The Effect of Using a Systems Approach to Project Control within the U.S. Small Arms Defense Industry

Patrick Cantwell
Dr. Shiram Sarkani
Dr. Thomas Mazzuchi
George Washington University
May 14, 2012

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Who am I?

- Former U.S. Marine Corps Infantry Officer
- Work Experience
  - Survivability/Lethality Engineer
  - Requirements Officer
  - Manager of Requirements Officers
  - Analyst/Consultant
- Academic Experience
  - Undergraduate degree in engineering
  - Masters in systems engineering/engineering management
  - ONGOING PhD in systems engineering
    - Classwork Complete, Last Year of Dissertation Research

Today's Objective

- Everyone learns something.
  - You develop a better understanding of the capabilities and limitations of project management tools.
  - I improve my model.

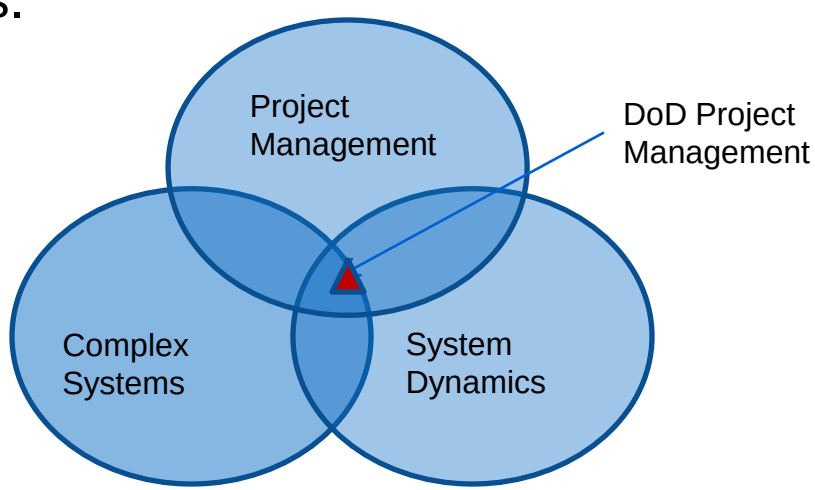
- I will consider my research successful if I graduate and help advance the understanding of DoD acquisition system responses.

Background

- Cooper and Mullen [1] note that only 50% of development projects meet their cost and schedule goals.
- The U.S. Department of Defense (DoD) FY12 budget totals $553.1 billion US [2].
  - $85.3 billion US (15.4%) accounts for development projects
- The U.S. Government Accountability Office has found that Department of Defense (DoD) programs take 22 months longer than expected and over 80% experience higher costs than expected.

Problem Statement

- Problem: Projects managers must make decisions to keep their dynamic programs on a desired trajectory. These programs have many moving parts which interact in complex ways amongst themselves and with external factors, all with the additional complication of time-lagged and uncertain understanding by the decision maker of the program's current state. We argue that current decision support methods do not address this phenomenology.
- Approach: Build off existing system dynamics project management research modeling the interactive effects of performance measures in DoD acquisitions.



Why DoD Project Management

- Resources and motivation should be present in DoD projects
- Multiple stakeholders with independent goals
  - No profit motivation
- Government offers unique dynamics not present in private industry
  - End-user is facing an adaptive enemy
  - Legal obligations limit responses
    - Mandatory PM training
    - Contracts
    - Limited personnel
  - Budget submission/approval process is lengthy and politically motivated.
- We believe these interactions form a complex system

Previous Research- Complex Systems

- Whitty and Maylor [3] have identified that there are many definitions of what a “complex system” is.
  - They conclude complexity varies across a range.
  - They note that there is no standard metric.
  - They note that uncertainty is an element of all projects.
  - They also highlight that the state of a system and its interrelationships of components are key to understanding a system.
- Ivory and Alderman [4] extend this and highlight the presence of non-linearity, non-equilibrium, and multiple interdependencies.
  - They note that assumptions are often wrong due to “social or technical realities”.

Previous Research- Complex Systems, cont.

- The problems caused by complex systems include:
  - Multiple combinations of components that all have unique conditions and actions. [5]
  - **Combinations that are not always defined by the sum of the component actions.** [6]
  - **Interactions and results are often not manifested quickly or as a result of one cause.** [7]
- Sterman [8] has conducted studies proving human's poor ability to intuitively predict third order systems.
  - Beer Game (http://beergame.mit.edu/)

Previous Research- Project Management

- Despite the claim that project management was invented in the 1950s, there are researchers that claim project management theory is not well understood. [9]
  - As an example, DoD has changed its project management policy nine times since its inception in the 1970s.
- Williams [10] notes that lack of project management understanding is due to the lack of theoretical development and little academic interest. He also highlights three major project management assumptions:
  - *Project management is rational.*
  - *Actual project states can be determined at any time.*
  - *All project work can be decomposed.*

Previous Research- Project Management, cont.

