

The Effects of Incentives in Acquisition Competition on Program Outcomes

William E. Novak
Harry L. Levinson

September 18, 2012

SEI Proprietary. Distribution: Director's Office Permission Required



Copyright 2012 Carnegie Mellon University

This material is based upon work funded and supported by the Department of Defense under Contract No. FA8721-05-C-0003 with Carnegie Mellon University for the operation of the Software Engineering Institute, a federally funded research and development center.

NO WARRANTY

THIS CARNEGIE MELLON UNIVERSITY AND SOFTWARE ENGINEERING INSTITUTE MATERIAL IS FURNISHED ON AN "AS-IS" BASIS. CARNEGIE MELLON UNIVERSITY MAKES NO WARRANTIES OF ANY KIND, EITHER EXPRESSED OR IMPLIED, AS TO ANY MATTER INCLUDING, BUT NOT LIMITED TO, WARRANTY OF FITNESS FOR PURPOSE OR MERCHANTABILITY, EXCLUSIVITY, OR RESULTS OBTAINED FROM USE OF THE MATERIAL. CARNEGIE MELLON UNIVERSITY DOES NOT MAKE ANY WARRANTY OF ANY KIND WITH RESPECT TO FREEDOM FROM PATENT, TRADEMARK, OR COPYRIGHT INFRINGEMENT.

This material has been approved for public release and unlimited distribution except as restricted below.

The Government of the United States has a royalty-free government-purpose license to use, duplicate, or disclose the work, in whole or in part and in any manner, and to have or permit others to do so, for government purposes pursuant to the copyright license under the clause at 252.227-7013 and 252.227-7013 Alternate I.

Internal use: * Permission to reproduce this material and to prepare derivative works from this material for internal use is granted, provided the copyright and "No Warranty" statements are included with all reproductions and derivative works.

External use: * This material may be reproduced in its entirety, without modification, and freely distributed in written or electronic form without requesting formal permission. Permission is required for any other external and/or commercial use. Requests for permission should be directed to the Software Engineering Institute at permission@sei.cmu.edu.

* These restrictions do not apply to U.S. government entities.

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Agenda

- Introduction
 - Acquisition Programs as Complex, Dynamic Systems
 - Structural Dynamics and Misaligned Incentives
 - Systems Thinking
- Acquisition Competition Scenarios
 - “Sacrificing Sustainment”
 - “Consolidation into Joint Programs”
- Addressing Misaligned Incentives in Acquisition
 - Research Approach
 - Strategy
- Summary

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Acquisition Programs *are* Dynamic Systems

Complex Interactions: Interactions between acquisition stakeholders are *non-linear* because of the presence of feedback

- *What you do depends on what I do, which depends on what you do...*

Non-linear Behavior: Non-linear behavior defies traditional mathematical analysis

Sensitivity to Initial Conditions: Results may vary greatly due to seemingly insignificant differences in the starting point(s)

Organizational: Key issues in software acquisition are often management and organization-related — *not* technical

- “No matter what the problem is, it’s always a people problem.”
—Gerald Weinberg

Partitioning: Partitioning isn’t possible when there are complex interactions between components

SEI Proprietary; Distribution: Director’s Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes Problem

Poor acquisition program performance inhibits military performance by depriving the warfighter of critical systems to achieve mission objectives

- Delayed systems withhold needed capabilities
- Wasted resources drain funding needed for new systems

Acquisitions fail for both technical and non-technical reasons; people issues often drive adverse acquisition dynamics

- Human, organizational, and management issues drive poor program performance

Acquisition programs are complex systems with structural dynamics

- Feedback in acquisition produces non-linear interactions (feedback) that add complexity
- Complex systems can produce seemingly unpredictable behaviors

Misaligned incentives are a key driver of poor acquisition outcomes

- “Social dilemmas” are a major category of misaligned incentives that have received much study
- Social dilemmas occur frequently in software-reliant acquisition programs

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Structural Dynamics in Acquisition

Structural dynamics are the natural and “physical” processes involved in carrying out a system’s function

Unrecognized structural feedback dynamics underlie acquisition, and can drive complexity and adverse acquisition behaviors

Example: Long Program Duration Grows Schedule (*Longer Begets Bigger*)

- Long duration allows greater capability to be built
- Long duration drives use of immature technology to avoid obsolescence
- Long duration drives scope creep due to changing threats and new technologies

Key Idea

Complex feedback and delays make the management and control of acquisition programs difficult

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Misaligned Incentives in Acquisition

Structural reasons like feedback and delays aren't the only causes for acquisition failure—incentives play a key role as well.

Misaligned incentives occur when:

- Lower-level individual goals conflict with group goals
- Short-term goals conflict with long-term goals

The result is that:

- Some group goals only succeed at the expense of individual goals
- Some long-term goals only succeed at the expense of short-term goals

Some acquisition programs are *prevented* from succeeding for structural and incentive reasons—not poor work or lack of effort.

