Acquisition Research Program:
Creating Synergy for Informed Change

Modeling the Integration of Open Systems and Evolutionary Acquisition

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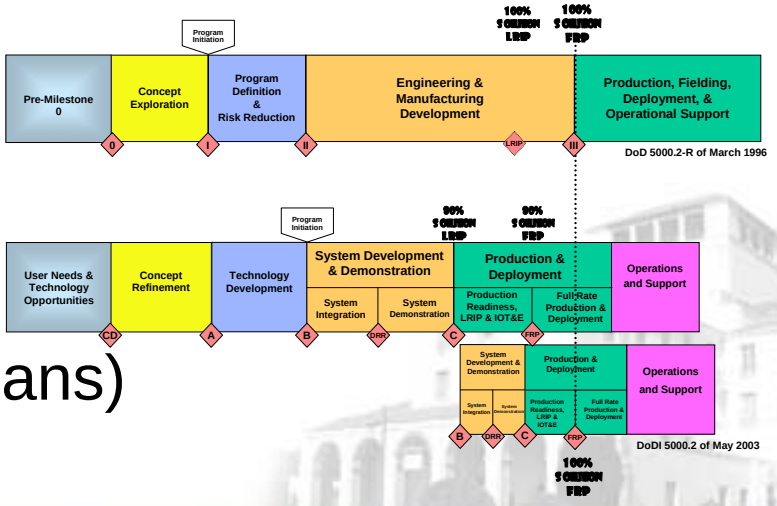
Introduction: Evolutionary Acquisition (EA)

- Multiple development blocks (vs. single step to full capacity)
- Concurrent development across development blocks (vs. sequential programs)
- Insert only adequately mature (TRL7) technologies
- Unspecified spirals are part of programs and become iterations (vs. independent development plans)

Single-step Acquisition (top) & Evolutionary Acquisition (bottom)



Introduction: Open Systems (OS)

- Select and commit to open (industry developed and maintained) standards – ***requires managing programs to external standards***
- Replace some customized design with COTS components, sub-systems, and systems
- Design open key interfaces to increase competition and allow systems and components to evolve with reduced impacts – ***requires managing interfaces***
- Program management shift from design to integration

Problem: Integrating Open Systems and Evolutionary Acquisition

- Great potential for open systems and evolutionary acquisition to synergistically support each other and improve acquisition program performance. Both…
  - Seek to reduce acquisition cycle time
  - Address interoperability
  - Provide flexibility to manage uncertainty in technologies & threats
- But benefits have not been fully captured – ***why?***
  - Both involve complex development processes that interact
  - Integration is difficult
- ***Simultaneous implementation of OS and EA is a major acquisition challenge…***
  - How do the requirements of OS and EA impact each other?
  - How do those interactions impact program performance?

Case Study: P-8 Poseidon Multi-Mission Aircraft Program

- Existing ASW P-3 fleet is approaching end of service life
  - Requires replacement
  - Continues to evolve and add capacity
- Opportunity to increase and improve capacities and performance (e.g. speed, altitude)
- Boeing selected in 2004 based on militarization of 737-800 aircraft
- Currently in SDD of baseline program

