Using Value Engineering to Propel Cyber-Physical Systems Acquisition

Alfred R. Schenker

Nickolas H. Guertin

Software Engineering Institute
Carnegie Mellon University
Pittsburgh, PA 15213

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8702-15-D-0002 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

DM21-0448

What We Want to Leave You With

Value Engineering Principles

1. to use VE to motivate changes to the workflow of organizations that develop computing platforms for CPS
2. to reward innovations that reduce the acquisition risk of embedded computing systems in DoD CPS
3. that we need to reward innovations based on a new way to count value that identifies and mitigates "showstopper" defects early in life cycle as a leading indicator of traditional VE values, e.g., cost, quality, schedule

We want to change the status quo for how we acquire cyber-physical weapon systems (CPS)

We have observed cost overruns, schedule delays, loss of promised warfighter capability

We are aware of improved product development technologies that may be relevant, but have not been widely adopted

What we know:

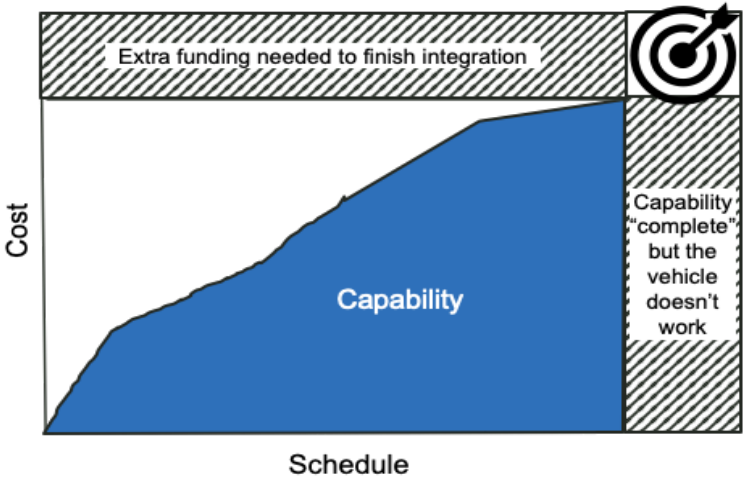
- We find defects and issues (~80%) too late in the development process
- These issues cost 10-1000x to fix then they would have if we found them prior to unit test
- We do not have adequate analysis of the defects and issues, i.e. Why didn't we find the defects earlier? What changes can we make to *the process* in order to reduce the incidence and severity of these late-stage defects?

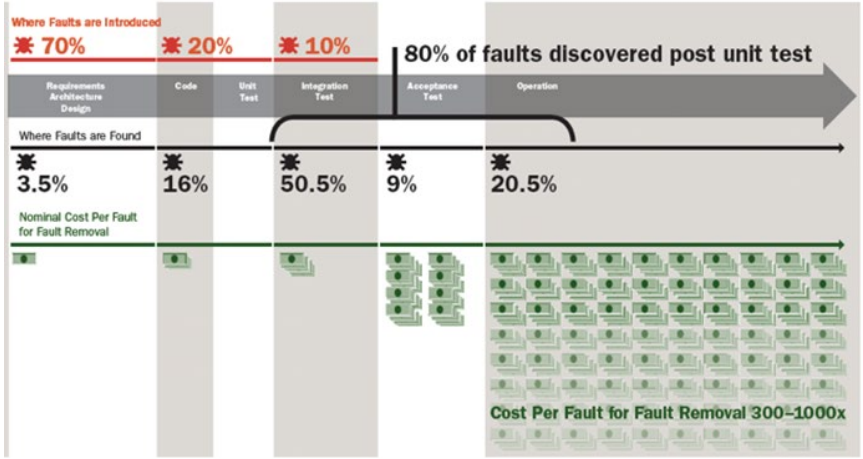
What can we do to motivate the right kinds of behavior to change the status quo?

Where is the Value?

Avoid Showstoppers

- Too often this picture is the reality of what happens on our CPS acquisitions
- Why do we continue to expect better results if we don't change the status quo?





Opportunities for harvest

- 80% of defects discovered post unit test
- Cost per fault increases rapidly after unit test, to as much as 1000x