Key Idea

Misaligned incentives can push people to make impossible choices and trade-offs

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Misaligned Incentives in Acquisition

Misaligned incentives in acquisition programs put individual or program-specific interests ahead of PEO or Service interests, turning cooperation into opposition

Example: Joint Programs

- To meet conflicting requirements, cost, schedule, size, complexity, risk all go up
- Users prefer custom solutions they control that are certain to meet their needs

Example: Shared Infrastructure Development

- Programs have an incentive to wait for another program to use the shared infrastructure first—better that others work out the problems, than risk failure of the program

Key Idea

Misaligned incentives are pervasive in contributing to poor outcomes for acquisition programs

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Misaligned Incentives in Acquisition

Risk: Low incentive to identify program risks if it can adversely affect personal standing.

Defects: Incentives to find defects can result in the intentional insertion of defects.

Schedule: Incentives to improve performance by meeting a set date can mean quality processes are sacrificed to meet that date.

Technology: Incentives to use risky, immature technology to achieve better system capability, and give good experience to the contractor.

Contracts: Incentives to drag out development on CP & T&M contracts to increase profits.

Staffing: Incentives to slow efforts/stretch schedule if there's no next project to move on to.

Cancellation: Low incentive to cancel ailing programs if it's not in interests of staff.

Scope: Low incentive for users to ask for only minimal system capability if it's free to them.

Key Idea

Misaligned incentives occur every day in acquisition programs

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Challenge

Acquisition leaders may have inadequate decision-making experience

- May be insufficiently trained in making key acquisition decisions
- Lacking software acquisition experience, they are unaware of:
 - The complexity of acquisition programs
 - The unintended consequences of many decisions made on programs

Education is the best alternative—but conventional training is ineffective for decision-makers in dynamically complex domains

- Traditional education methods may not translate well to acquisition realities
- Well-intentioned decisions are undermined by complexity and adverse unintended consequences
- Poor acquisition management has major cost, schedule, and quality impacts
- Improved decision-making requires different mental models [Shute 2009]

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Systems Thinking

Systems Thinking is a method for analyzing complex systems

Developed by Jay W. Forrester at MIT while modeling electrical feedback

- Also recognized in economic, political, business, and organizational behaviors

Uses feedback loops to describe and analyze common system structures that spin out of control, or regulate themselves

Relationships between *reinforcing* feedback loops and *balancing* feedback loops drive the behavior of the system

Time delays *obscure* the connections in cause-and-effect relationships

- Time delays in feedback affect the way the system behaves
- People are poor at controlling systems with long time delays

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

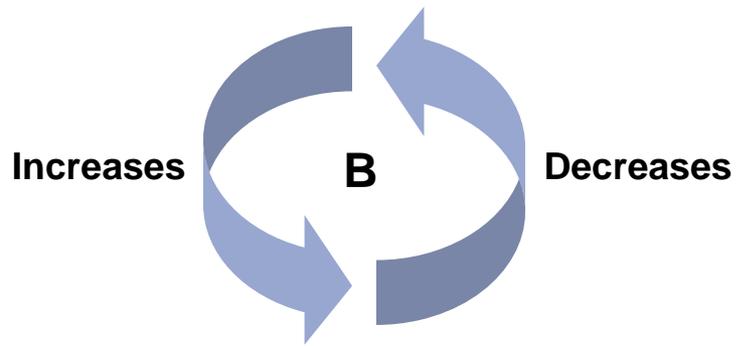
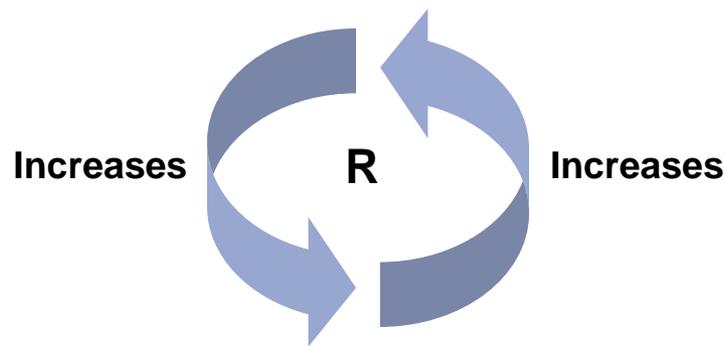
Causal Loop Diagrams (CLDs)

Depict qualitative “*influencing*” relationships (increasing or decreasing) and time delays between key variables that describe the system

Show relationship direction by labeling them **Same (+)** or **Opposite (-)** to indicate how one variable behaves based on the previous variable

Consist primarily of two types of feedback loops:

- **Reinforcing** – Changes to variables *reinforce*, moving in one direction
- **Balancing** – Changes to variables *alternate*, achieving equilibrium