Case Study: P-8 Poseidon Program Evolutionary Acquisition and Open Systems

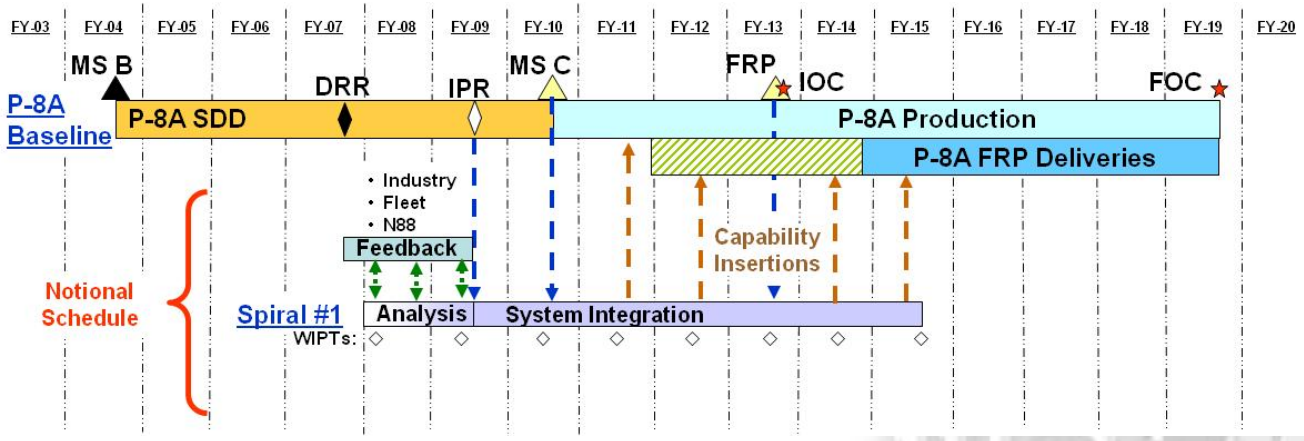
P-8 Acquistion Philosophy: "Design a baseline platform with significant physical and virtual capacity for future growth."

1) Excess power, cooling, and payload carrying capacity coupled with an open systems design allows for Spiral Acquisition of capability
2) Leverage on-going P-3 mission system development and design where possible to develop once and integrate twice

Evolutionary Acquisition Plan (Spirals)

1) **Baseline program** – integrate existing P-3 capabilities into P-8 aircraft (in progress)
2) **Spiral 1** – candidate list of capabilities identified, APB under development, WIPT formed and working, *No impact to baseline program*
3) **Spirals 2+** integrate evolving ASW/ASuW/ISR capabilities into P-8, in preliminary planning

How can the P-8 program integrate open systems and evolutionary acquisition to capture their potential benefits?



Research Plan

1. **Identify potentially important interactions and impacts with modeling. Use model to find initial lessons**
   - Map changes required by open systems into impacts on an evolutionary acquisition process
   - Model the impacts of open systems use on an evolutionary acquisition process
     - Map impacts onto changes in model variables
     - Simulate an evolutionary acquisition program with and without open systems
     - Compare behaviors of simulated programs
2. Look for modeling lessons in active program (1-8).
3. Validate and improve model.
4. Use model to design and test EA/OS program management strategies

Changes Required by Open Systems and Impacts on Evolutionary Acquisition Programs

Required Change	Impacts on Development
Build baseline of standards and COTS products	Increases scope of first block early design to describe the requirements in terms of standards
Build high-level system model to apply open systems approach	Increases scope of early design in first block
Document open architecture to show evaluation of alt. architectures, ident. components, technologies, etc.	Increases scope of early design advanced development phases in all blocks
Coordinate standards & establish liaisons with standards bodies and users	Ongoing process - increases scope of all phases in all blocks
Implement use of selected standards in development	Replace some component design with component selection
Integrate components into product & test integrated system	Increases problems/rework in advanced development and manufacturing phases of all blocks

Based on Meyers and Oberndorf (2001):

Changes Required by Open Systems and Impacts on Evolutionary Acquisition Programs

