NDIA CMMI Technology Conference

Looking Beyond Quantitative Defect Management

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Presentation Agenda

- Background
- Issues involved
- Where do we need to look and why
- Recommendation – “The Three-Prong Approach“
- Defect insertion vs. detection analysis
- An integrated approach to defect analysis
- A robust causal system
- Summary
- In closing

Background

- Organizations aspiring to be (or operating at) high CMMI maturity levels generally focus on defects
- Typically they collect defects from work product inspections or reviews in development phases
- For CMMI Maturity Levels 4 and 5, it is required to quantitatively manage and statistically analyze the defects to:
  - Understand the impact of common as well as special causes of variations
  - Perform root cause analysis of high impact defects

Issue is …

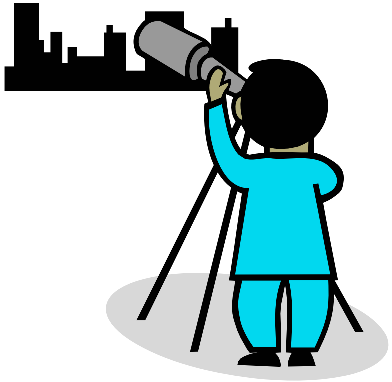
Quantitative defect analysis most often focuses on "quantity" of defects, not other aspects of defect analysis, such as:

- Defect prevention throughout the development lifecycle
- How early are the defects detected after getting inserted?
- What is the "chasm" between defect insertion and defect detection?
- How do we reduce this "chasm" and thus cause left-shift in phase detection of defects?
- What is the cost-effective approach to impact both quantity of defects and early detection of defects?

Looking Beyond … Where?

Need to:

- Have a defect management approach that complements quantitative analysis
- Analyze defect insertion, detection, and correction process
- Consider other significant defects beyond the software and systems defects detected through peer reviews and inspections
- Review defects from more of an integrated engineering view rather than a single functional discipline view
- Examine the effectiveness of the causal system and apply it to a broader range of anomalies and opportunities than just defects



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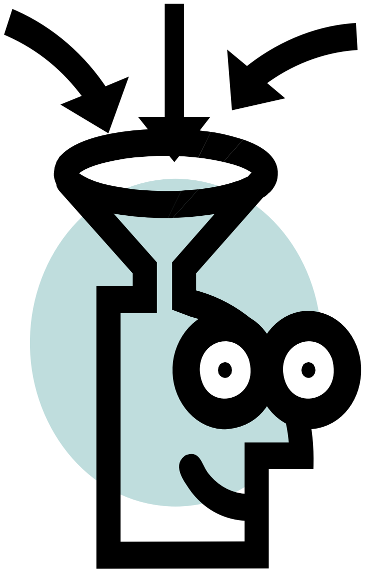
Why is it important?

- Quantitative management and application of statistical control techniques for defect analysis is “necessary” but not “sufficient”
- Defects getting detected at later development lifecycle phases do not receive the scrutiny of the quantitative management
- A non-integrated approach of defect management misses out on some of the key opportunities of addressing defect prevention and early detection in the most cost-effective manner
- Lacking a robust causal system leads to treating the symptoms rather than addressing the causes of deeper issues

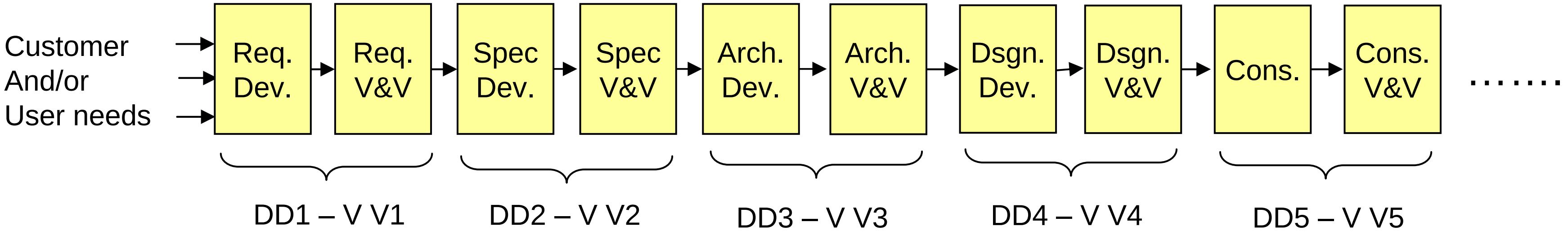
The Answer is …



A Three-Prong Approach:

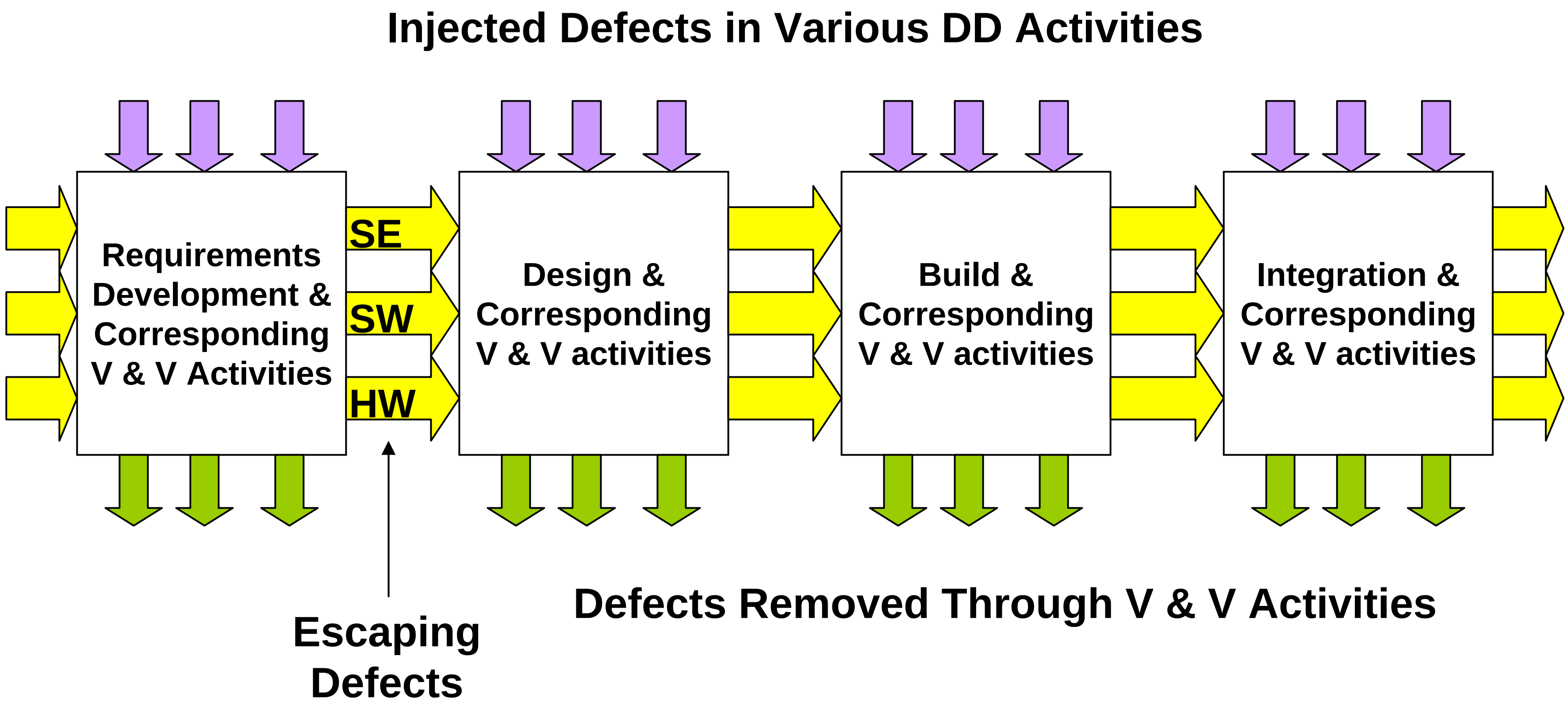
- Reduce the gap between phase of defect insertion and defect detection
- Adopt an engineering integrated approach to defect analysis
- Apply a robust causal system

Engineering Development Lifecycle



- Engineering development lifecycle can be considered as a series of 1 to n Design-Development (DD) activities followed by a corresponding Verification and/or Validation (V & V) activities
- Assumptions:
  - One or more functional disciplines (Software, Systems, Electrical Hardware, Mechanical, etc.) are working in parallel in various phases
  - Every functional discipline may or may not be performing a corresponding V & V activity after its DD activity
  - Parts of the development lifecycle may be repeated incrementally and/or iteratively