SEI Proprietary; Distribution: Director's Office Permission Required

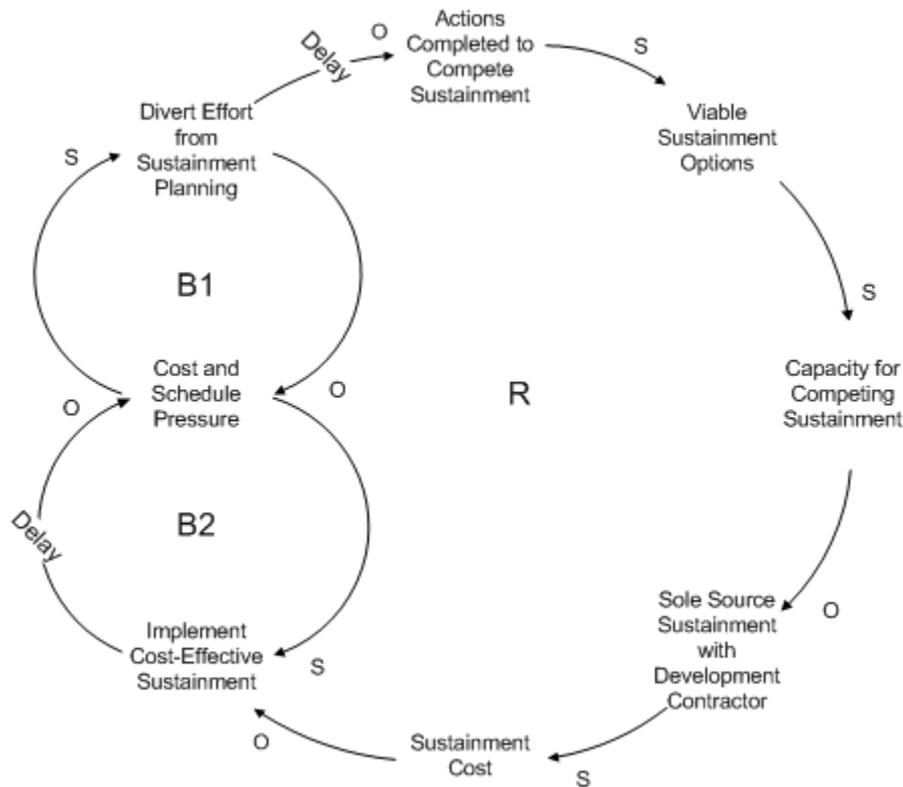




Acquisition Competition Scenarios



The Effects of Incentives in Acquisition Competition on Program Outcomes “Sacrificing Sustainment”



Diverting Effort from Sustainment Planning reduces Viable Sustainment Options, along with a program's Capacity for Competing Sustainment. This makes Sole Source Sustainment with the Development Contractor more likely, driving up Sustainment Cost, and, after a delay, increasing Cost and Schedule Pressure.

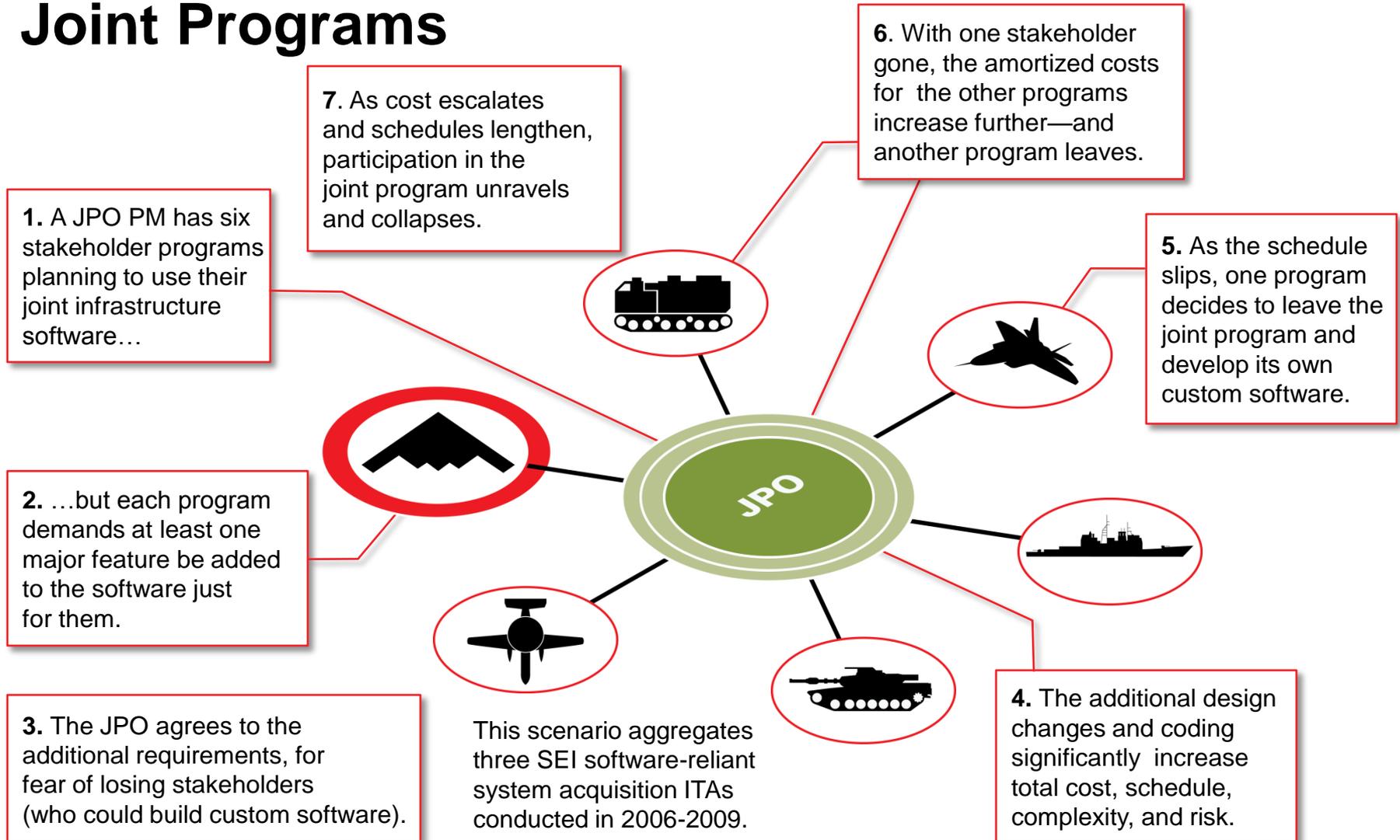
Based on “Shifting the Burden”

