Successful Verification and Validation Based on the CMMI^{SM} Model

NDIA 2003 CMMI^{SM} Conference

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Presentation Objectives

Briefly describe the purpose and benefits of verification and validation (V&V).

Describe the EEVVA Model and how it maps to the CMMI^{SM}.

Describe some best-in-class V&V processes and results.

Answer any questions.

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Outline

V&V Overview

EEVVA Model

Some Best-In-Class V&V Processes

Summary

Questions and Answers

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Verification and Validation Concepts

<u>Verification:</u> compares intrinsic properties of a work product to policies, standards, processes, procedures, requirements, etc.

<u>Validation:</u> compares the information content of a product or product component to extrinsic properties (i.e., Is the customer's need met? Does the product fulfill its intended use?).

<u>A short-hand rule to help remember V&V:</u>

- **Verification: "Am I building the product right?"**
- **Validation: "Am I building the right product?"**

• B. W. Boehm, "Verifying and Validating Software Requirements and Design Specifications", IEEE Software, Vol.1, No.1, 1984

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CMMI^{SM} Verification

"The purpose of Verification is to ensure that selected work products meet their specified requirements."

"Verification is inherently an incremental process because it occurs throughout the development of the product and work products, beginning with verification of the requirements, progressing through the verification of the evolving work products, and culminating in the verification of the completed product."

• Reference: "CMMI^{SM} for Systems Engineering, Software Engineering, IPPD, Supplier Sourcing", CMMI-SE/SW/IPPD/SS, Continuous Version, Version 1.1

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CMMI^{SM} Validation

"The purpose of Validation is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment."

"Validation activities can be applied to all aspects of the product in any of its intended environments, such as operation, training, manufacturing, maintenance, and support services. The methods employed to accomplish validation can be applied to work products as well as to the product and product components. The work products (e.g., requirements, designs, prototypes) should be selected on the basis of which are the best predictors of how well the product and product component will satisfy user needs."

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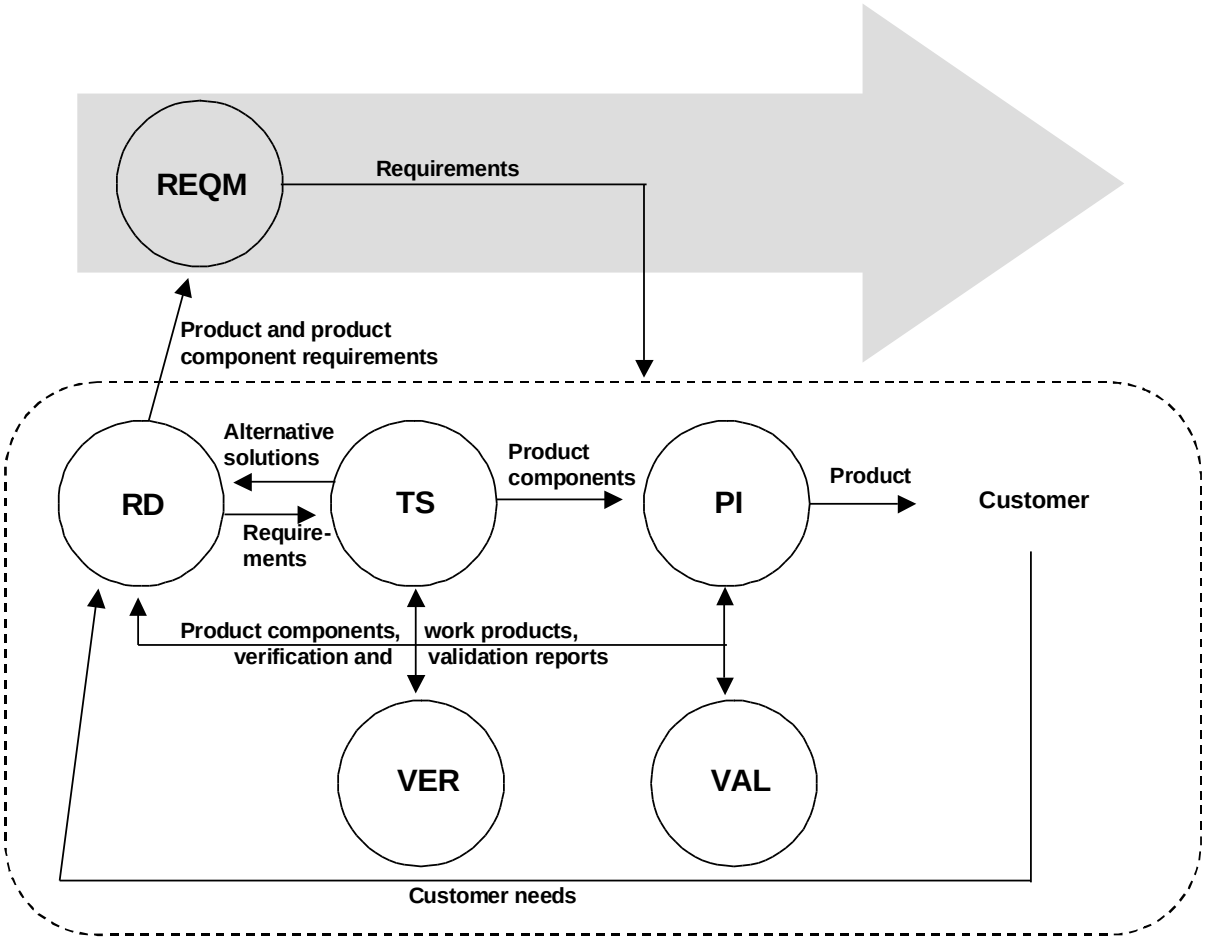
CMMI^{SM} Engineering PAs



