



Software-Intensive Weapons



Assessing Software Risk

Multi-Dimensional Assessment of Technology
Maturity Workshop
Fairborn, Ohio
May 11, 2006

Report Documentation Page

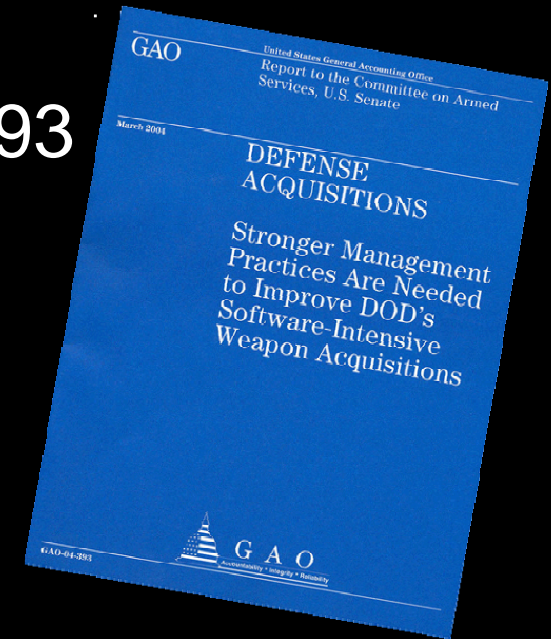
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Briefing Outline

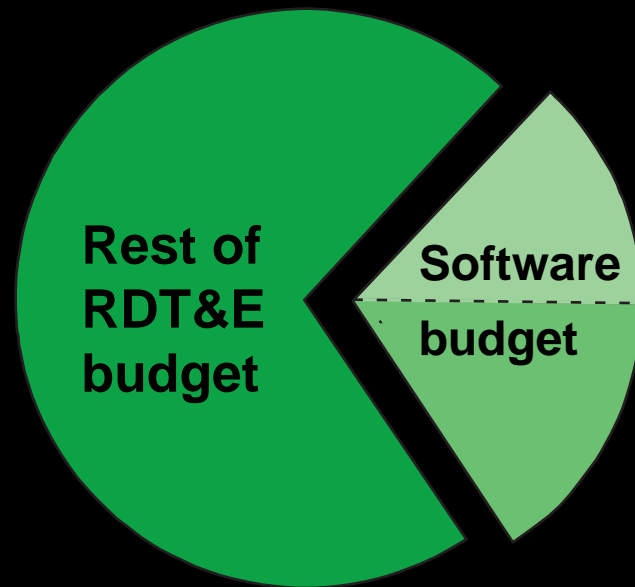
- Overview of GAO-04-393
- Background
- Objective, scope, and methodology
- Audit findings
- Conclusions and recommendations



DOD Funding

Background

- DOD estimates that 40% of the RDT&E budget is spent on software (about \$30 billion in FY 06)



As much as 40% of software budget is spent on rework
(about \$12 B in FY 06)

Objectives, Scope, and Methodology

Objectives

- Identify best practices and metrics
- Analyze causes of poor outcomes

Scope and Methodology

DOD cases

- F/A 18 C/D fighter attack aircraft
- Tactical Tomahawk missile
- F/A-22 air superiority and ground attack aircraft
- Space-Based Infrared System, a missile-detection satellite system
- Comanche, a multi-mission helicopter

Commercial cases

- Motorola
- NCR Teradata
- General Motors
- Computer Sciences Corp.

Audit Findings

F-22 Experience



Initially put together a sound strategy for software development. However.....