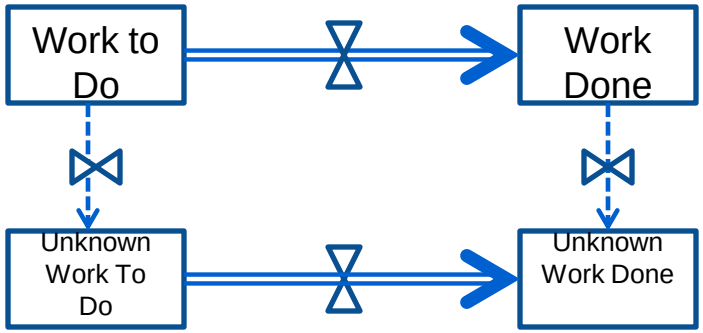
- Several researchers have identified the lack of utility in traditional project management techniques.
  - Most rely on averages. [10]
  - Most utilize linear analysis. [11]
  - Most are highly dependent on assumptions. [11]
- Other critiques of traditional project management techniques:
  - Do not resolve external/environmental influences. [10]
  - Do not handle human interactions. [5,12]
  - Do not handle “strategic” issues. [12]
  - Do not well tolerate changes over time. [15]
- Many researchers have looked to systems methodology and system dynamics to handle project management.

Previous Research- System Dynamics

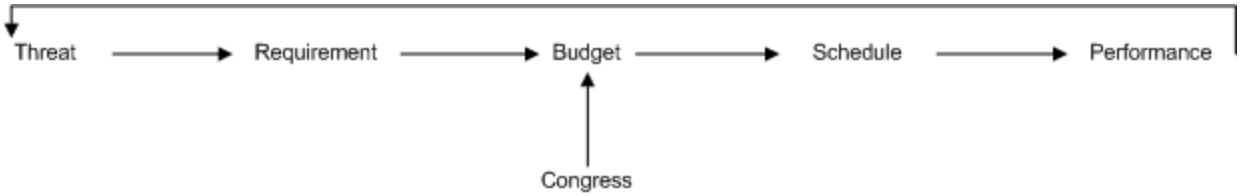
- System dynamics has had wide use in multiple disciplines with specific focus elements including: [14 - 16]
  - Strategic perspective
  - Non-linear results
  - Dynamics of human component interactions
  - Dynamics of system interactions with the environment
  - Feedback loops
  - Delays
  - Archetype Elements and Sub-elements
- Barlas [17] notes that system dynamics is a “white box” approach using the model structure to produce the results.

Previous Research- System Dynamics, cont.

- There has been wide use of system dynamics in the domain of project management, even within the U.S. DoD. [18]
  - Most has been supporting delay legal claims.
  - Not much published.
  - None from the government perspective.
- Two key archetypes applicable to project management:
  - Rework Cycle [18]
  - Resource Management [16]