• Reference: "CMMI^{SM} for Systems Engineering, Software Engineering, IPPD, Supplier Sourcing", CMMI-SE/SW/IPPD/SS, Continuous Version, Version 1.1

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V&V Benefits

V&V activities are important because they:

- **Ensure that requirements are met.**
- **Remove defects from the product through out a project's life cycle, reduce rework, and reduce the cost of poor quality.**
- **Ensure that user needs are met and ensure the the product fulfills its intended use when placed in its intended environment.**
- **Improve the quality of the process and the product.**
- **Improve productivity and performance.**

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EEVVA Model

EEVVA	Review Purpose/Type
Education	Communication; Raise Issues (e.g., Walkthroughs)
Evaluation	Raise issues; Consensus (e.g., Peer Reviews)
Verification	Verify req.s; Remove defects (e.g., Inspections)
Validation	Meet user needs (e.g., User Groups)
Assurance	Product and process assurance (e.g., Audits)

•Adapted from Ebenau, *Software Inspection Process*, McGraw Hill, 1994

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Mapping EEVVA to CMMI℠

Education is in the CMMI℠, but not necessarily aligned with verification or validation (e.g., using walkthroughs for education).

Evaluation is implied in the CMMI℠.

Verification was in the CMM® (e.g., testing, peer reviews, etc), but not explicit. Verification is explicit in the CMMI℠.

Validation was missing in the CMM®, but is explicit in the CMMI℠.

Assurance is also explicit in the CMMI℠ (e.g., PPQA).

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EEVVA to CMMI^{SM} Summary

The major strength of EEVVA is that it helps organizations to have an explicit objective for each type of review.

EEVVA also provides additional objectives for reviews not explicitly in the CMM® or CMMI^{SM} (e.g., education, evaluation).

CMMI^{SM} supports EEVVA (better than the CMM®).

However, there are some V&V best practices that are not required in CMM® or CMMI^{SM}.

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Best-In-Class Verification

Prevent and remove defects/problems as early in the life cycle as possible.

Use inspections, peer reviews, and walkthroughs to verify life cycle work products (e.g., requirements, design, implementation, etc).

Use education (e.g., walkthroughs) to share product knowledge with professionals.

Use testing best practices to remove remaining defects (e.g., unit test, integration test, system test, regression testing, reliability/statistical testing).

Use verification processes as early as possible.

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Best-In-Class Validation

Remove problems as early in the life cycle as possible (e.g., meet with users/customers).

Use validation processes (e.g., user group meetings, reviews, prototyping) to validate life cycle work products (e.g., requirements, use cases).

Educate users/customers on the product (e.g., usage scenarios, product training, etc).

Use validation best practices to prevent and detect remaining defects/problems (e.g., simulation, acceptance testing, etc).