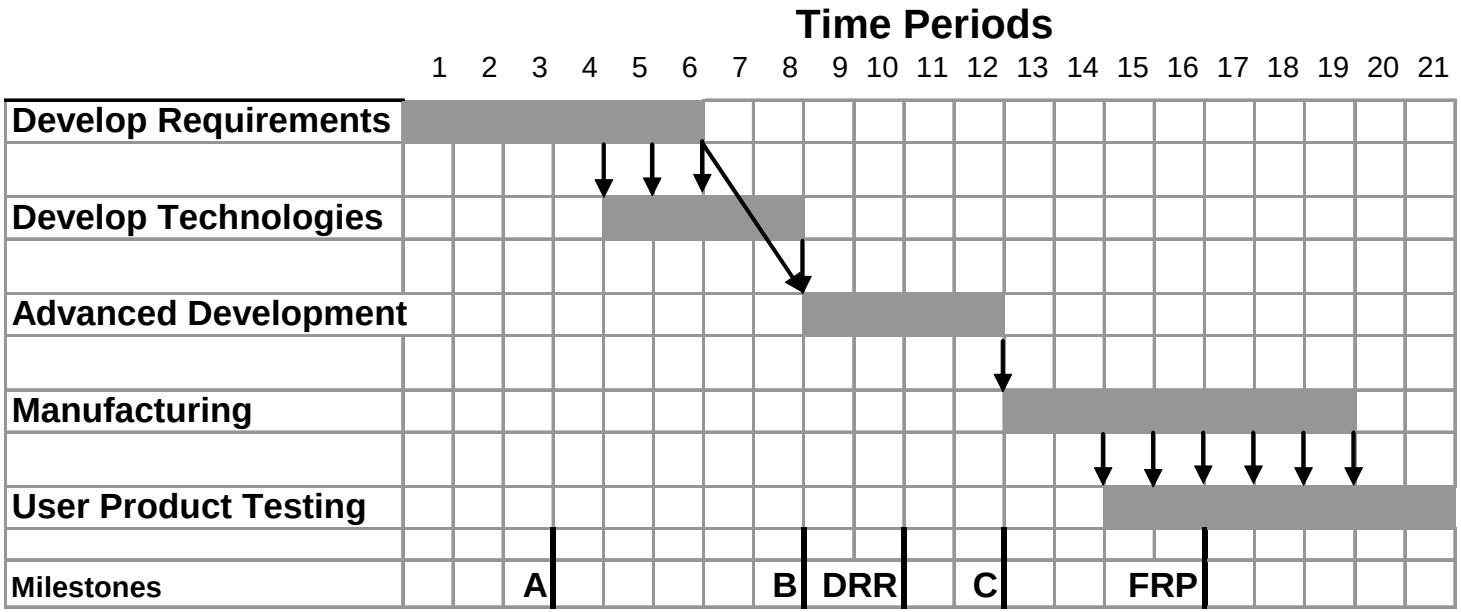
Required Change	Impacts on Development
Slower integration & testing of standards-based elements	Delays discovery of integration problems
Reduced DoD control over standards (Faster evolution of the standards in directions less likely to support the program)	Increases number & size of design problems
Standards evolve and chosen standards may not endure - increased standard choice risk. More frequent standard changes	Increases number & size of design problems & Increases testing and integration
More difficult to know when to shift from one standard to another - increased standards change and choice risk	Increases testing and integration & Increases number & size of integration problems to be discovered and resolved
Increased integration needs due to more and evolving commercial and non-developmental items	Increaseed and continuous testing requirements
Development of support concepts early in the acquisition cycle - increased standards selection risk	Increases standards research and planning early in acquisition & increased interface design and management.
Component design by industry based on industry-controlled standards - reduced control over detailed component design	Increases number & size of integration problems

Based on Hanraty, Lightsey, and Larson (1999):