- Significant requirements volatility

- RDT&E estimate grew 127%
- Cycle time grew 104%

Audit Findings

Comanche Experience



- Inadequate Requirements Analysis
- Requirements Volatility

- 231% increase in RDT&E cost estimate
- 120% change in cycle time

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Audit Findings

SBIRS Experience

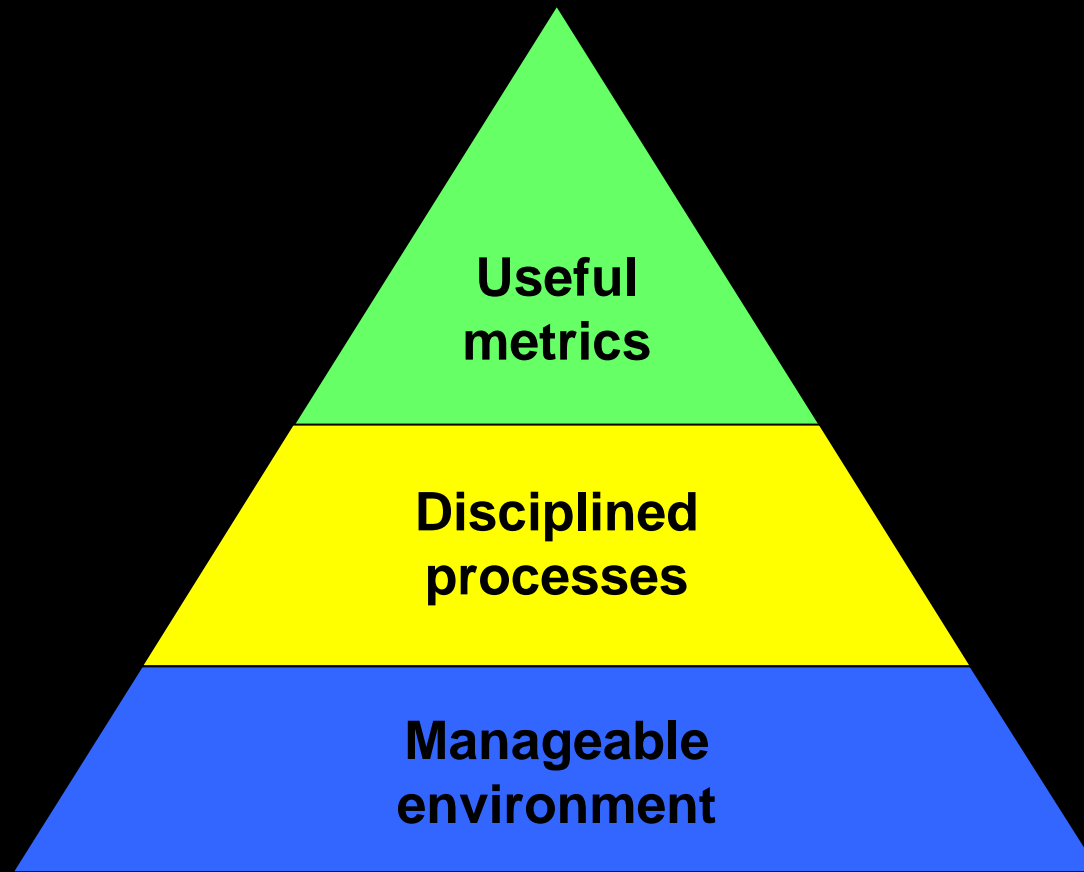


- Uncontrolled Requirements Growth
- Optimistic Reuse Expectations
- Systems Engineering Deficiencies