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Joint Programs

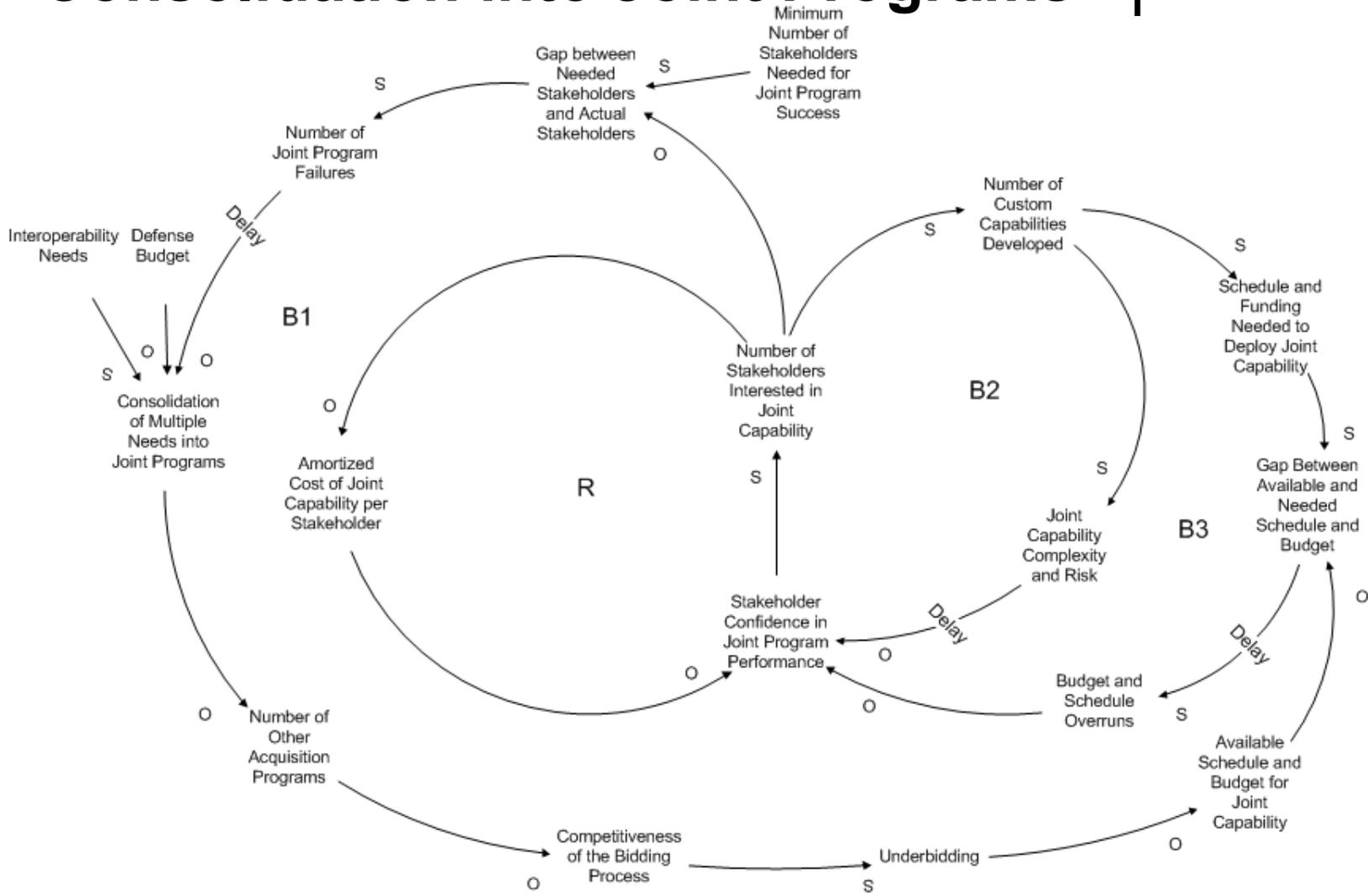


SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

“Consolidation into Joint Programs”¹



required





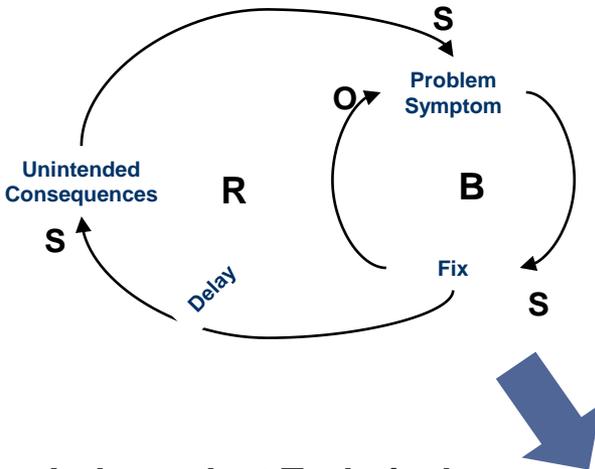
Misaligned Incentives in Acquisition



The Effects of Incentives in Acquisition Competition on Program Outcomes

Research Approach ₁

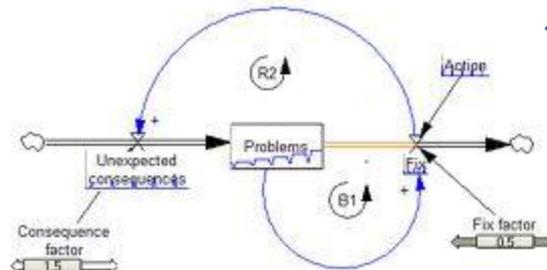
General Qualitative Model



Independent Technical Assessment (ITA) Data

Detailed examinations of challenged programs with interviews, document reviews, and code analysis