Issues in Integrating Open Systems into Evolutionary Acquisition - *Summary*

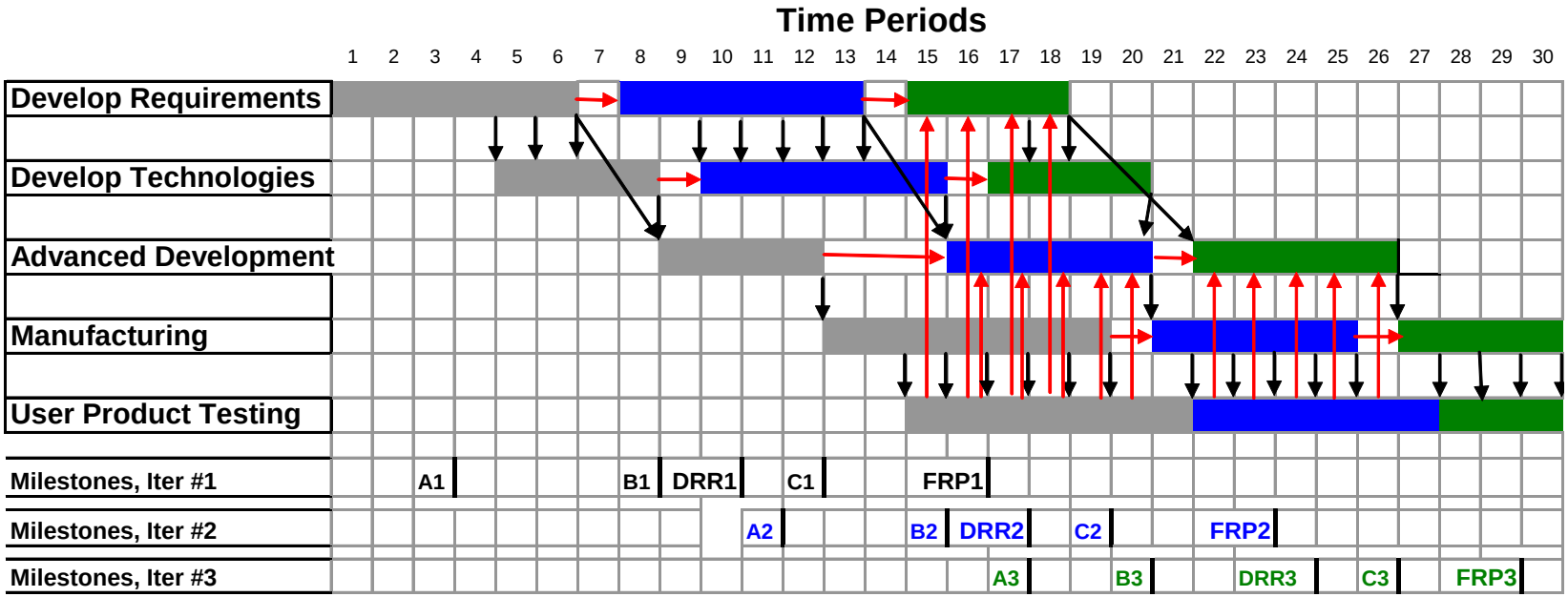
- **Shift in acquisition management from design to integration**
  - Reduced design capacity needed (e.g. for COTS components & systems)
  - Increased integration capacity needed (e.g. for testing)
  - Delays in discovery of problems
- **Program "openness" is a new and critical program management need**
  - Selection, monitoring, using, and documenting use of industry standards
  - Different and new opportunities and risks