113% Increase in RDT&E Costs

Audit Findings

Factors Contributing to Successful Outcomes



Audit Findings

Factors Contributing to Successful Outcomes

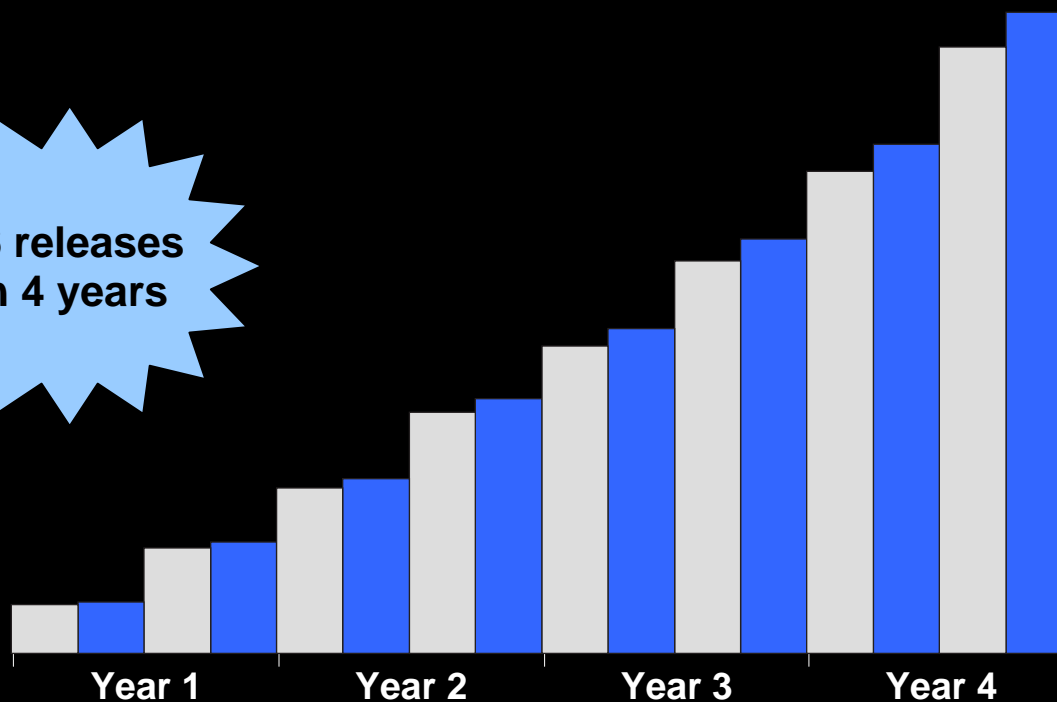


Manageable Environment

General Motors' Development Approach: Growing Capability Over Time

- Releases with new functionality
- Releases with upgrades to existing functionality