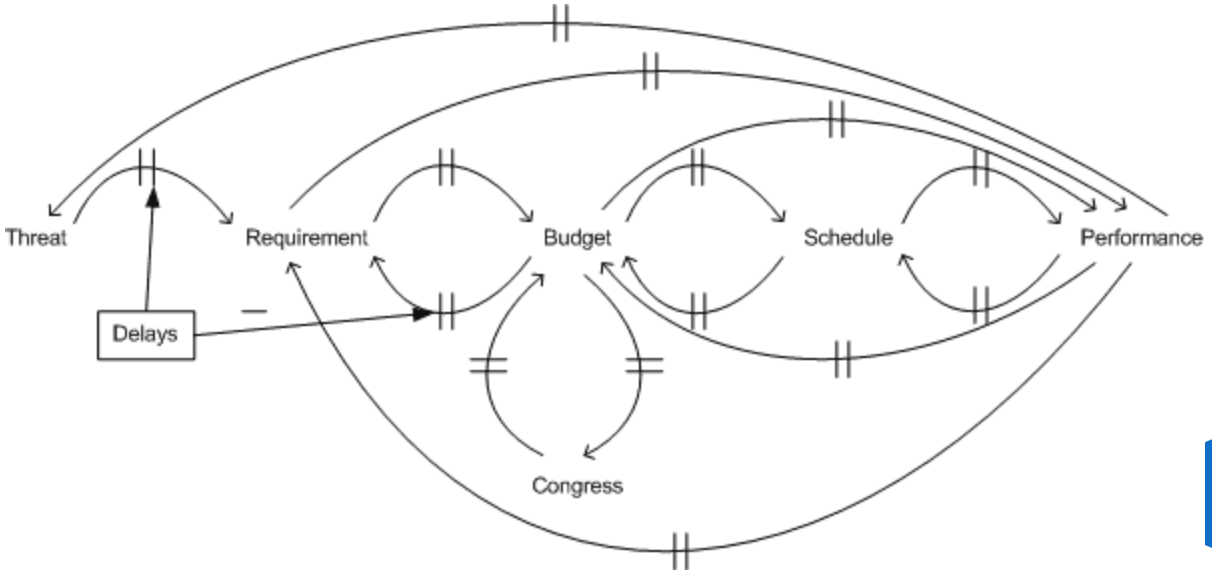


Dynamic Hypothesis



This is how most people believe DoD project management works

This is how the authors believe DoD project management really works.



Modeling Approach

- We subscribe to the contingency theory of project management in that every project is different.
- However, we are developing a generic strategic model as a first step in understanding.
- This model could be advanced and tailored to any project.
- There are also potential opportunities to create a “management flight simulator” for training and education.

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2. U. S. Dept.of Def. (Comptroller), "Overview- FY2012 Defense Budget," U. S. Dept. of Def, Ed., ed. Washington, DC, 2011.
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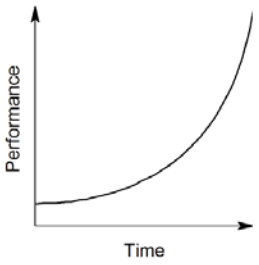
BREAK

System Dynamics Modeling

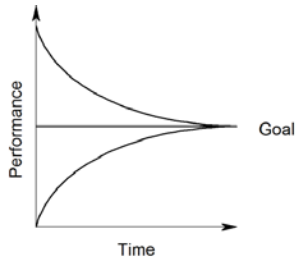
- Developed by MIT Professor Jay Forrester in 1960s
  - Initially used to explain industrial dynamics
  - Also developed a world population model
- Combines control theory and management theory
- Can incorporate social elements that can be represented by the construct.
- Three key areas of focus:
  1. Stocks and Flows
  2. Feedback
  3. Non-linearities
- *Essentially a representation of accumulations over time*

System Dynamics Modeling

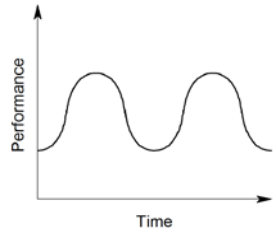
- From the decades of system dynamics research, there are three general system responses (or a combination thereof):
  1. Exponential Growth/Decay



  2. Constrained (Logistic) Growth



  3. Oscillation

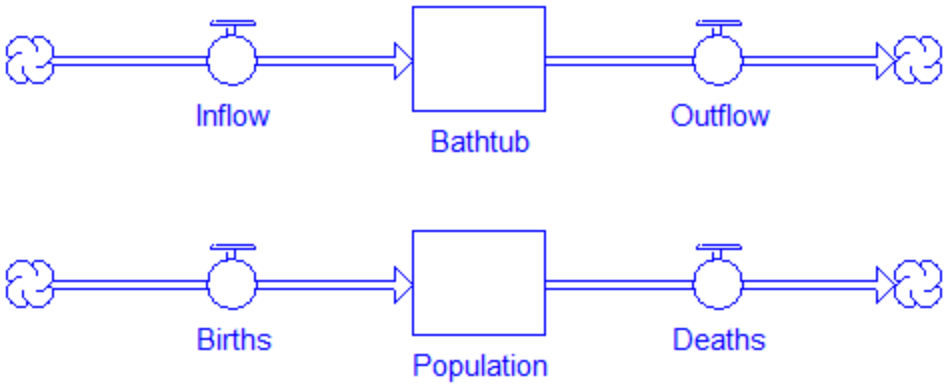


System Dynamics Modeling

- This has led to system archetypes.
  1. Limits to Growth
  2. Success to the Successful = competition for limited resources
  3. Tragedy of the Commons = limited resources are used for individual gain
  4. Growth and Underinvestment = growth approaches a limit that could have been prevented with early investment
  5. Fixes that Fail = short-term success that causes long-term consequences