Use validation processes as early as possible.

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Example V&V Activities

EXAMPLE VERIFICATION ACTIVITIES

REQUIREMENTS	DESIGN	IMPLEMENTATION	TEST	RELEASE
Inspect 100% SyRS/SRS	Peer Review 100% Designs	Inspect 100% Critical Implementation	Reliability/ Statistical Testing	Verify Changes
Use Cases; User Reviews; Customer Priorities	Prototyping; Decision Analysis & Resolution	Simulation	Acceptance Testing	User/ Customer Feedback Reviews

EXAMPLE VALIDATION ACTIVITIES

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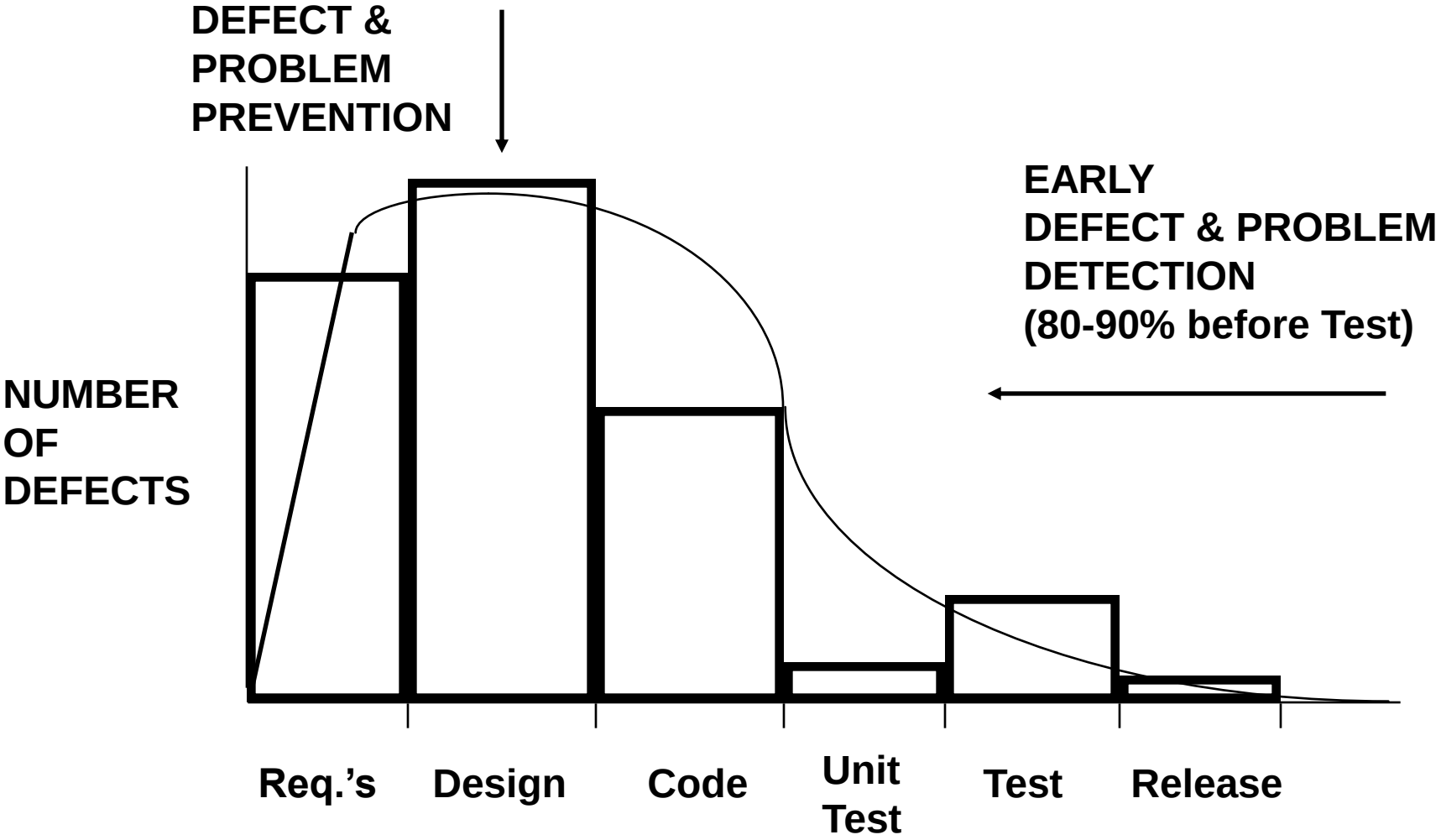
Best-In-Class V&V Strategies



