Modeling System Dynamics

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What Is Sustainment?

- Sustainment: Everything that happens to a system after the production line is closed down (product maintenance, infrastructure)
- Hardware: Repair, Remove corrosion, Replace worn parts
- Software
  - Corrective Maintenance (Bug fixes)
  - Adaptive (fix for changed environment, e.g., other systems, operating system...)
  - Perfective (New requirements)
  - Preventive (reliability/maintainability fixes)

All software sustainment is engineering work
Why Model Sustainment Dynamics?

Sustainment has

• Many loops
  – bug fixes, small enhancements, large enhancements

• Many stakeholders
  – operational forces, programs, sustainment organizations

• Many funding sources
  – O&M, program procurement, modernization procurement

Simple cost/benefit models fail to capture dynamic nature

• Varying time cycles for decisions

• Dramatic consequences: Funding delays can cause a “tipping point”: recovery very expensive

Dynamic model allows exploration of funding scenarios
Sustainment Cycles

Threats

Operational Needs Analysis

Operational Performance

Fix & Install

Corrective

Engineering & Delivery

Adaptive, Preventive

Perfective

Acquire New Materiel

Build / Fix Infrastructure

= Capability & Capacity Development

Budgeting

Operational System

= Relative cycle times
Factors to Model

• **Sustainment Capability**
  – skills and knowledge held by staff

• **Sustainment Capacity**
  – amount of sustainment work the staff can do
  – = # staff * capability

• **Performance**
  – amount of work the staff does, compared to needed

• **Productivity**
  – amount of work done per unit cost

• **Desired output**
  – sustained systems, number of system capabilities added
Systems Dynamics Modeling

• Create causal loop diagram
  – Stocks (quantities with an amount)
  – Flows (change the amount in stocks)
  – Relationships (and auxiliary variables)

• Simulate
  – Establish equilibrium
  – Pulse
  – Understand results

• Finalize
  – Calibrate
  – Publish
  – Productize
Sustainment Systems Dynamics Diagram

R1: Represents the need for additional missions and additional capability
B1/R2: Demand for sustaining work and development
B2: Sustainment performance vs. System performance and gaps
B3: Efforts to work overtime and do more with less
B4: Building additional capability and capacity to sustain
Not a loop but lower right: Effects of delayed funding decisions and commitment

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Conclusion

• Determined sustainment variables
• Dynamic relationships
• Calibrating with customer now
• Can calibrate to your organization
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Modeling Sustainment Dynamics
BACKUP CHARTS
Calibration and Validation
Comparing performance to goals

Mission Capable
Availability

Time to Deliver

Time to Receive
Funds

Goals
Performance
Gap
Request