



An Agile Model-based Systems Engineering Method to Accelerate Value Delivery

Ronald E. Giachetti, PhD

Professor

Department of Systems Engineering

Naval Postgraduate School

regiache@nps.edu

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Research Objective



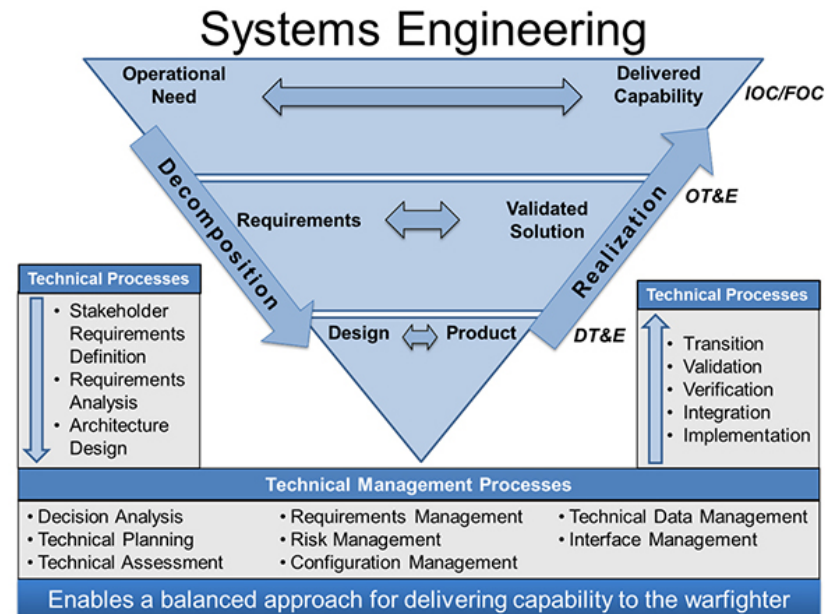
How does the Department of Defense reap the benefits observed with using agile methods in the software industry?

System Development Challenges



Traditional plan-driven system developing struggles with some of the challenges facing programs today

- Volatile, Uncertain, Complex, and Ambiguous (VUCA) environment
- Highly dynamic and changing requirements
- Need capability quick
- Technical risk
- Software-intensive systems
- Complexity

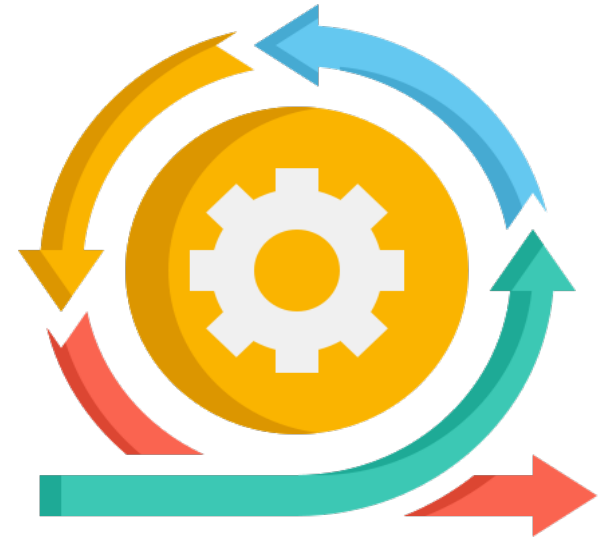


Agile Development



Dissatisfied with overhead and performance of prevailing methods led to Agile Manifesto

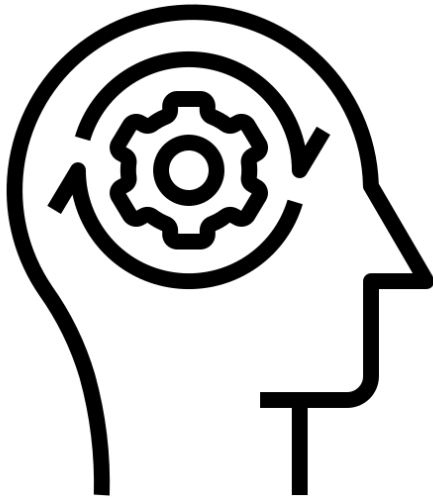
1. Individuals and interactions over processes and tools
2. Working software over comprehensive documentation
3. Customer collaboration over contract negotiation
4. Responding to change over following a plan



