Modeling Sustainment Investment

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Sustainment Investment: the Problem

How do we make decisions about the allocation of funds between areas?

What are the consequences of poor and delayed decisions?

How can we forecast the consequences of various alternatives?

Agenda

Sustainment Overview

Understanding Our Simulation

Using Scenarios to Apply the Tool

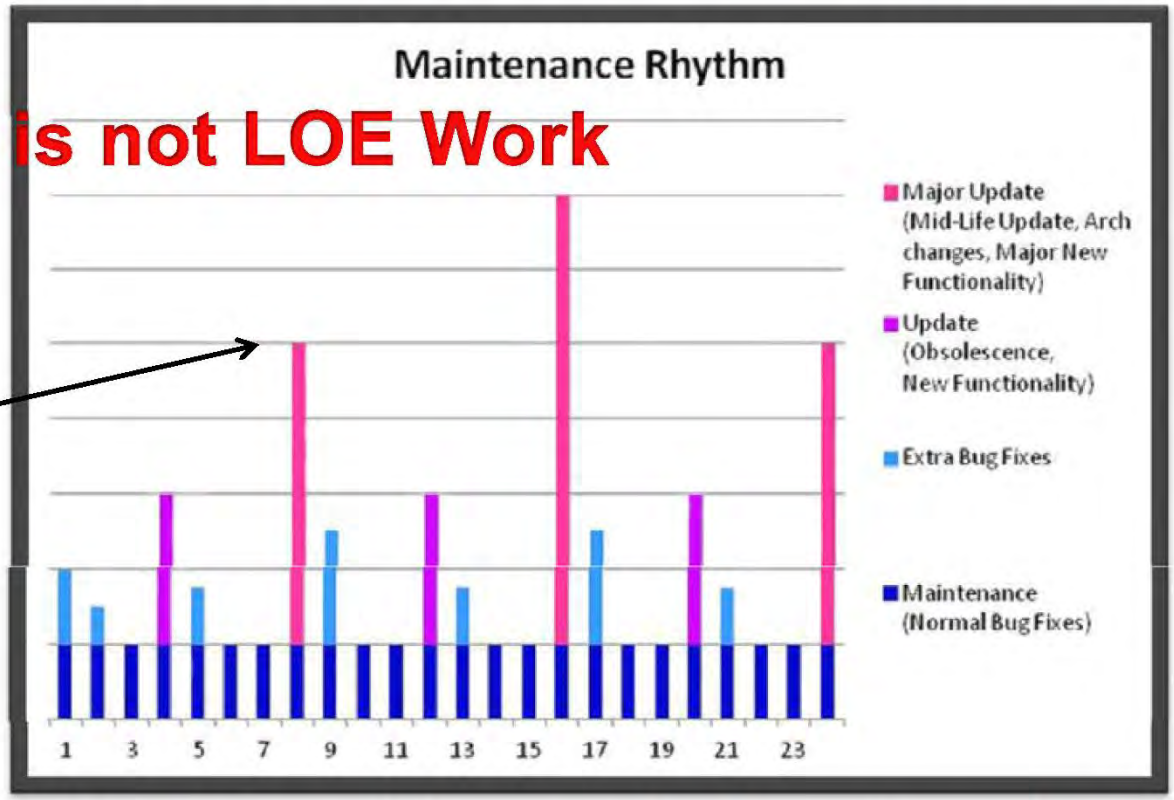
Results and Challenges

Demand for Sustainment is “Lumpy”

Slide from PSM Conference, 2012

Program Software Maintenance Release Profile

Sustainment is not LOE Work



Modernization

Cycles are different - platform dependent
User needs drive release content

The Decision Trade-Space

Context

We are managing the sustainment of a system.

- Some modernization work requiring a new technology is funded.
- New threats introduce new mission performance criteria.
- Changes to interfacing system obsoletes a component.

Potential Consequences of a Technology Change

- Productivity estimates may change requiring cost and schedule adjustments.
- Failure to update process may result in product quality deficiency.

Trade Space

Budget allocation decision between product development costs vis-à-vis the cost of improving the process and training people.