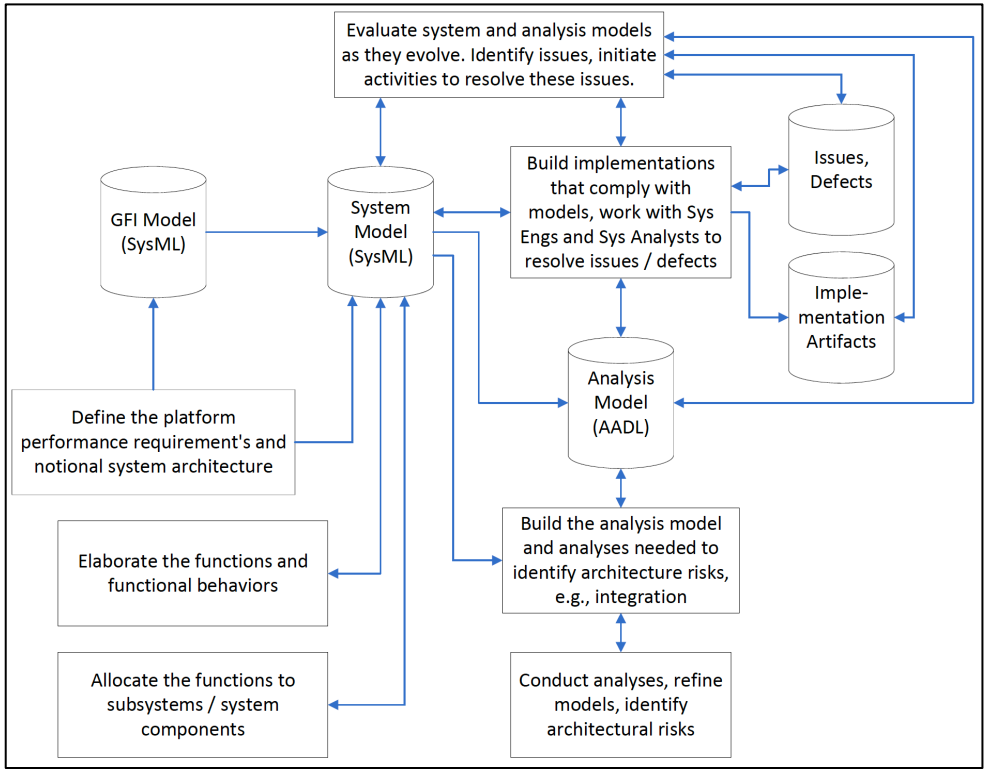
Workflow Implications

Stakeholders:

- USG Acquirer(s)
- Certification Authorities
- Prime Contractor(s)
- Subcontractor(s)

Functional Organizations:

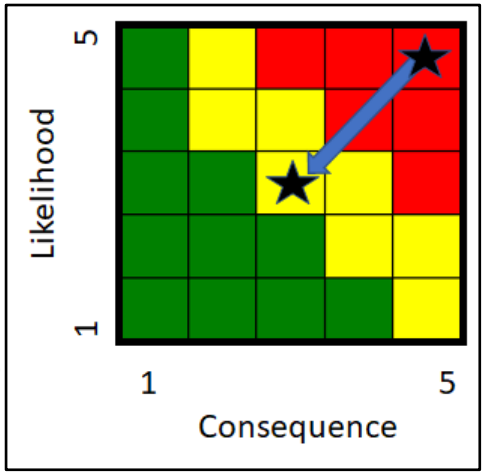
- Systems Engineering
- Software Engineering
- Model-Based Engineering
- Integration
- Test/Evaluation



Many Possible Configurations Exist – We Cannot Be Prescriptive

Risk Implications across the life cycle

Reduce both Consequence and Likelihood



- Consequence – usually hard to do
  - Identify integration alternatives early
  - Evaluate new implementations early
  - Examine reuse from other programs
  - Governance and workflow modifications
- Likelihood
  - Improve methods of addressing MOSA requirements
  - Find structural errors in the architecture
  - Find infrastructure errors in modules
  - Analyze prior to committing
  - Find implementation errors in platforms, systems, subsystems and modules early in the design synthesis phase

Find Government and Industry Win-Wins

Costs of large cyber-physical products are rigorously analyzed

- Independent Cost Estimates validated by RFP responses
- Use financial and programmatic incentives to change behavior

Contract incentives and source selection evaluation factors grab industry's attention

- CPIF or CPAF type contracts that reward VE in the fee
  - Structured to benefit industry for innovation
  - Take programmatic credit for avoiding schedule/cost overruns
- Evaluation criteria for technical and business characteristics
  - Requirement and implementation changes can be beneficial
  - Early-stage design synthesis to drive actions taken that drive down development and integration risk
  - Continuous innovation and process reform as a part of the approach

Recommendations

1. Build the metrics for a process performance baseline, focused on the "showstopper" defects and issues. Identify methods that would have found them earlier in lifecycle.
    - Establish the existing defect escape rates
    - Implement process changes to inform VE benefits
2. Reward local process change agents that will try out these new development methods
    - Use the "showstopper" defect baseline to assess success/failure
    - Incorporate the successes into a new process status quo
    - Rinse. Repeat. (continuously improve)
3. Determine how to scale the improvements up to the enterprise level -
    - Solidify the processes and products that generate the most benefit
    - Use VE to evaluate leverage points for the overall portfolio and identify greatest benefit areas for systemic reuse strategies

Let's acknowledge new value propositions and use them to "level up" our acquisition of CPS

Questions