Engineering Development – Defects Injection & Removal



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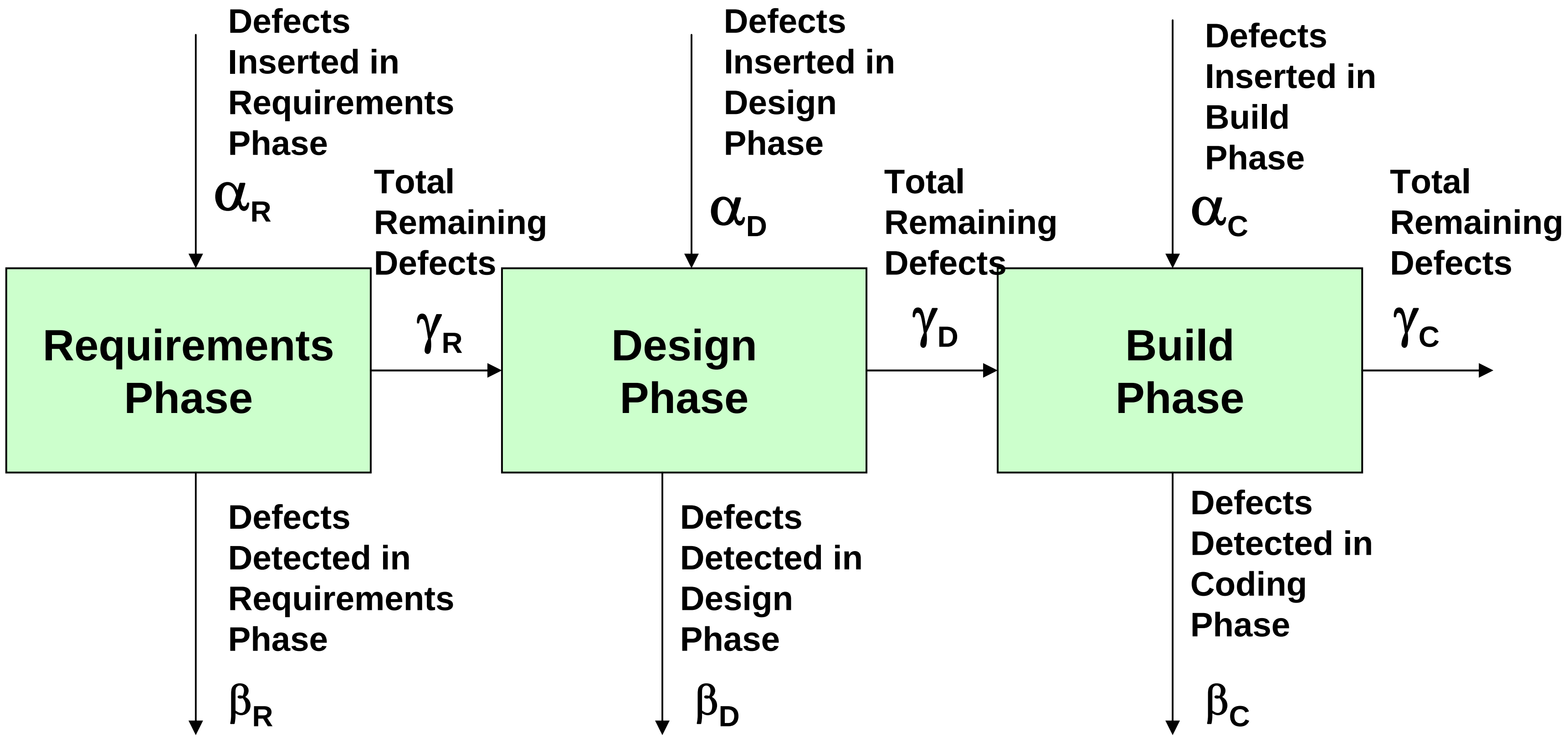
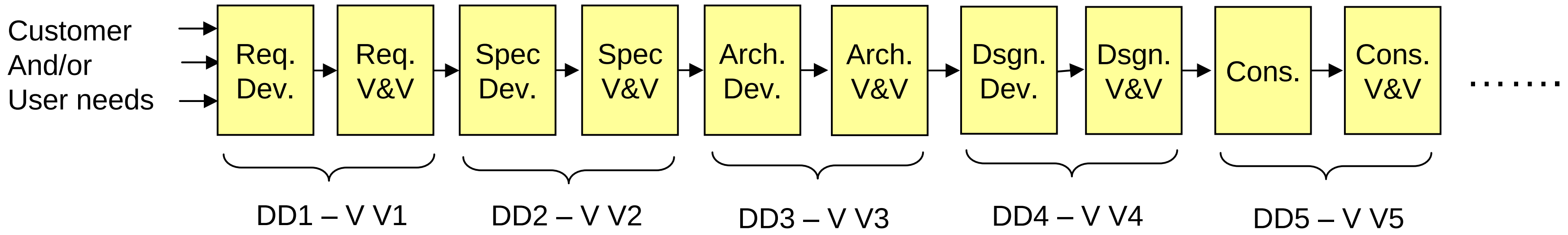
Conceptual Defect Insertion/Detection Model