Problem

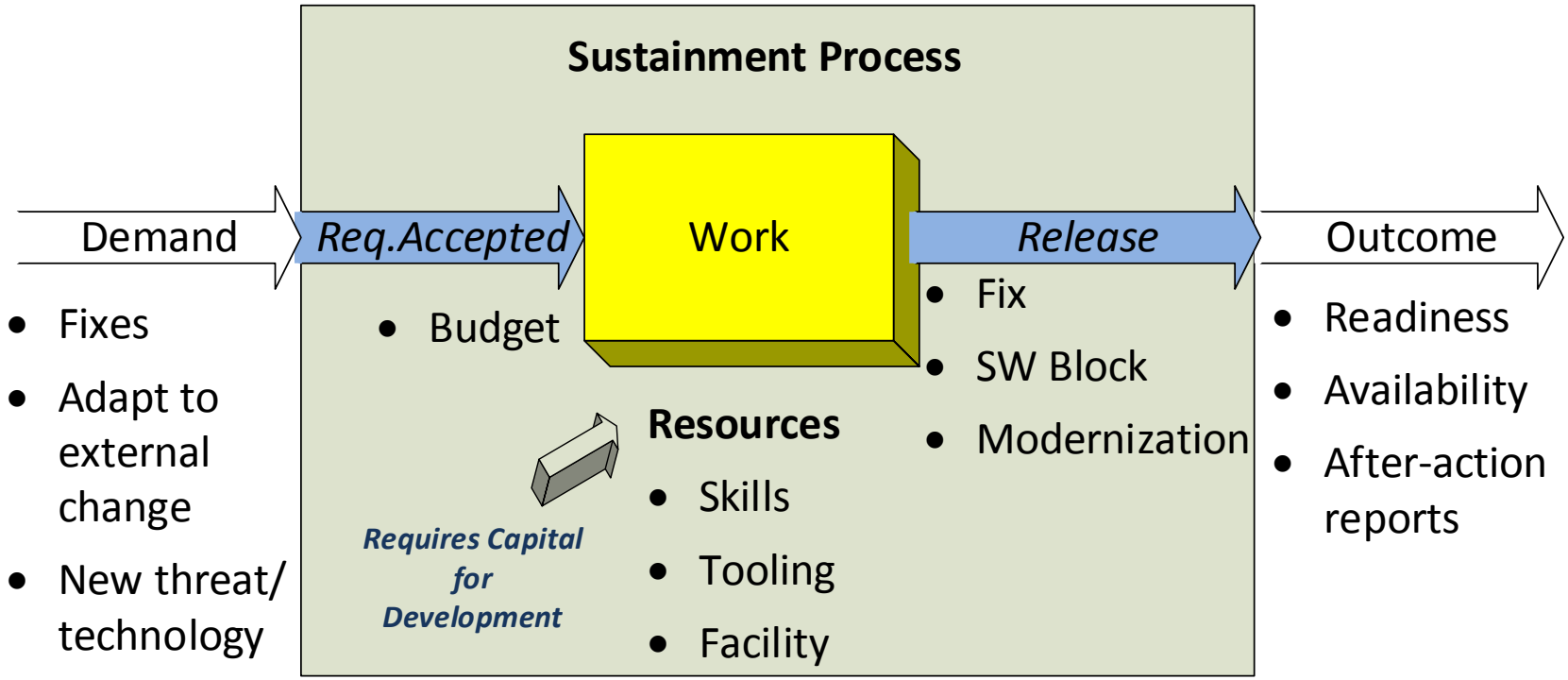
Multiple stakeholders causes decisions delays.

The Sustainment Business

The process is inside the gray box.