Research Method: Simulation Model



Information Flows in a Single Block of an Evolutionary Acquisition Project

Research Method: Simulation Model



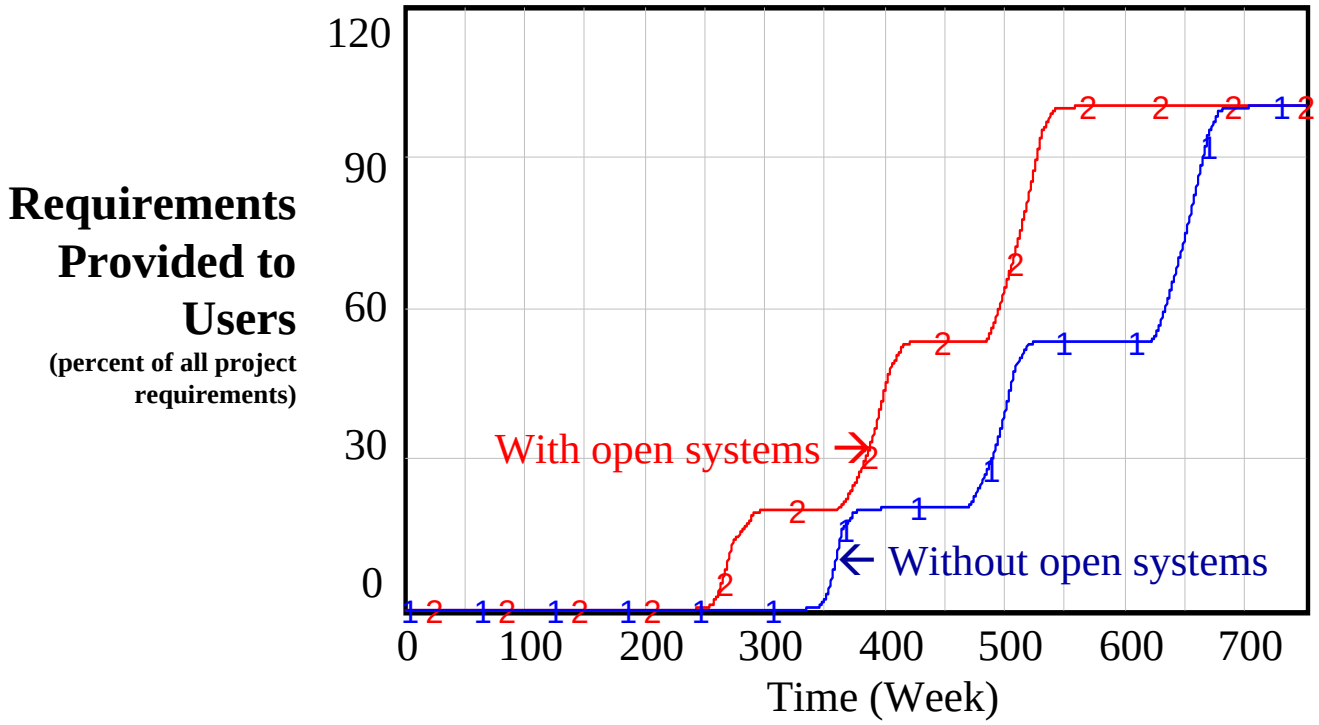
Information Flows in a Three-Block Evolutionary Acquisition Project

Mapping Open Systems Impacts into the Simulation Model

Program Block and Phase	Scope of Work	Rework Fraction	QA Effectiveness
DEVELOPMENT BLOCK 1			
Requirements	+7	0	0
Develop Techn.	-15	0	-10
Advanced Dev.	-17	-5	-10
Manufacturing	+2	+5	+5
Testing by User	+1	0	-5
Net Change from Base Case	**-22%**	**0%**	**-20%**
DEVELOPMENT BLOCK 2			
Requirements	+1	0	0
Develop Techn.	-16	0	-5
Advanced Dev.	-17	0	-5
Manufacturing	+2	+10	+10
Testing by User	+1	0	0
Net Change from Base Case	**+29%**	**+10%**	**0%**
DEVELOPMENT BLOCK 3			
Requirements	+1	0	0
Develop Techn.	-16	0	0
Advanced Dev.	-17	+5	0
Manufacturing	+2	+15	+15
Testing by User	+1	0	+5
Net Change from Base Case	**+29**	**+20**	**+20**