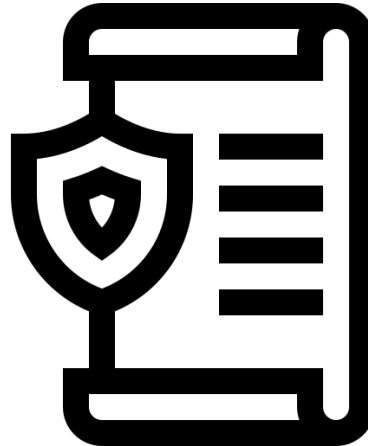
Agile Mindset



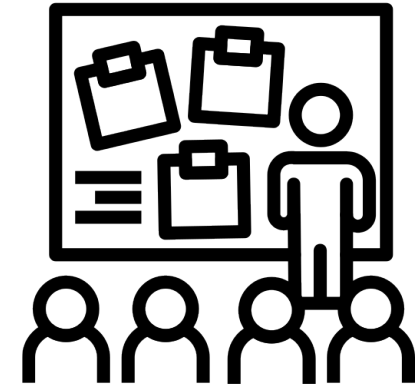
Agile is a
mindset



Informed by
principles



Put into practice
through methods



Hybrid plan-driven and agile method



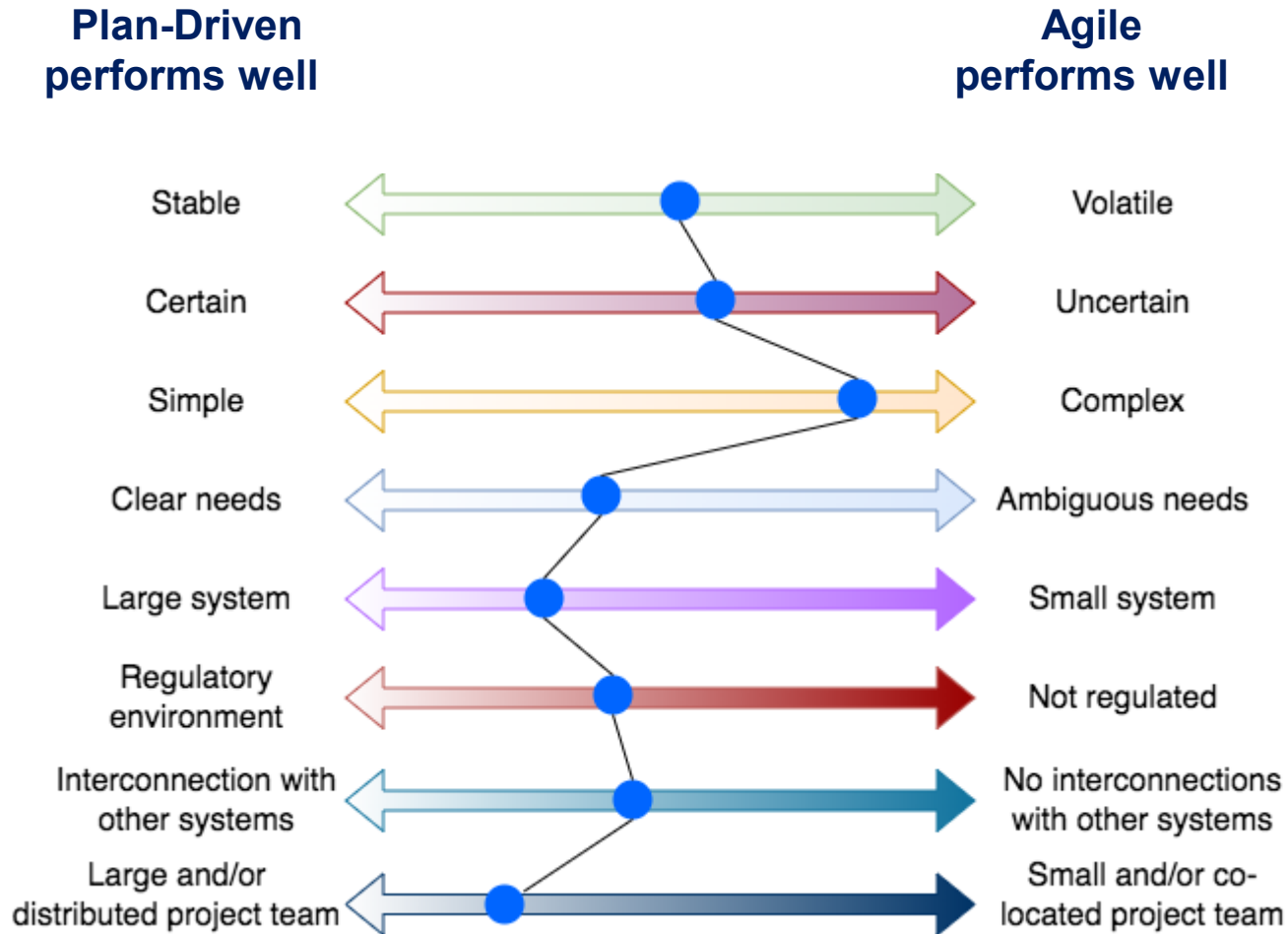
Plan-driven

- ◆ Align budget, schedule, and resources (e.g., test range)
- ◆ Top-down design
- ◆ Long lead-time items (e.g, submarine parts > 300 days)
- ◆ Interconnections with other systems
- ◆ Identify needed quality attributes (-ilities of reliability, maintainability, ...)
- ◆ Comply with regulations, policies, and strategies
- ◆ Safety critical issues
- ◆ Ensure traceability

Agile

- ◆ Iterative and incremental development of work products