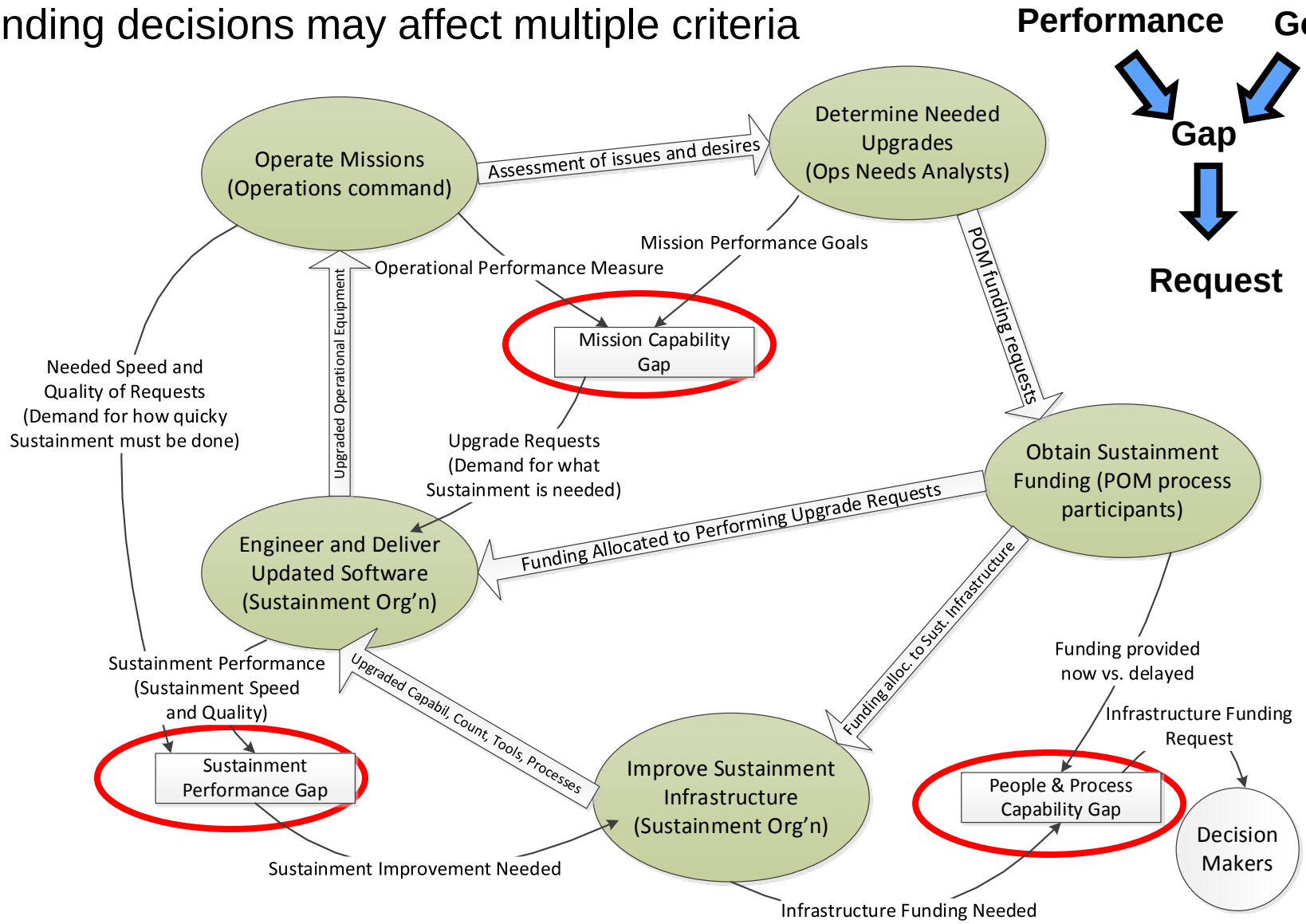
Customers are outside. Work input translates “demand” to requirements.

Demands that involve new technology require re-skilling and retooling.



Stakeholders in Sustainment

Funding decisions may affect multiple criteria



Agenda

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Results and Challenges

Reasons to Use A Simulation

Type of problem

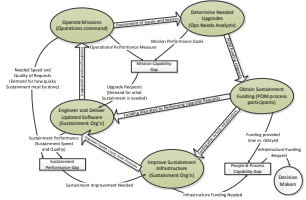
- Multiple sources of change (stakeholders, technology, threat)
- Change events occur asynchronously
- Multiple opportunities for decisions to control the situation
- Outcomes of changes and decisions do not appear at the same time and appear after significant delays.