Estimated Changes in Evolutionary Acquisition Processes to Reflect Open Systems

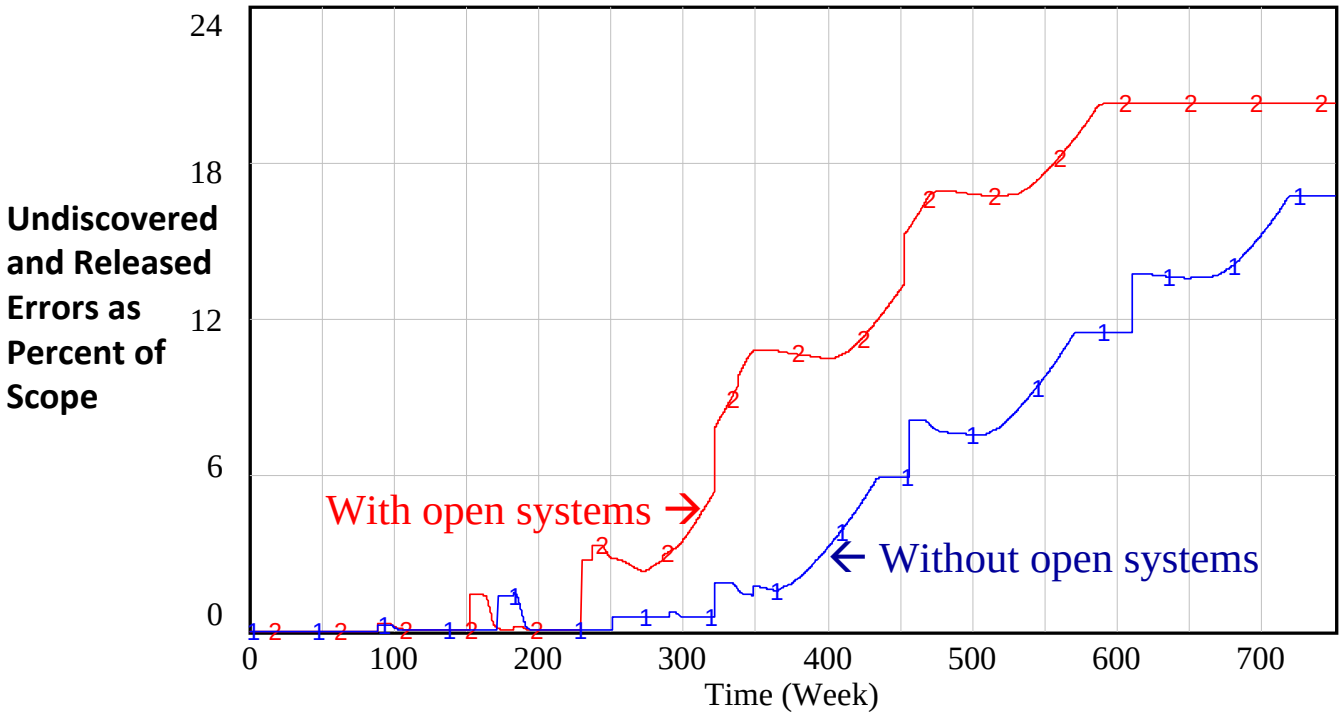
Simulation Results: Cycle Time and Cost



Open systems and Evolutionary Acquisition can reduce cycle time and time-based costs due to less and faster component design.

Requirement Fulfillment with Evolutionary Acquisition Without and With Open Systems

Simulation Results: Hidden Errors

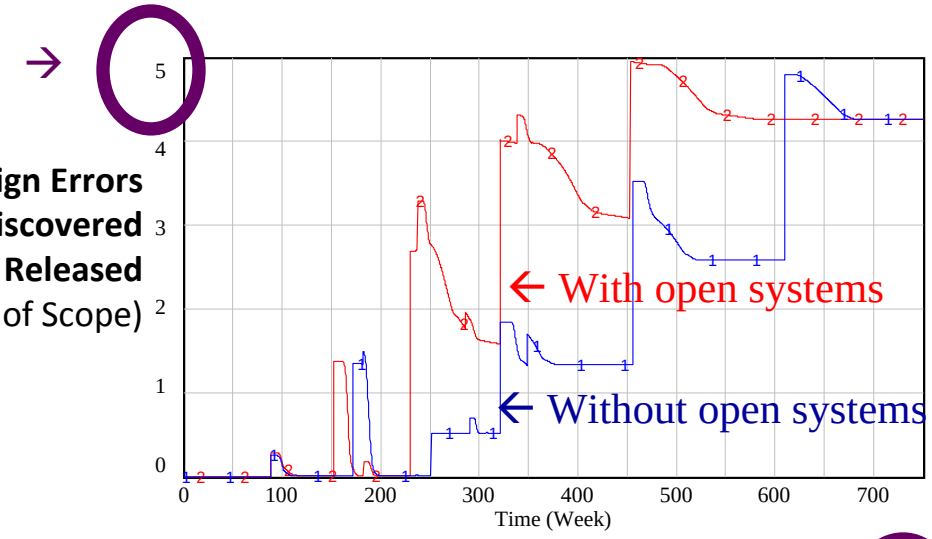


Open systems appear to generate more errors that are undiscovered and released – what types of errors?