- ◆ Close and frequent engagement with stakeholders
- ◆ Continuous verification
- ◆ Self-managing teams, empowerment
- ◆ Continuous integration
- ◆ Rapid learning and risk reduction

Typical System Development Characteristics



Typical system development now calls for both plan-driven and agile

Plan-Driven at Macro Level

- Plan at the macro project level
- Develop an architecture and project vision
- Top-down development

Agile at Micro Level and In Mindset

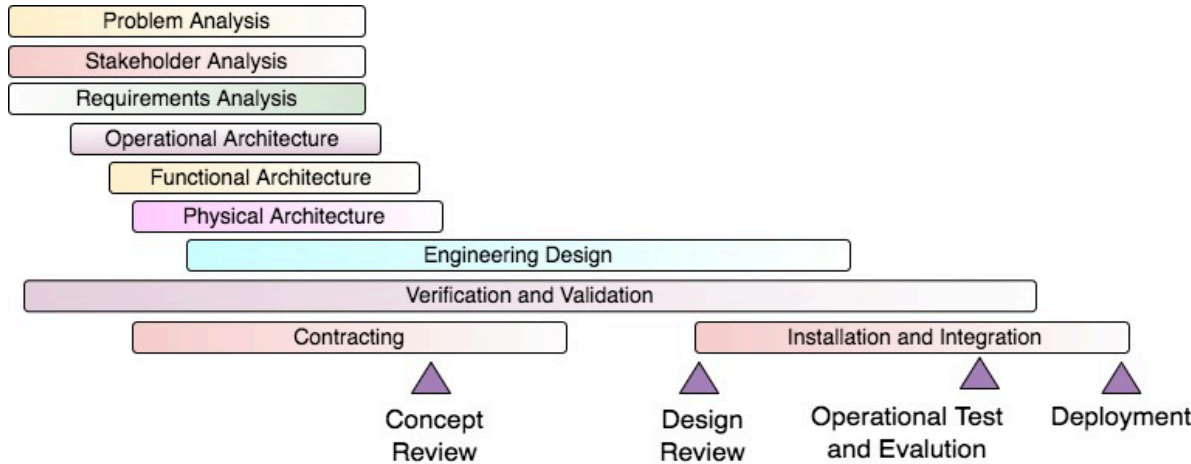
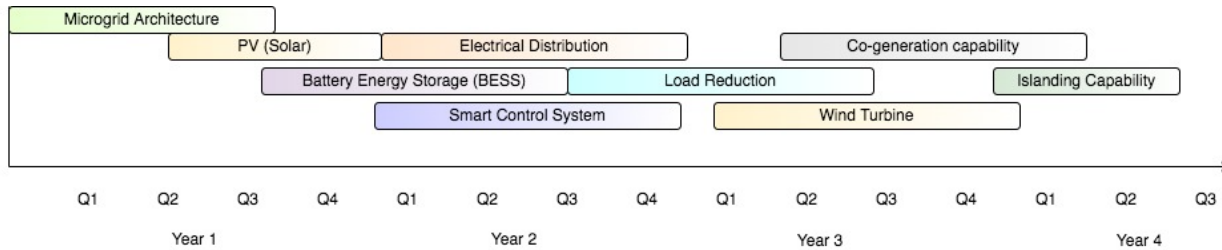
- Iterative and incremental development of work products
- Continuous verification and validation
- Continuous integration
- Empowered teams

