- Start small
- Evaluate and improve the effectiveness of the selected model(s) over time

SWEEP Model



$$V_t = E (1 - e^{-Bt^2})$$

Where:

V = Number of defects discovered by time t

E = Total number of defects inserted

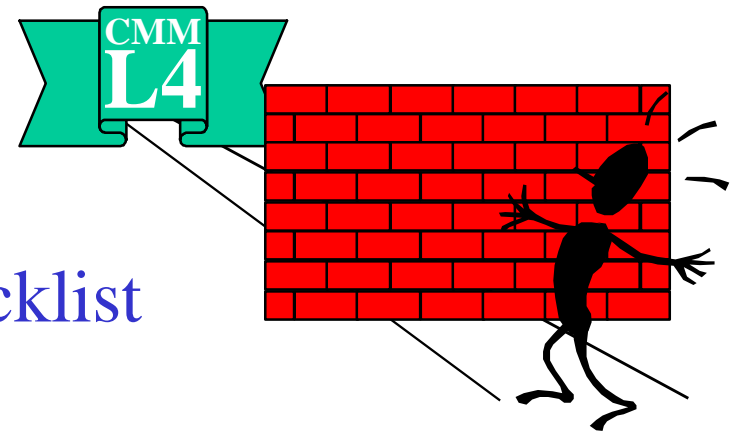
B = Location parameter for peak

Using a Defect Model

- Determine the maximum acceptable defect rate (number of defects) at delivery
- Use the model to determine the maximum acceptable defect rate at earlier milestones or for earlier activities
- These maximum rates become the goals in the QP and the specification limits for control charts and process capability analysis

Observed “Common Problems”

- No clear understanding of
 - Intent of CMM Level 4/5
 - Infrastructure required
- The CMM is viewed as a checklist or legal document
- Improvement not tied to the bottom line
 - Improvement for improvement’s sake (to make a statement)
 - Generalized improvement mantra (better, faster, cheaper)
- Weak or dysfunctional measurement program
 - Measurement not a priority
 - Measurement data not used to effectively manage
 - Little or no previous validation of collected data



Summary

- Measurement scales and data distributions are often not known in advance
- Best measure and best analysis technique can't be decided "a priori" except in controlled experiments
- Data problems are the first obstacle to overcome for accurate analysis
- Understand the data first, then select techniques - adapt as you learn more
- Issue or goal driven measurement is correct "mind set" needed to advance measurement as process maturity increases

Questions or Comments...