Acquisition Problem Model



Acquisition Qualitative Model

Deep Understanding of Dynamic Acquisition Behavior

Model-Based Simulation of Potential Solutions

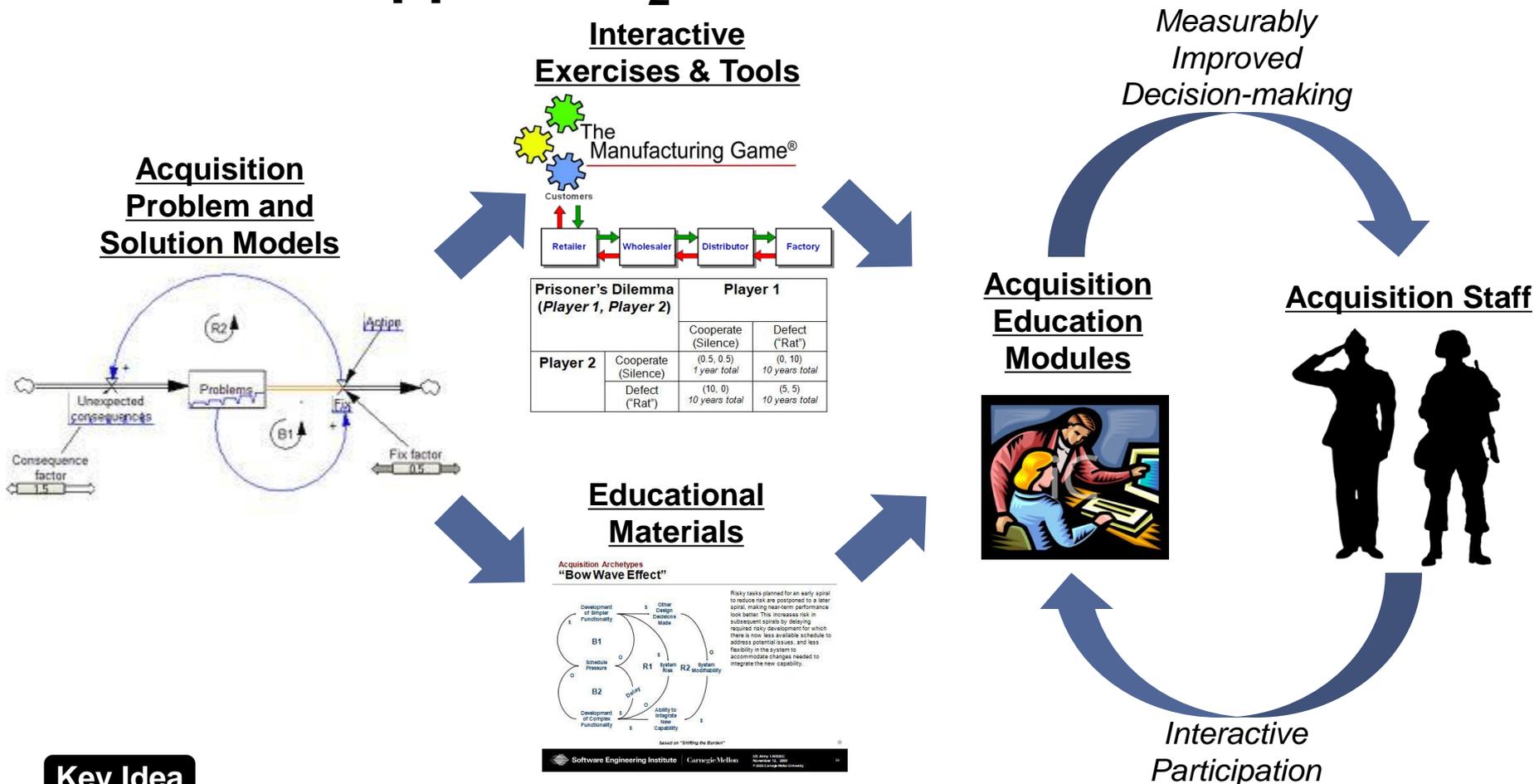
Foundation for Acquisition Instructional Simulations

Firefighting: If design problems are found in the current release, more resources must be used to fix them. This reduces problems, but now less work is done on the *next* release. This undermines its early development work, and increases design problems in the next release.