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

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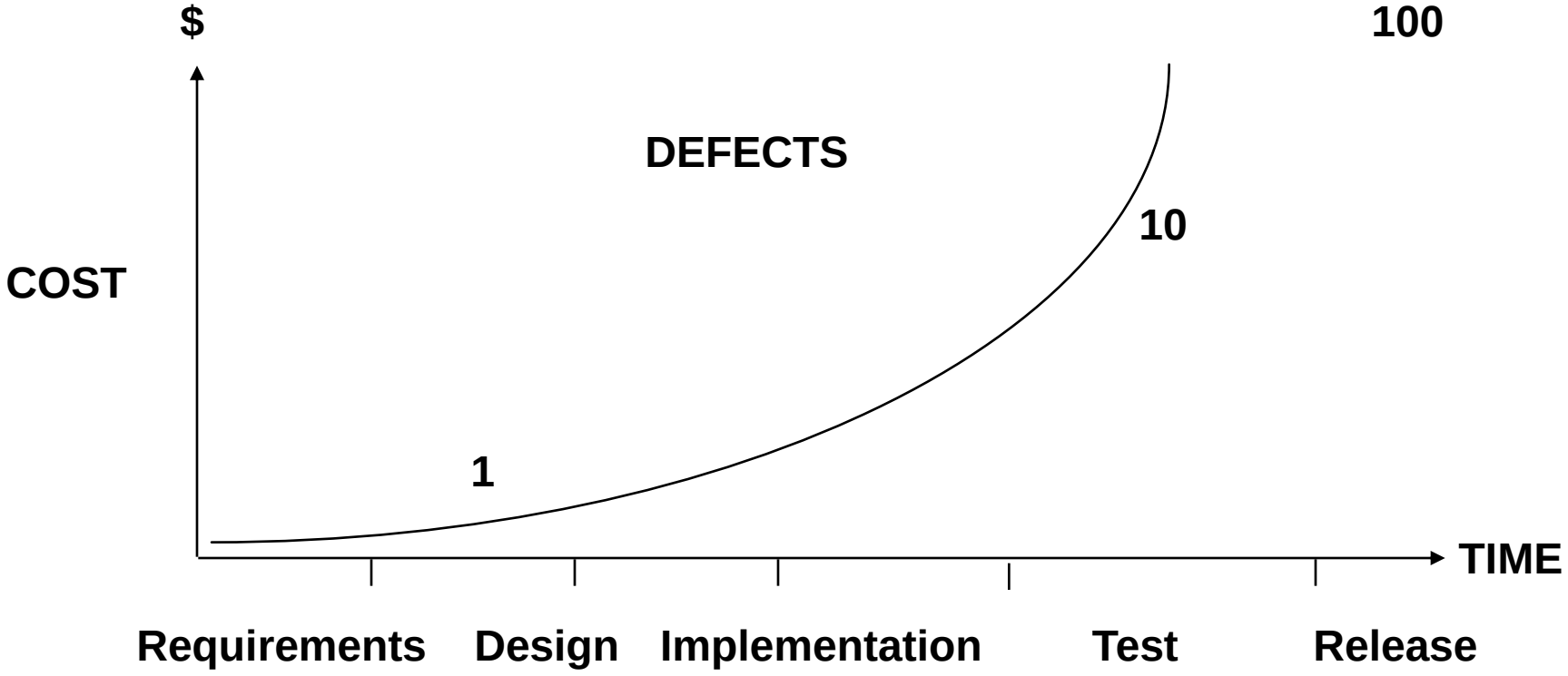
Industry Standard Cost Ratio to Fix a Defect

Defects cost less to fix when detected earlier in the process



- Data from Gilb, T. and Graham, D. *Software Inspection*. Addison-Wesley, 1993.