$\alpha_R >= \beta_R$ **Total Defects in Design Phase, T =** $\gamma_R + \alpha_D$ **and so on …**

$\beta_D < T$

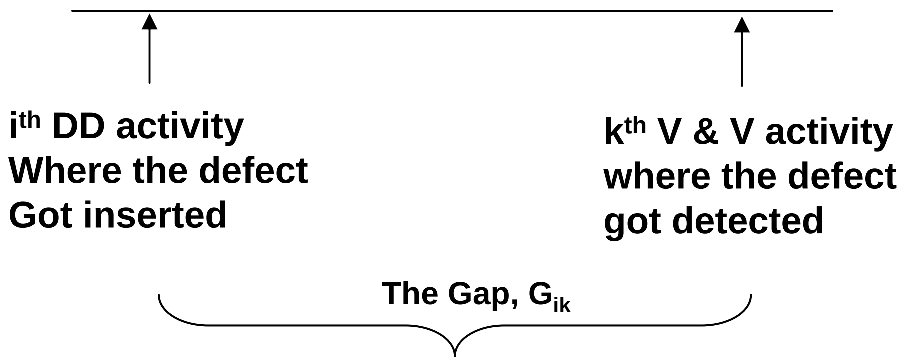
Defect Insertion vs. Detection (1)



- A defect detected in k^{th} V & V activity might not have been inserted in the corresponding preceding kth DD activity
- Usually it is an earlier DD activity of the same or a different functional discipline in which the defect got inserted
- In some extreme cases, the defect might have been inserted in an earlier DD activity of a different spiral/iteration

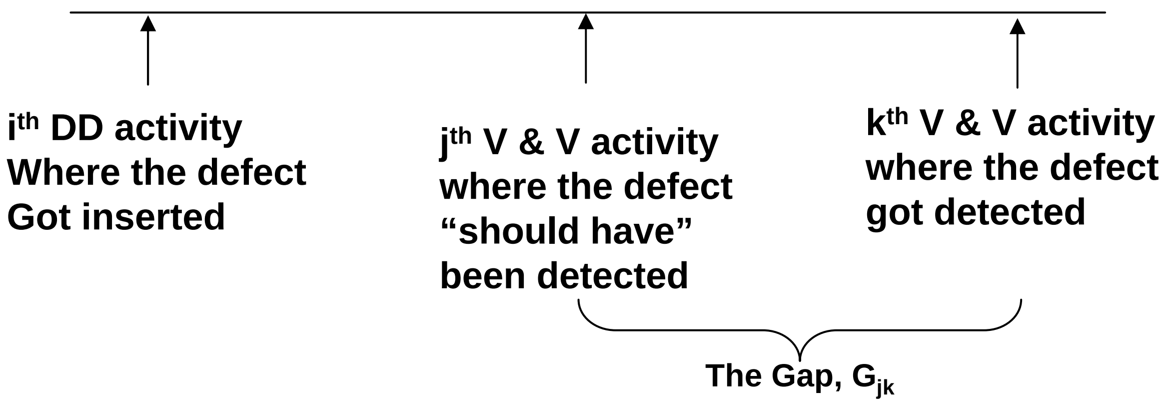
Defect Insertion vs. Detection (2)