Digital Engineering Enabler

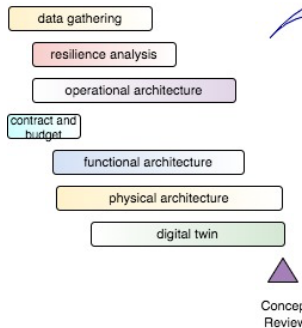


- Crucial enabler of agility
 - ◆ Iterative cycles of analysis, design, build, and test
 - ◆ Continuous verification and validation
 - ◆ Continuous integration
 - ◆ Earlier and faster learning
- Digital thread
 - ◆ connected engineering using architecture-driven design fully integrated across domains
 - ◆ Connect models through to prototyping
 - ◆ More efficient engineering, less unnecessary rework
 - ◆ More effective engineering, propagating changes and seeing effects of change in design

Macro Planning



Milestone Plan

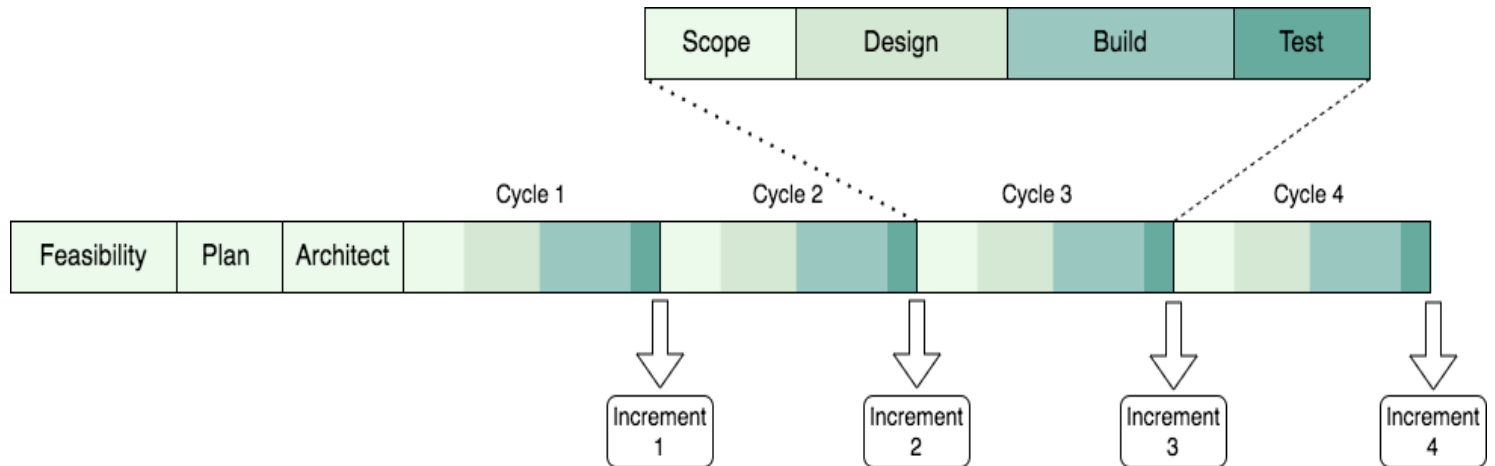
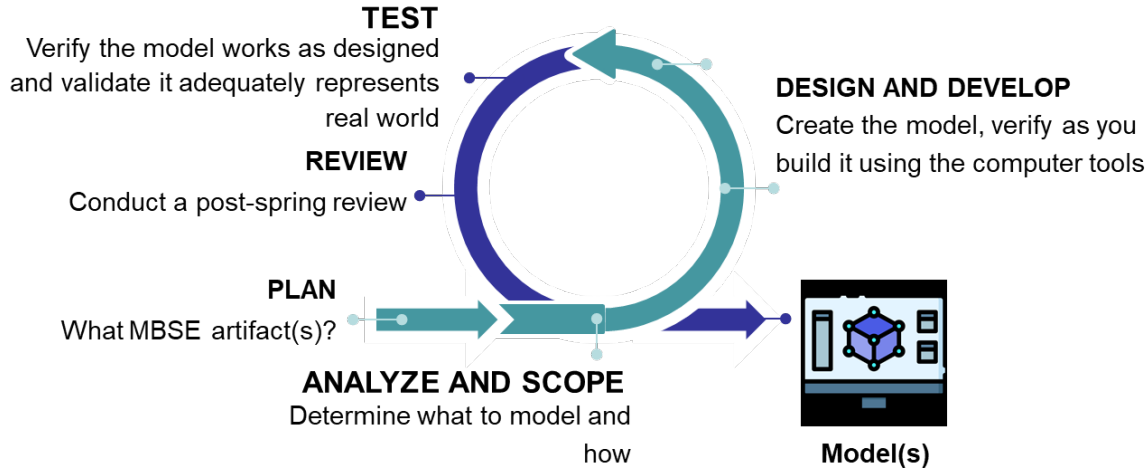