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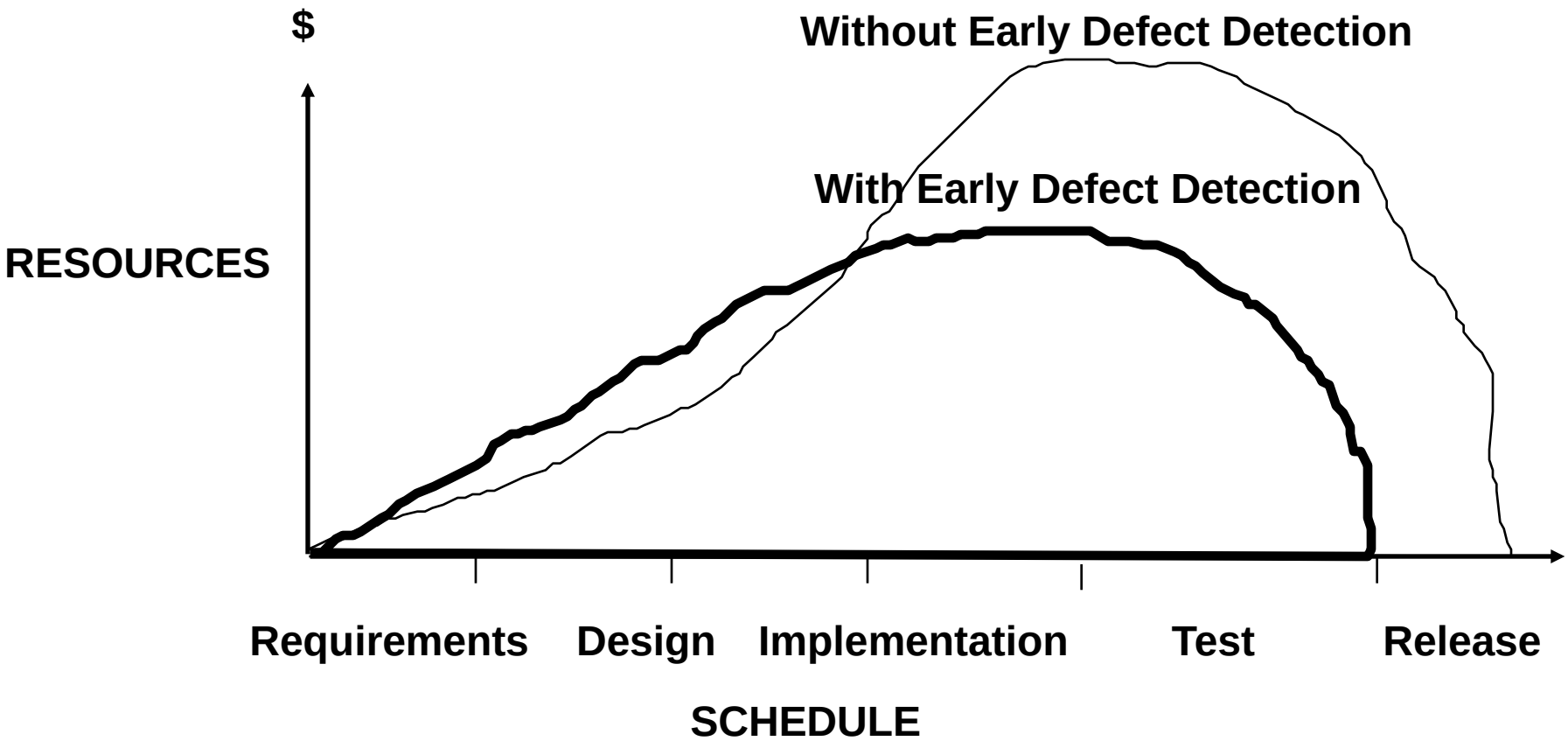
Early Defect Detection (EDD) Shortens the Schedule



- Adapted from Fagan, M. "Advances in Software Inspections", IEEE Transactions on Software Engineering, July 1986