- Ideal Case: A defect inserted in the k^{th} DD activity gets detected in the k^{th} V & V activity
- Typical Case: A defect inserted in the k^{th} DD activity gets detected in the i^{th} V & V activity, where i^{th} activity is an earlier DD activity in the time sequence
- The gap, G_{ik} is the number of intervening V & V activities between the i^{th} and the k^{th} V & V activities
- One would like the gap, G_{ik} to be zero



Defect Insertion vs. Detection (3)

- Practically, it may not be possible to get this ideal state because it may be one of the intervening V & V activities (like a simulation) that might have been the only practical first V & V activity to detect the defect
- Analyze which V & V activity "should have" detected the defect; let us assume it is jth V & V activity



- It is this real gap, G_{jk} – let us call "***Opportunity Gap"***, that must be reduced

Defect Insertion vs. Detection Analysis (1)

- For each significant defect in each V & V activity, we need to collect and analyze:
  a) Sequence number of the DD activity where the defect got inserted
  b) Sequence number of the V &V activity where the defect got detected
  c) Sequence number of the V &V activity where the defect should have been detected (by default, it should be same as for defect inserted)
- Calculate Opportunity Gap (OG) = difference of sequence numbers between (b) and (c)
- Best Case: OG being zero, i.e., no V &V activity missed detecting the defect
- Typical Case: OG being greater than zero;   i.e., 1 or more V &V activities missed detecting the defect

Defect Insertion vs. Detection Analysis (2)

- Goal: Reduce OG for all significant defects
- Further analyze the data for:
  - Which V & V activities are able to detect more defects?
  - Which DD activities are more error prone in inserting defects
  - Which VV activities are more prone to missing defect detection?
- This analysis should lead to strengthening:
  - Those V & V activities that are missing defect detection
  - Those DD activities that are prone to defect insertion
- Over time – with appropriate process adjustments – OG should be reducing

Benefits of The Approach

- By paying close attention to defect insertion and detection, the process changes will be applied where it would be most needed
- Over time, most of the defects will tend to be detected in the earliest possible detection opportunity
- Over time, most of the defect detection will have a “left shift” effect
- This will lead to the most cost effective DD and V&V activities, also impacting product development cycle time and quality

Need for an Integrated Approach to Defect Analysis

- Defects detected in the later development lifecycle phases are usually more complex – they impact most disciplines, are the most expensive to fix, and require broader & deeper scrutiny

- Often superficial analysis leads to categorizing the detected defect in one or the other discipline, while it may have been best addressed in a multi-discipline approach for the most optimal solution

- Addressing only a subset of root causes of the problem may lead to a partial or sub-optimal solution