Backlog of Work

- req'mnt and capability model
- microgrid risk analysis
- contract request
- funding proposal
- interview command
- load balance simulation
- solar feasibility study
- site visit
- resilience analytical model
- obtain one-line drawings
- interview facility mgr
- gather load data history



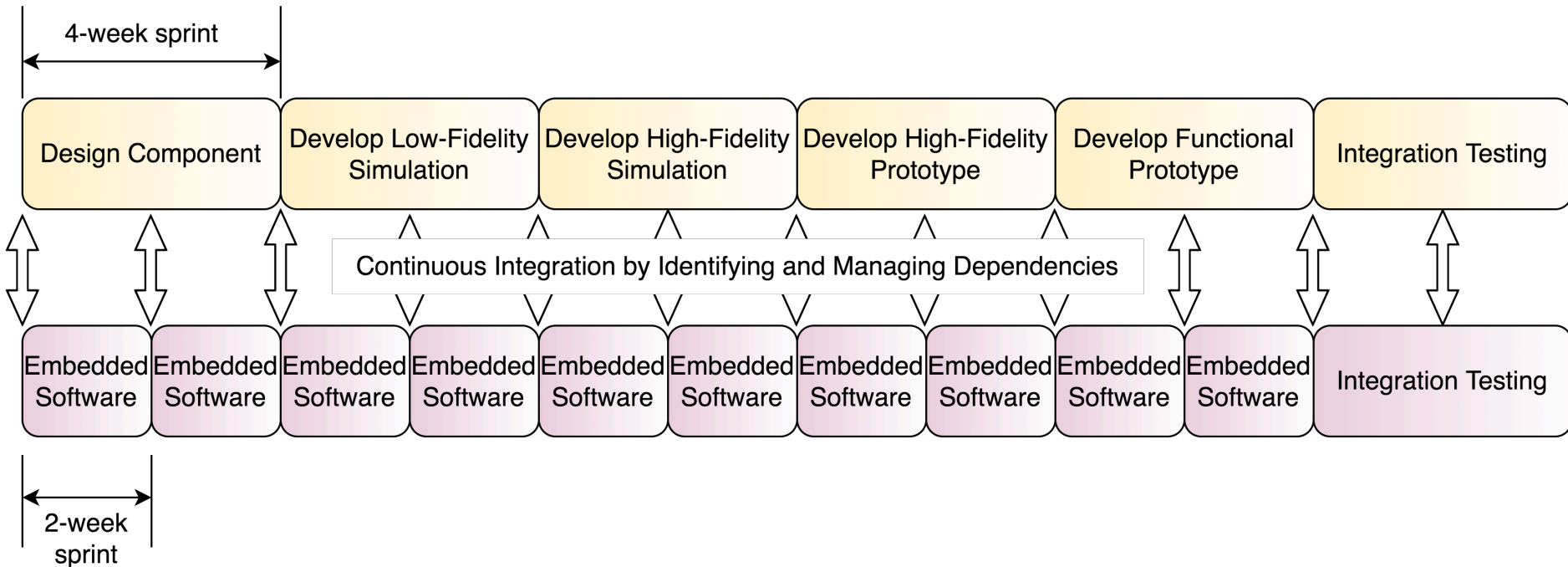
Agile and MBSE



Synching Hardware and Software



Hardware takes more time to design, develop, and to have a testable prototype; hence plan for multiple intermediary but testable artifacts.



Orchestrate hardware progress with software progress

Characteristics



- Strong system vision articulated in architecture
- Continuous verification and validation
- Frequent prototyping
- Analyze and incorporate –ilities
- Value-based design
- Control interfaces
- Continuous integration

Ending Observations



- The research examined the characteristics and principles of agile methods through the lens of how they could be adopted within the defense acquisition community.
- Compared plan-driven approaches with agile approaches
- Proposed a hybrid approach combining the plan-based perspective at the macro level and adopting agile practices at the micro level.
- The method is enabled by digital engineering, which allows for iterations of model development and test during the early phases.
- Preserves important aspects of systems engineering such as top-down refinement.
- If agile is a mindset, then adopting agile involves a transformation of the DOD organizational culture, and such transformations take a lot of time and dedicated leadership.