16 releases in 4 years



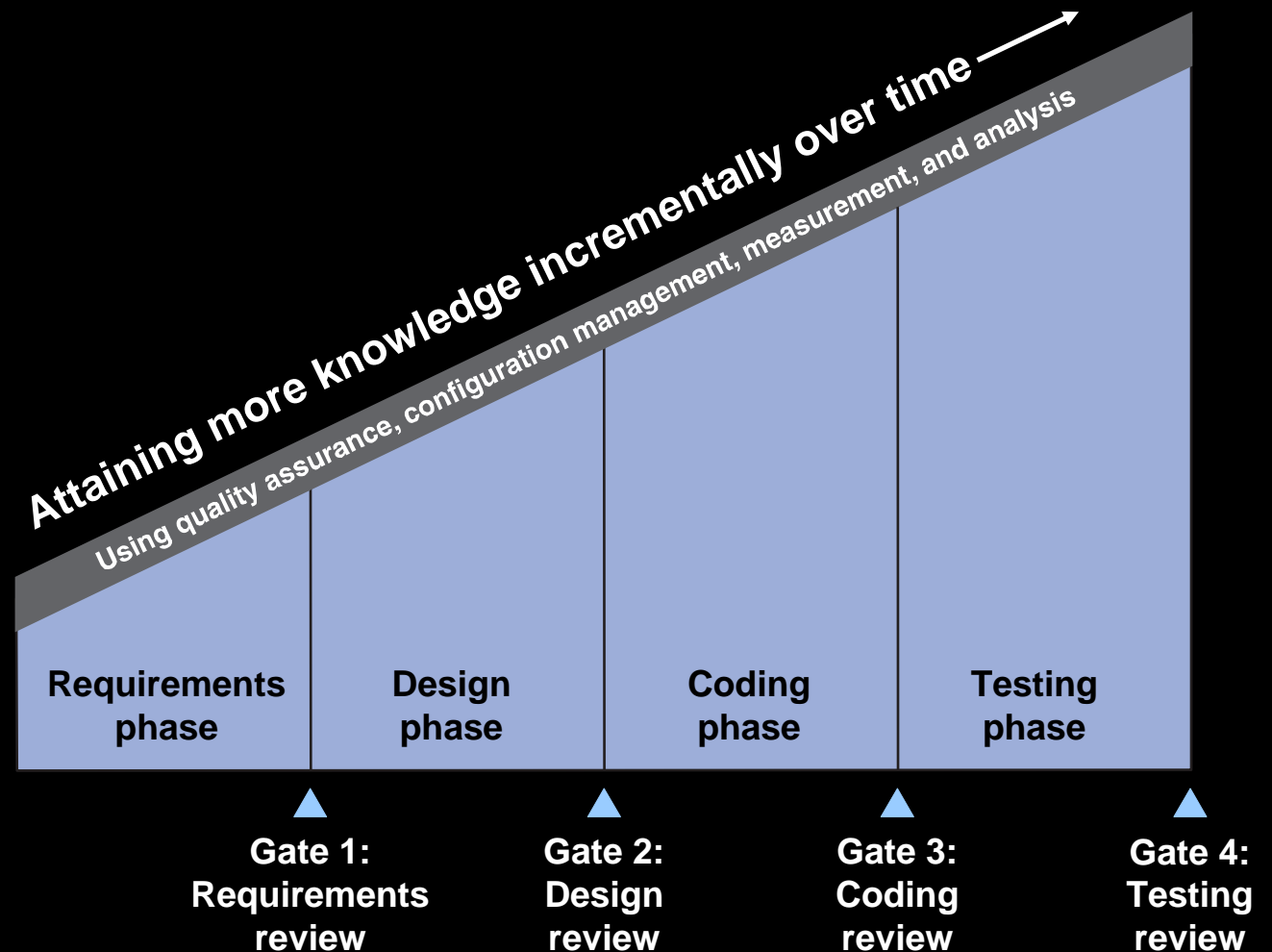
Structured, Gated Reviews

Audit Findings

Factors Contributing to Successful Outcomes



← Disciplined Processes

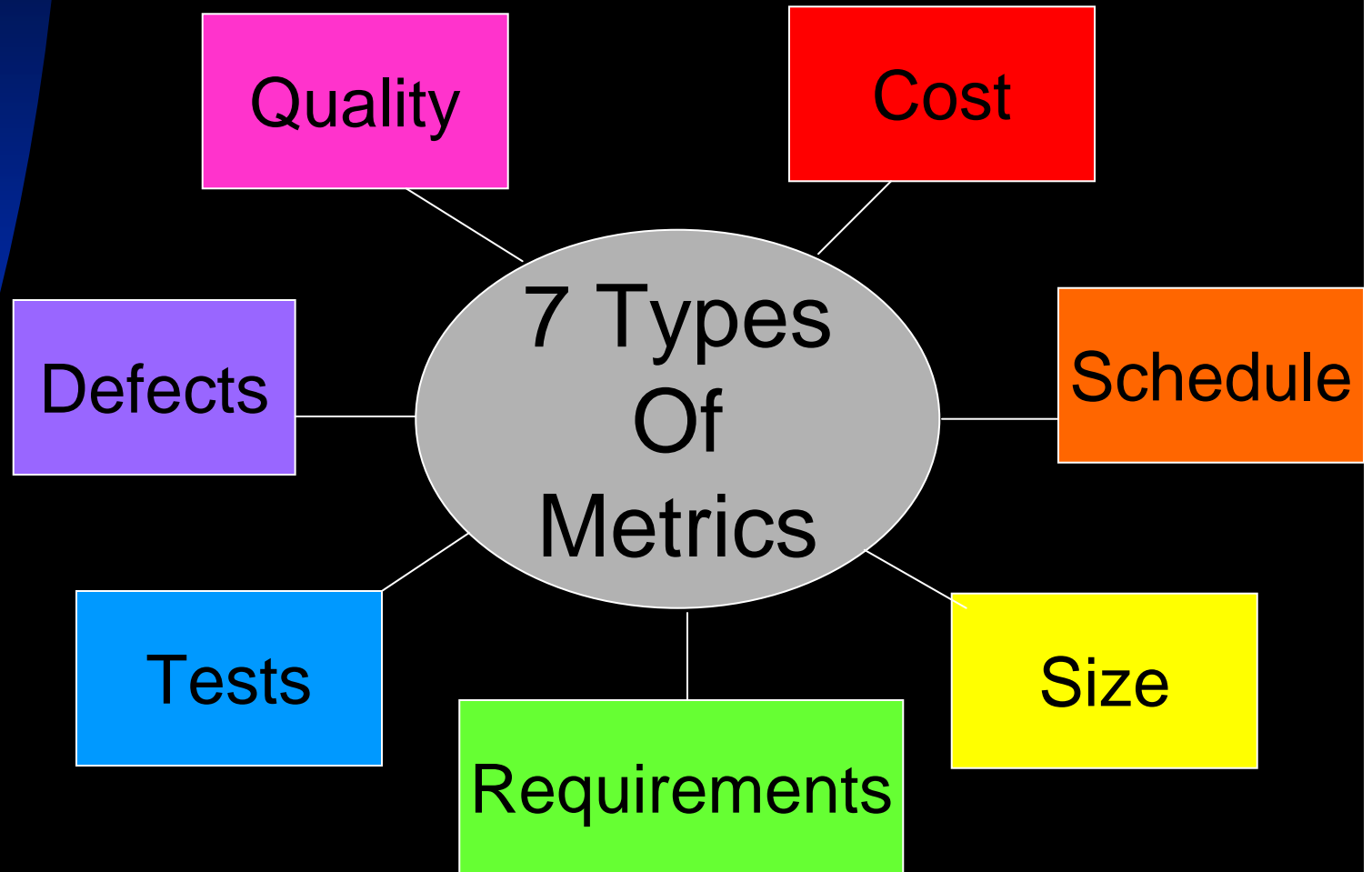


Good developers don't just wait for the four gated reviews to come along; they proactively review software development on a weekly basis

Metrics

Audit Findings

Factors Contributing to Successful Outcomes



Audit Findings

Factors Contributing to Successful Outcomes



F-18 C/D

Schedule
Requirements
Size
Design
Cost
Quality
Test

36% RDT&E Cost Growth
6% Schedule Growth

F-22

Schedule
Requirements
Size
Design
Cost
Quality
Test

127% RDT&E Cost Growth
104% Schedule Growth

Audit Findings

Factors Contributing to Successful Outcomes



DOD Program Outcomes Linked to Management Controls

Program	Evolutionary environment	Disciplined process	Useful metrics	% change in research, development, test, and evaluation cost estimate	% change in cycle time estimate
Tomahawk	Yes	Yes	Yes	7.6	22.4
F/A-18 C/D	Yes	Yes	Yes	36.4	6.2
F/A-22*	No	No	No	127	104
SBIRS*	No	No	No	113	Not available
Comanche*	No	No	No	231	120

* GAO's assessment addresses conditions found before these programs were restructured

Conclusions

Conclusions

- Software-intensive weapon programs are more likely to reach successful outcomes if they used evolutionary environments and disciplined process and managed by metrics. Programs that did not employ these practices consistently garnered poor results from software acquisition.

Recommendations

Recommendations

- Develop a list of systems engineering deliverables
- Set requirements based on systems engineering
- Require contractors to report on seven types of metrics
- Include and enforce practices in policies, improvement plans, and development contracts

DOD Response

DOD Response

- Air Force adopted recommendations
- 5000 Series Acquisition Policy was amended to include more emphasis on systems engineering and evolutionary development