Undiscovered Problems in Evolutionary Acquisition Without and With Open Systems

Simulation Results:

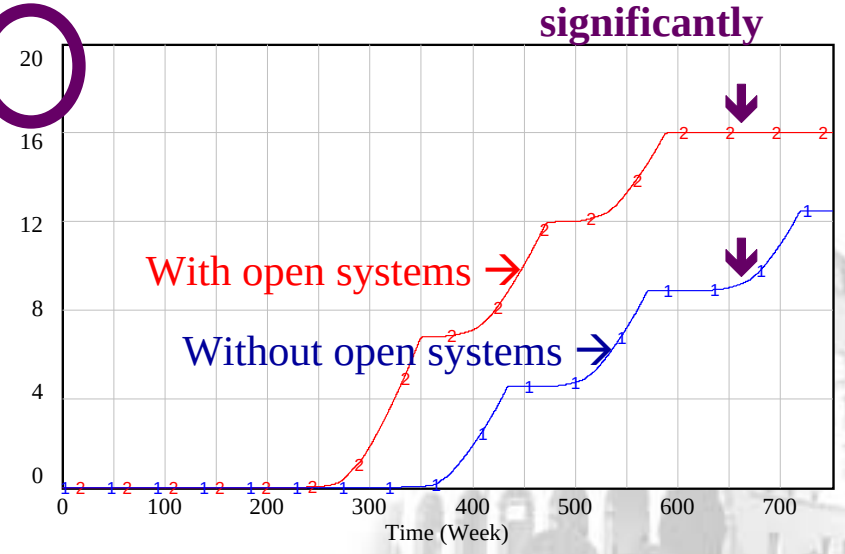
Undiscovered and Released Errors - Design vs. Integration



1) Design errors are about the same with and without open systems

2) There are 3-5 times more integration errors than design errors

3) Open systems can increase the number of integration errors significantly



Open systems shifts some program management from design challenges (earlier, manifest) to standards and integration challenges (later, latent)

Implications for Practice (1 of 3)
Different Types and Amounts of Risks and Skills

- Shift in focus from design to standards and integration impacts the types and amounts of risk that programs accept and must manage.
- Open systems reduce design risks
- Open systems creates standards selection and standards change risks
- Different types of skills are needed to manage different types of risk…less detailed technical expertise will likely be needed and more integration and systems