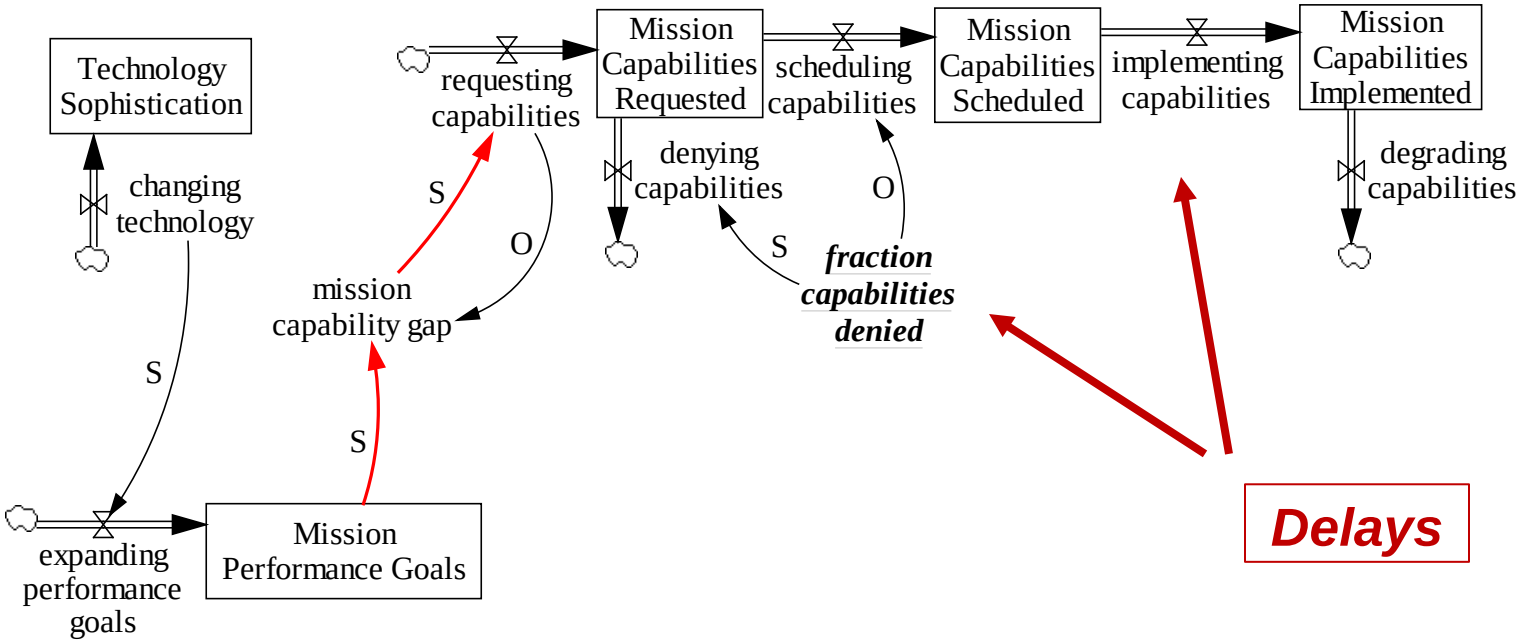
The Investment Simulation Model

- Clarifies the trade space for the decisions.
- “Slider bars” represent alternative decisions; sensitivity can be tested.
- Simulation provides insight about future effects of decisions ***and***
- Suggests how to prevent problems before they become too expensive.

Next: A sample piece of the simulation model.