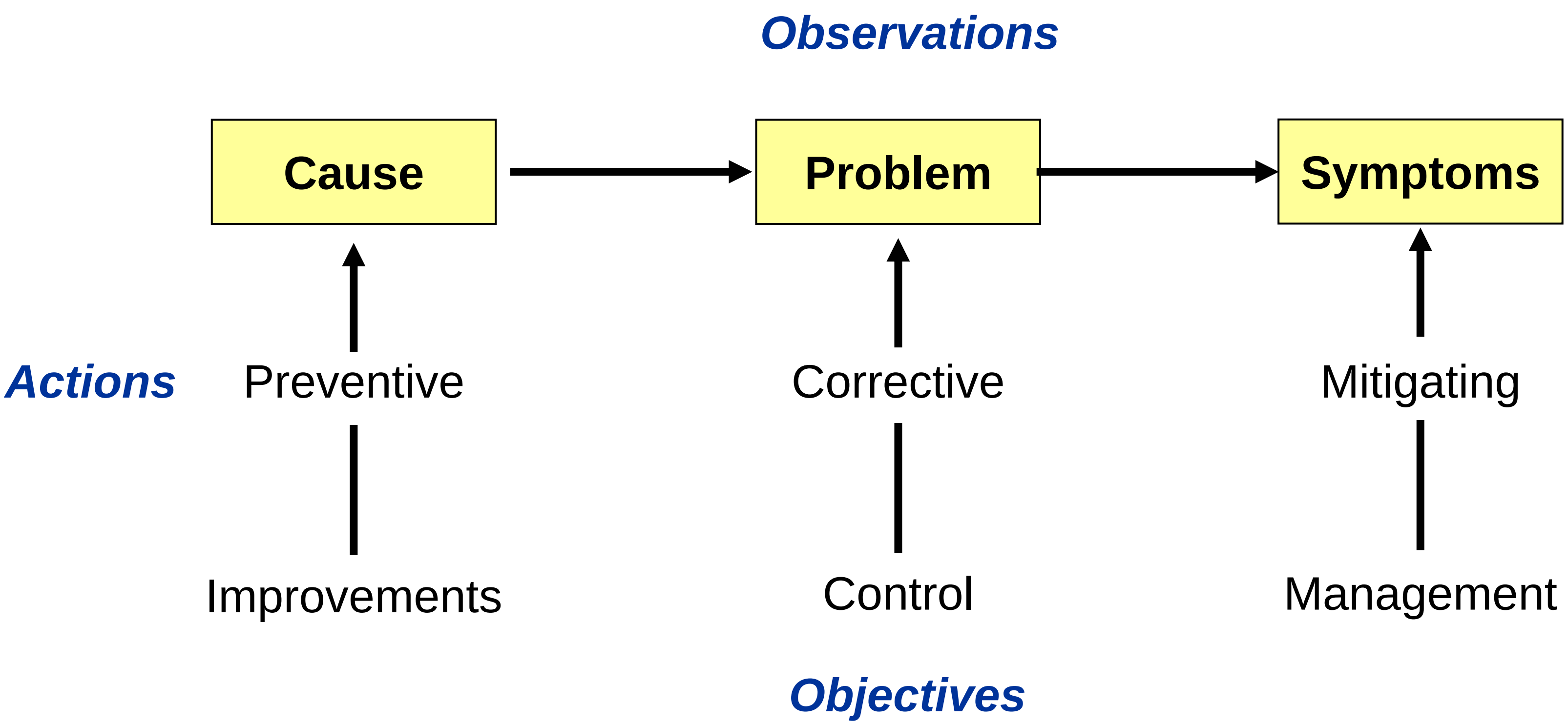
An Integrated Approach to Defect Analysis

- Record all integration and systems test defects in a cross-discipline engineering defect tracking system
- Review the detected defects in a multi-discipline team to:
  - Analyze all possible causes of the problem
  - Assess the impact in all subsystems/components in all functional disciplines
  - Identify an optimal near-term solution while simultaneously analyzing if there is a better longer-term solution for later implementation
- Implement the identified solution using a systems approach
- Address root causes of the defect to implement preventative actions for the future

Need for a Robust Causal System

- Inadequate root cause analysis may lead to:
  - Treating the symptoms rather than the problem
  - Addressing the wrong problem
- A robust causal system would help uncover real causes of the problems so that actions could be taken to avoid similar problems in the future
- Addressing root causes of the problems is one of the most effective defect prevention mechanisms

A Robust Causal System (1)



Elements of a Causal System

Reference: Card, David N. “Understanding Causal Systems” CrossTalk, October 2004

A Robust Causal System (2)

- For each significant defect:
  - Isolate and Identify symptoms and problem
  - Use Ishikawa diagram approach to identify all the root causes of the problem
  - Understand that it may produce multiple symptoms
  - Identify all possible causes that may have contributed to the problem
- Identify appropriate preventive, corrective, and mitigating actions to address causes, problem, and the symptoms

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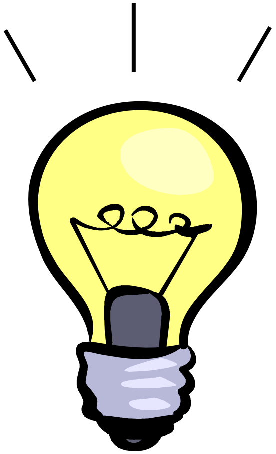
Summary

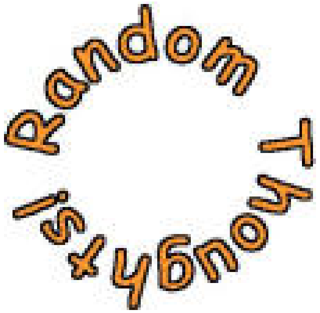
- The Three-Prong Approach needs to complement, not replace, quantitative defect management and statistical control
- Defects needs to be detected in the earliest possible V & V activity
- Adopt an integrated systems approach to address the significant problems identified in the later development lifecycle phases
- Use a robust causal system to analyze significant defects and their root causes

In closing …



Reducing the number of defects is as important as preventing them and detecting them at the earliest opportunity.

Thank You!



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