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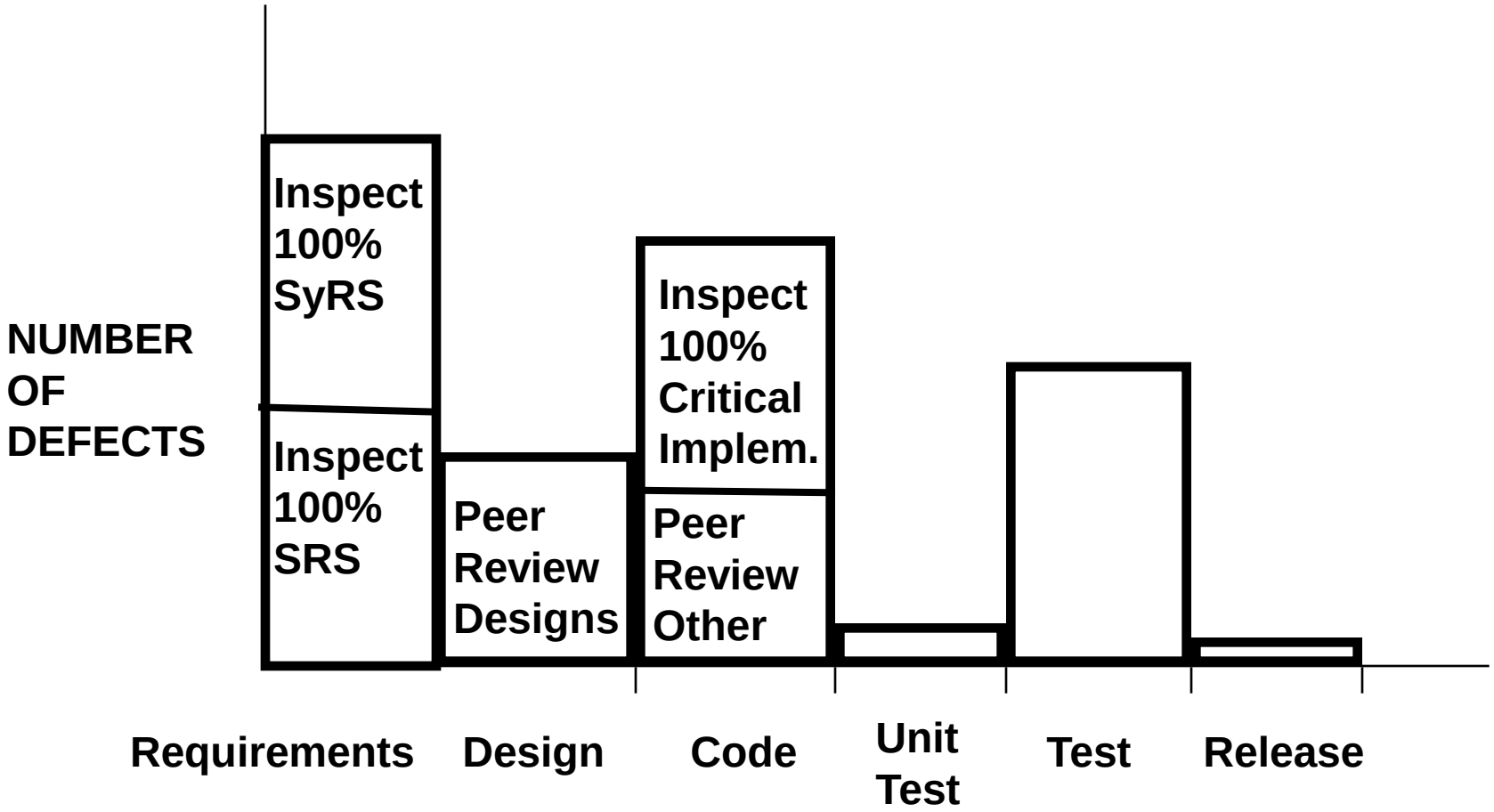
EDD Strategy: Defect Removal Efficiency (DRE)



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

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Best-In-Class EDD Benchmarks

MEASUREMENT	WORLD-CLASS BENCHMARK
Costs of Poor Quality (COPQ)	Reduced from ~33% to ~15% (e.g., cut COPQ in half)
Defect Removal Efficiency	70-90% defect removal before test
Post-Release Defect Rate	Six Sigma (i.e., .01 Defects Per Million)
Productivity	Doubled (e.g., in 5 years at ~20% a year)
Return on Investment	7:1 - 12:1 ROI
Schedule / Cycle Time	Reduced by 10-15% (e.g., per year)

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The purpose of Validation is to demonstrate that a product or product component fulfills its intended use when placed in its intended environment.

V&V activities:

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