Mission Operations, Requesting Enhancements





Beginning with Mission Performance Goals:

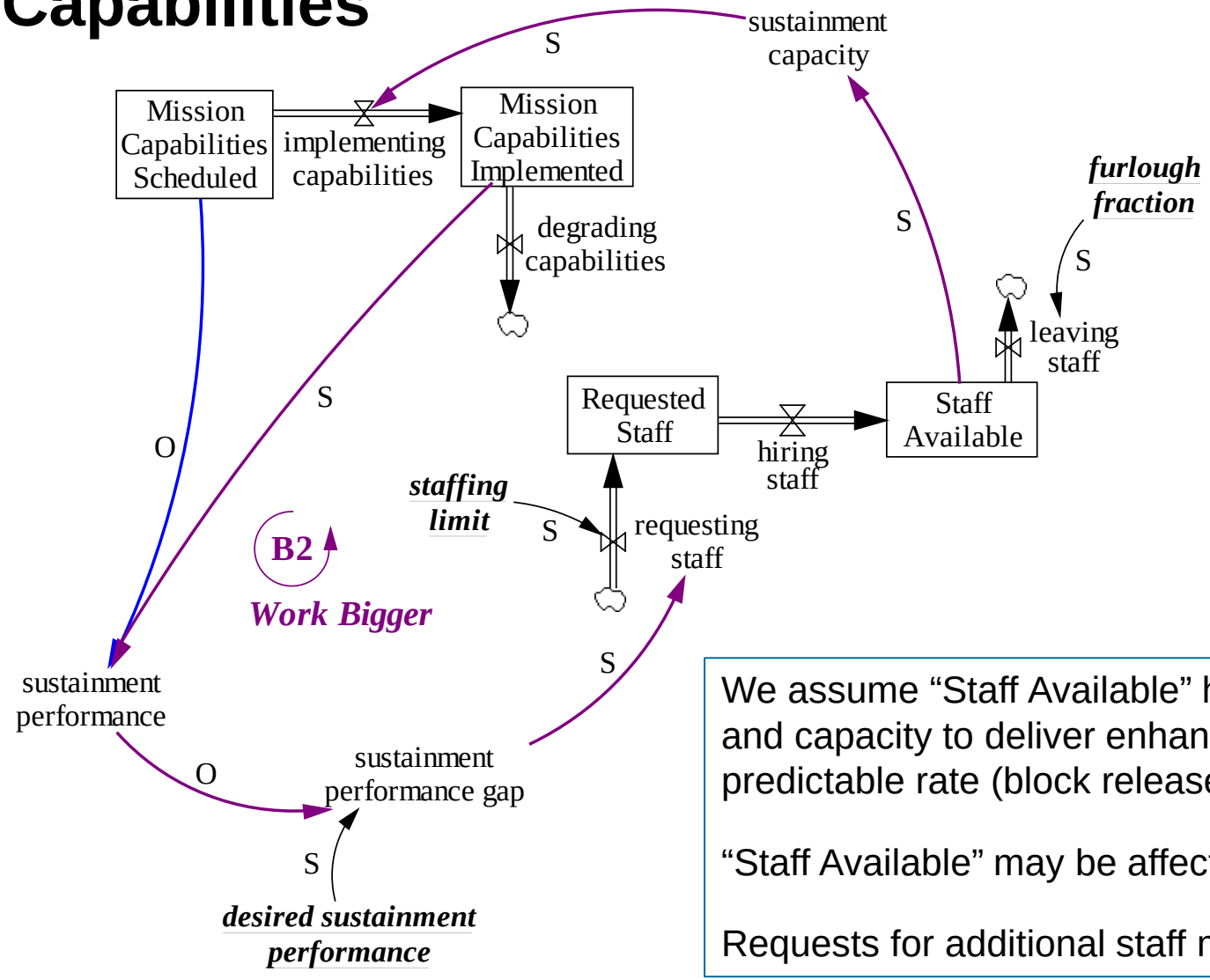
These goals normally expand overtime. If we keep up, they keep expanding. (Good)

Changing technology will result in additional requests.

As requests are received, the sustainment organization has to decide which to accept and how to deliver the enhanced product. (click)

The request can be “sized” before being accepted for implementation.

Sustainment Capacity Implements Mission Capabilities



We assume "Staff Available" has the capability and capacity to deliver enhancements at a predictable rate (block release).

