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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<th>2. REPORT TYPE</th>
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<th>13. SUPPLEMENTARY NOTES</th>
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<tr>
<td>See also ADM002184. Presented at the Air Force Research Laboratory Seminar/Workshop on Multi-Dimensional Assessment of Technology Maturity in Fairborn, OH on 9-11 May 2006.</td>
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18
Overview of GAO-04-393
Background
Objective, scope, and methodology
Audit findings
Conclusions and recommendations
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

- 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.
Significant requirements volatility

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

Audit Findings

- Inadequate Requirements Analysis
- Requirements Volatility

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

CANCELLED
SBIRS Experience

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

113% Increase in RDT&E Costs
Factors Contributing to Successful Outcomes

- Useful metrics
- Disciplined processes
- Manageable environment
General Motors’ Development Approach:
Growing Capability Over Time

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

Year 1
Year 2
Year 3
Year 4

16 releases in 4 years
Structured, Gated Reviews

Attaining more knowledge incrementally over time

Using quality assurance, configuration management, measurement, and analysis

Requirements phase
Design phase
Coding phase
Testing phase

Gate 1: Requirements review
Gate 2: Design review
Gate 3: Coding review
Gate 4: Testing review

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

7 Types Of Metrics

- Quality
- Cost
- Schedule
- Size
- Requirements
- Tests
- Defects

Factors Contributing to Successful Outcomes
Useful Metrics

Audit Findings
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
## DOD Program Outcomes Linked to Management Controls

<table>
<thead>
<tr>
<th>Program</th>
<th>Evolutionary environment</th>
<th>Disciplined process</th>
<th>Useful metrics</th>
<th>% change in research, development, test, and evaluation cost estimate</th>
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* GAO’s assessment addresses conditions found before these programs were restructured.
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

- 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

- Air Force adopted recommendations

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