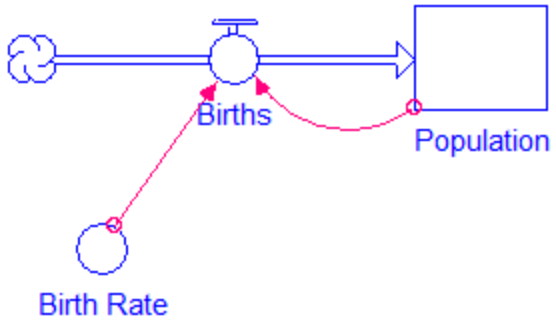
System Dyanmics Modeling

- Stocks = a single accumulation point
  - Measurable at a point in time
  - Often referred to as a “bathtub”
  - Cannot directly change
- Flow = rates of change
  - “Inflow” or “Outflow” of a stock
  - Can be changed

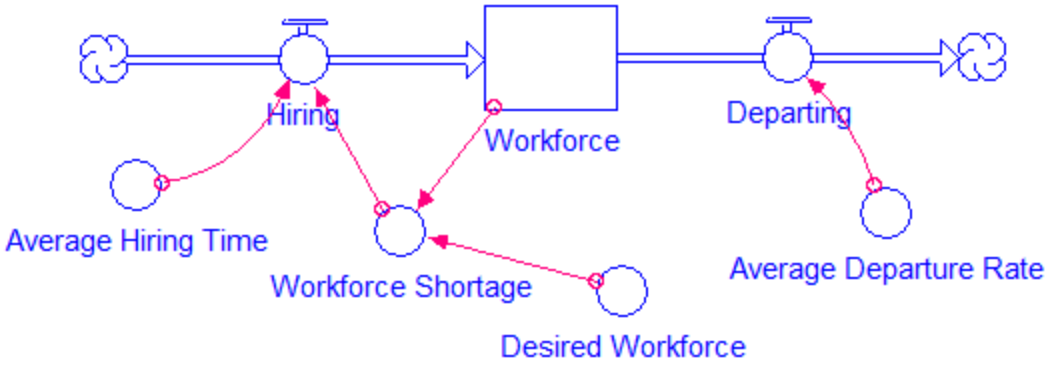


System Dynamics Modeling

- Converter (Auxillary Variable) = anything that impacts a flow
  - Frequently a rate or constant
  - Could be a curve or any function



- SD models are no more than combinations of stocks, flows, and converters

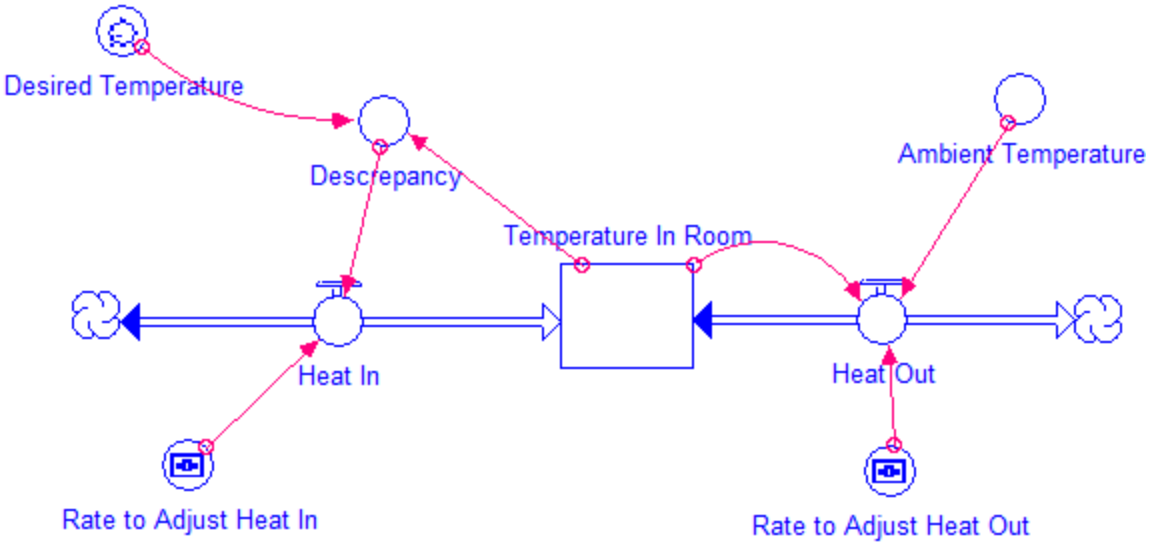


Word of Warning

- System dynamics is not perfect.
  - Must know relationships
  - Must know all variables
  - Like any model, it is tailored to purpose.
- Ultimately SD strives to develop a better understanding of system response
  - Then various policies can be tested and evaluated.