The Effects of Incentives in Acquisition Competition on Program Outcomes

Research Approach 2



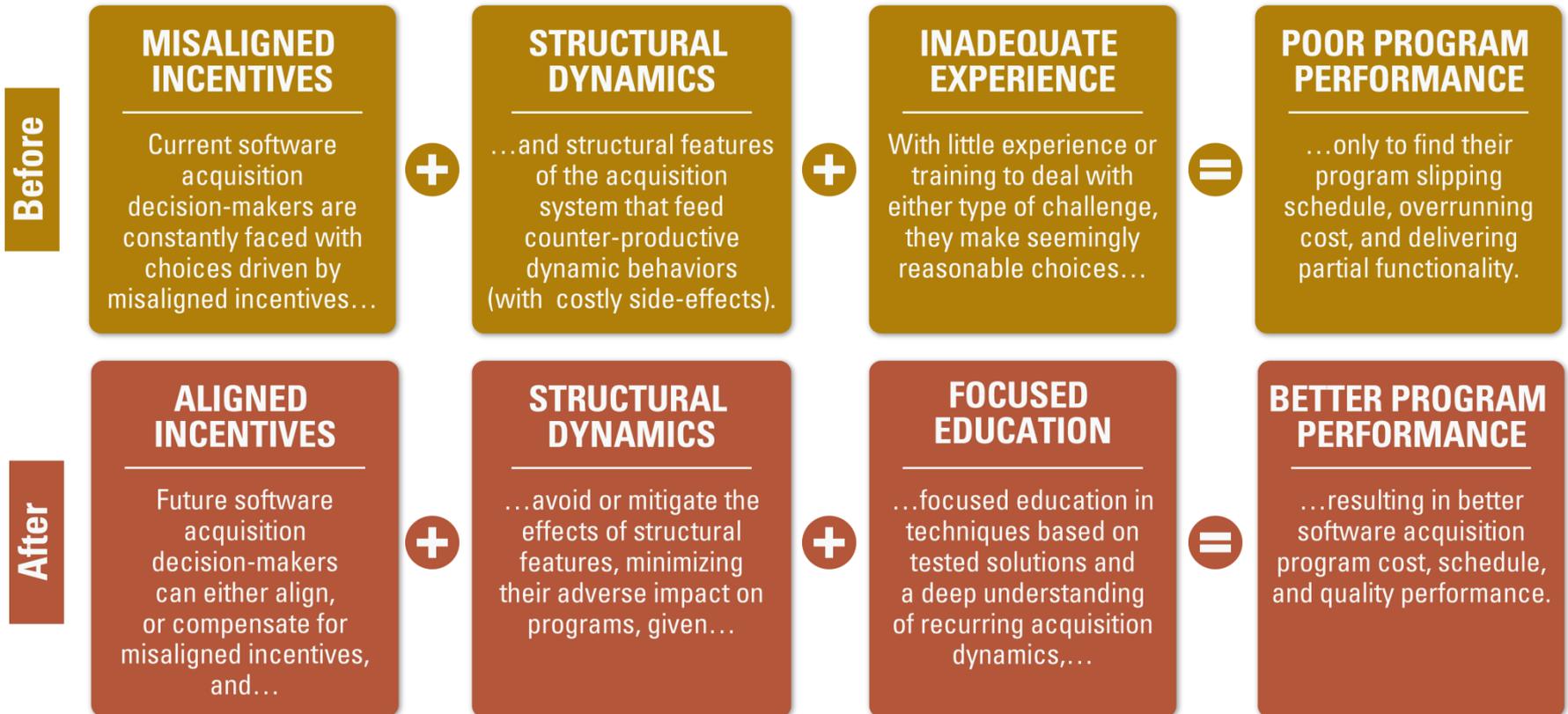
Key Idea

Experiential learning can significantly improve learners' mental models and their acquisition decision-making

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes Strategy



SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Key Incentives Behind Acquisition Failure

Immature Technology

- Government prefers providing greatest capability, which requires latest technologies
- Contractors prefer using latest technologies to boost staff competency for future bids

Joint Programs

- To meet conflicting requirements, cost, schedule, size, complexity, and risk all go up
- Users prefer custom solutions they control that are certain to meet their needs

Long Duration

- Long duration allows greater capability to be built
- Long duration drives use of immature technology to avoid obsolescence
- Long duration drives scope creep due to changing threats and new technologies
- Contractors prefer the stability and revenue of longer programs