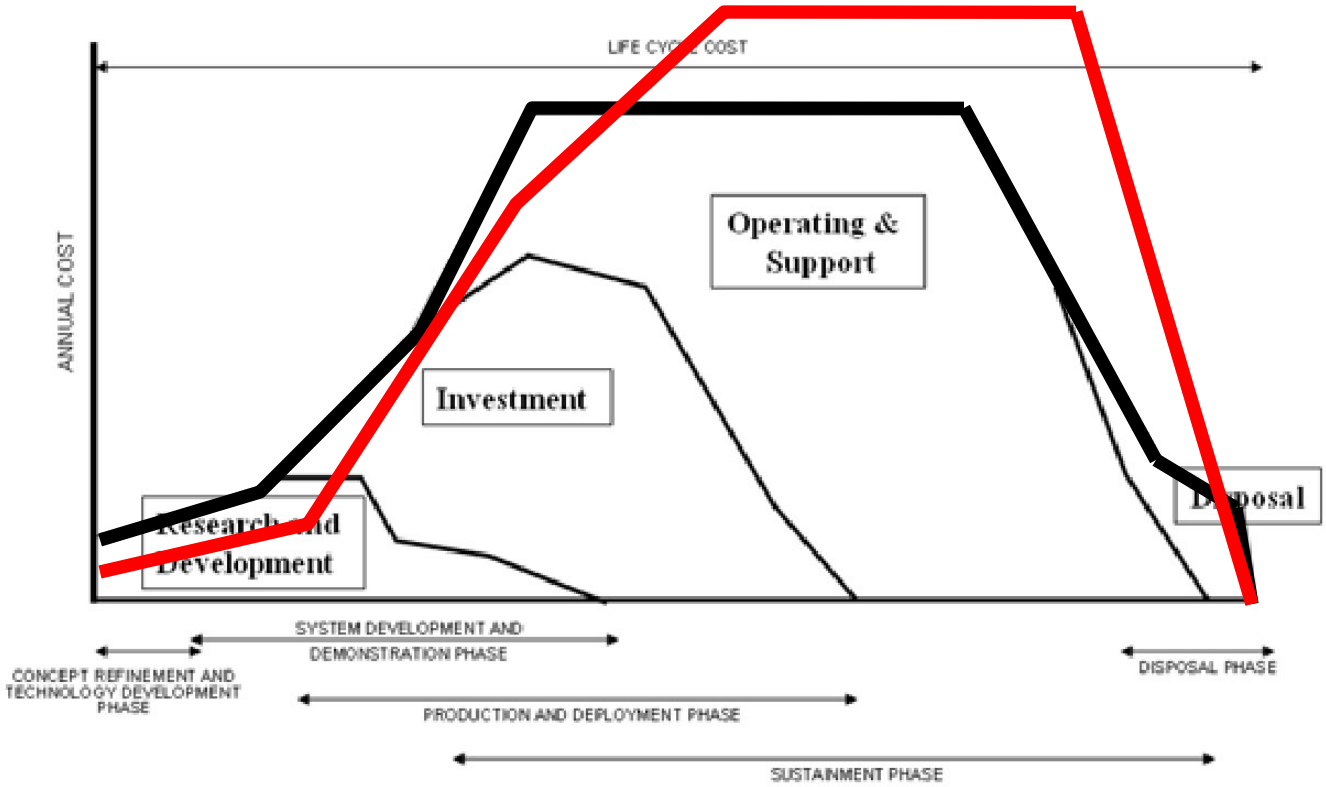
  Ex.: Detailed component design risk management requires technical expertise for design review and component testing, but integration risk management requires a broader systems understanding of the product, and how subsystems work together to fulfill requirements.

Integrating open systems and evolutionary acquisition, which repeats the development process over multiple blocks, will require significant, extended need for integration and systems expertise within acquisition programs.

Implication for Practice (2 of 3)

A Temporal Shift in Program Risks and Potential Costs

The interaction of open systems and evolutionary acquisition may reduce R&D costs but increase and delay integration costs



Relative Costs during a Product Life Cycle

(based on Defense Acquisition Guidebook, Nov. 2004, p. 43)

Implications for Practice (3 of 3)

Trading Design Obsolescence for Integration Obsolescence?

- Traditional acquisition processes commit programs to customized designs and therefore bear significant ***design obsolescence risk*** when threats and technologies evolve away from the design.
- Using open systems requires a program to commit to one or more standards early in a program and therefore bear significant ***standards obsolescence risk*** if and as standards evolve away from the needs of the program and integration problems increase.

Adding open systems to evolutionary acquisition may cause programs to trade away design risk for increased integration risk.

Closing

- **Open systems and evolutionary acquisition *can* interact synergistically. But, program managers must:**
  - Design programs to capture specific benefits
  - Design programs to manage (different) risks
- **Future work**
  - Test lessons in active acquisition programs
  - Learn from experience of multiple programs
  - Extend lessons into additional implications for practice and recommendations for management