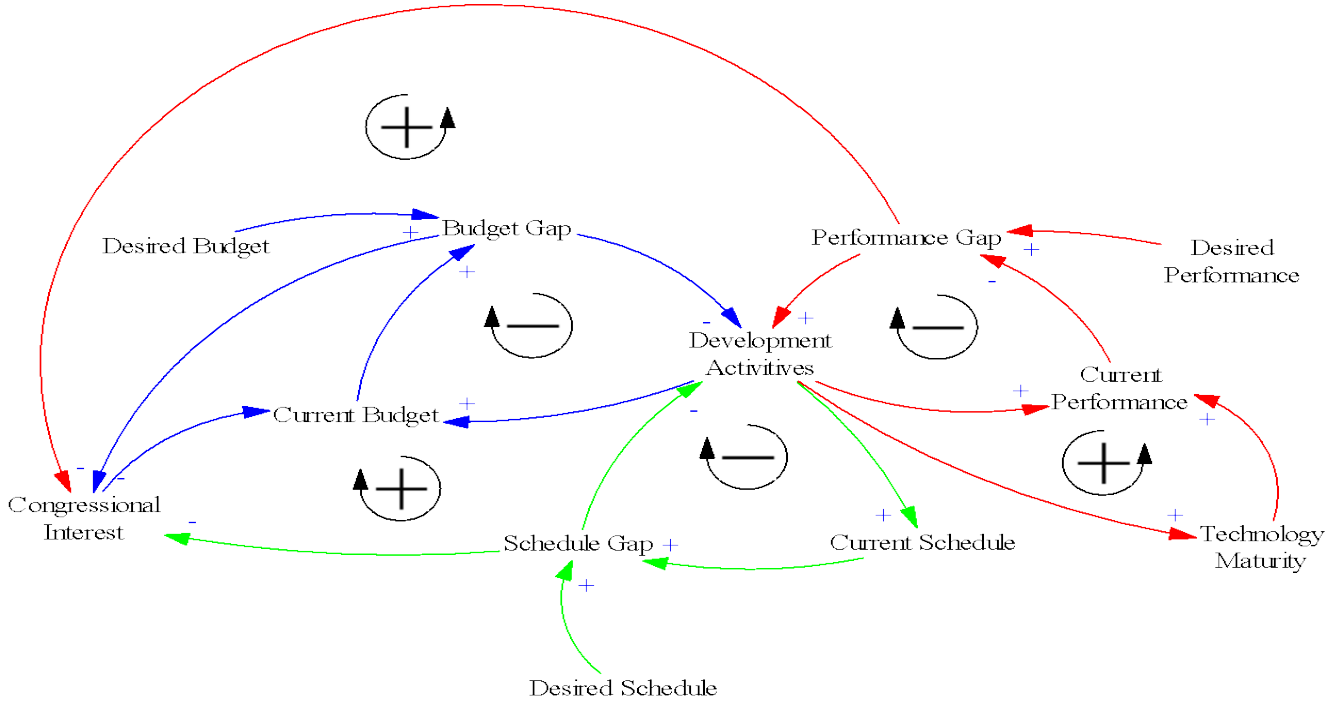
System Dynamics Example

- Let's look at a simple example with interesting results.
- Room Temperature Control



My Model

- Dynamic Hypothesis:



- Five variations of simple models all experience increased cost, schedule, and performance.

Discussion

- What do you like in the model?
- What would you like to see that is not in the model?
- What actions are typical to close:
  - Cost Gap?
  - Schedule Gap?
  - Performance Gap?
- Are changes ever made to schedule or performance without cost implications?

Additional Information

- *Business Dynamics: Systems Thinking and Modeling for a Complex World* by John Sterman, Irwin McGraw-Hill, 2000.
- *System Dynamics Modeling* by R.G. Coyle, Chapman & Hall/CRC, 1996.

- System Dynamics Society
  - www.systemdynamics.org
- www.systemswiki.org

- My email: prcwell@gmail.com

Questions?

Thank you for your attendance.