Turnover and Inexperience in Acquisition Program and Technical Management

- Personnel on short rotations may not be invested in decisions about long-term needs
- More difficult for government to hire and retain highly experienced personnel

Unrealistic Estimates and Underbidding

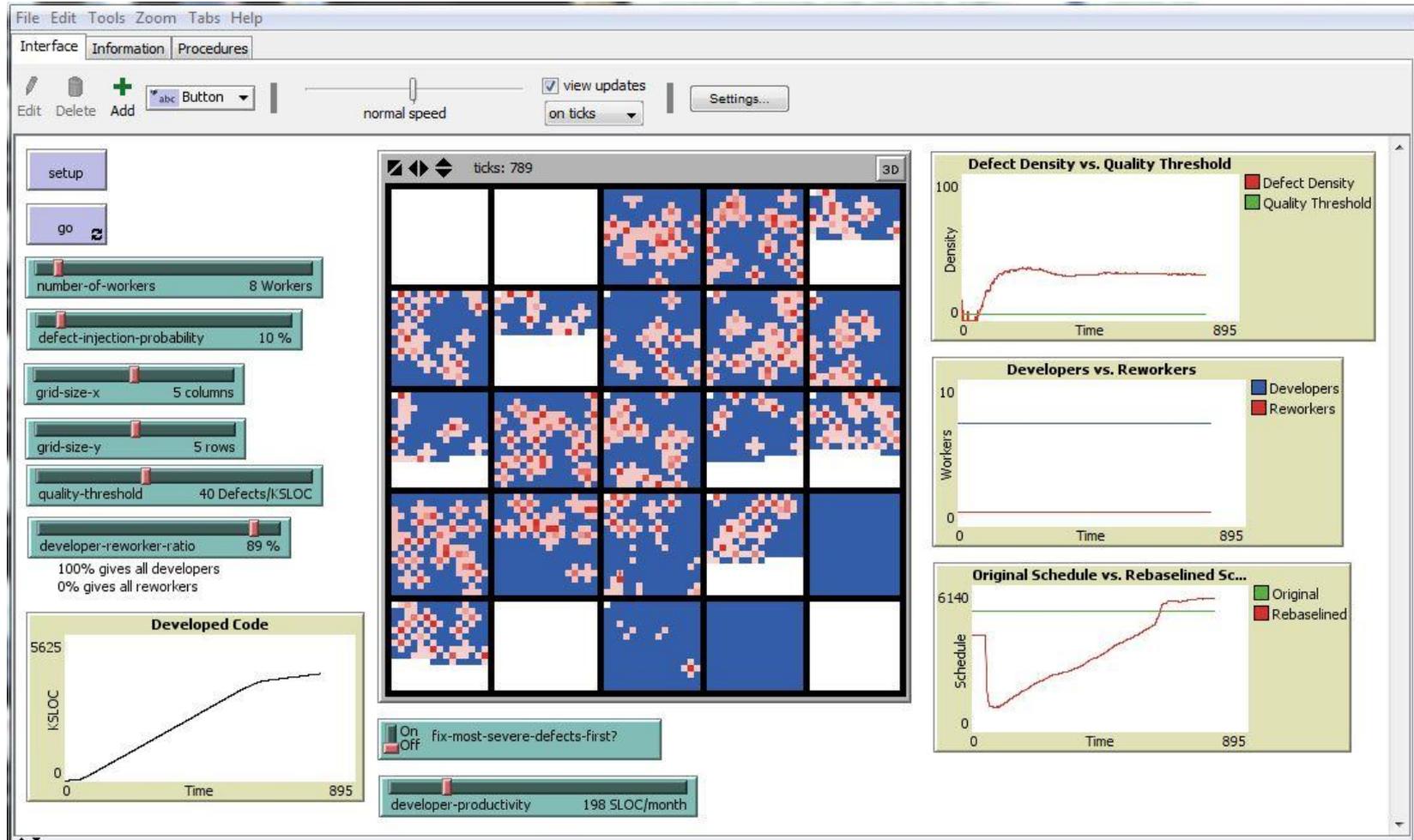
- Government wants low cost estimates to get programs approved
- Contractors want low bids to win contracts

SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

“Firefighting” Interactive Exercise



SEI Proprietary; Distribution: Director's Office Permission Required

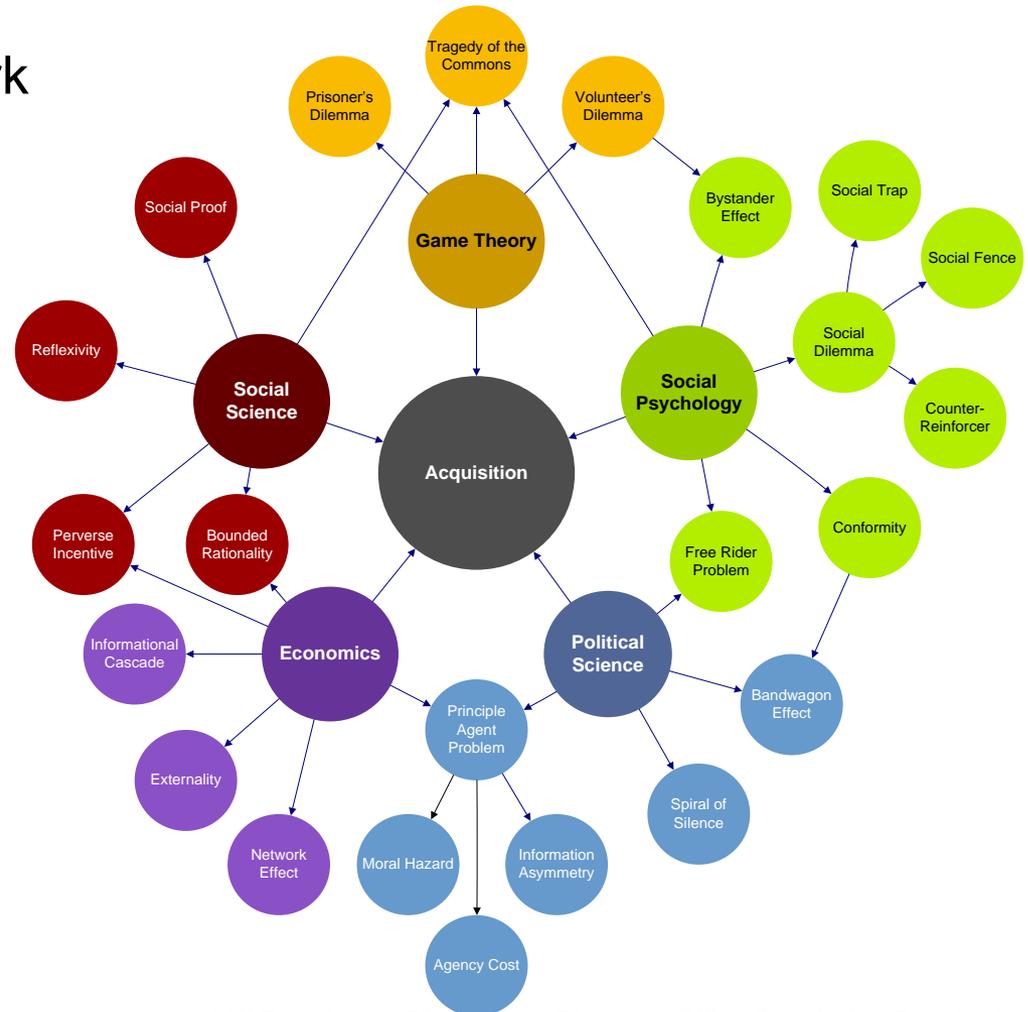


The Effects of Incentives in Acquisition Competition on Program Outcomes

Related Disciplines and Concepts

The Acquisition Dynamics work starts with real acquisition problems, and then draws on ideas and concepts from a variety of different disciplines:

- Social Science
- Game Theory
- Social Psychology
- Political Science
- Economics



SEI Proprietary; Distribution: Director's Office Permission Required



The Effects of Incentives in Acquisition Competition on Program Outcomes

Summary

Many recurring patterns of adverse acquisition behavior can be explained by structural dynamics and misaligned incentives

Sacrificing longer-term planning in favor of nearer-term priorities inadvertently undermines ability to compete sustainment, with likely longer-term adverse effects of increasing costs

Consolidating multiple needs into single joint acquisition programs promotes underbidding, inadvertently fostering cost and schedule overruns that undermine the joint effort

Use executable acquisition models to analyze known adverse software acquisition dynamics, and test proposed mitigations/solutions

- Turn existing software acquisition domain expertise into a more usable form
- Apply both new and known solutions to solving recurring dilemmas in acquisition

Provide experiential learning to DoD acquisition staff through hands-on simulations of key recurring acquisition dynamics

- Understand common side-effects of decisions that lead to poor performance
- Let acquisition staff gain experience through *education*—not costly mistakes



The Effects of Incentives in Acquisition Competition on Program Outcomes For Additional Information

SEI Report: *"The Evolution of a Science Project: A Preliminary System Dynamics Model of a Recurring Software-Reliant Acquisition Behavior"*

SEI Report: *"Success in Acquisition: Using Archetypes to Beat the Odds"*

SEI Blog: *"Themes Across Acquisition Programs": Parts 1-4*

Website: <http://www.sei.cmu.edu/acquisition/research/archetypes.cfm>

Download all twelve:

- PMO vs. Contractor Hostility
- Underbidding the Contract
- Everything for Everybody
- The Bow Wave Effect
- Brooks' Law
- Firefighting
- "Happy Path" Testing
- Longer Begets Bigger
- Shooting the Messenger
- Feeding the Sacred Cow
- Staff Burnout and Turnover
- Robbing Peter to Pay Paul



SEI Proprietary; Distribution: Director's Office Permission Required



Contact

William E. Novak

Senior Member of Engineering Staff

Military Services Team

Acquisition Support Program

Telephone: 412.268.5519

Email: wen@sei.cmu.edu

Address

Software Engineering Institute

Carnegie Mellon University

4500 Fifth Avenue

Pittsburgh, PA 15213-3890





Software Engineering Institute

Carnegie Mellon



Software Engineering Institute

Carnegie Mellon

© 2012 Carnegie Mellon University