"Staff Available" may be affected by furlough.

Requests for additional staff may be refused.

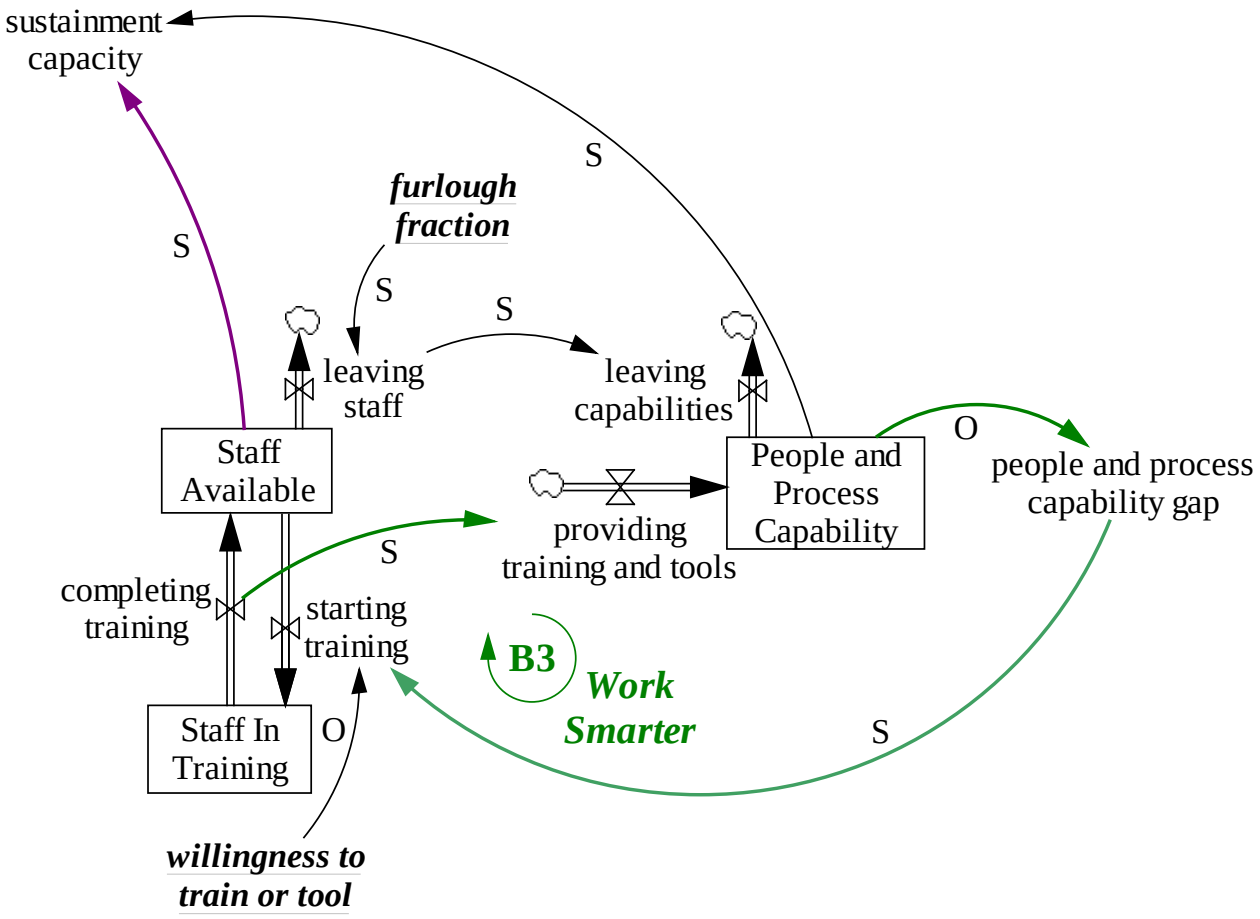
Investing in People, Processes and Tools

"Capability" used as a proxy for peoples' skills, processes, and tools.

"Training" is a proxy for investment since "the people are the process."

Sustainment capacity

= Capability * Staff Avail.

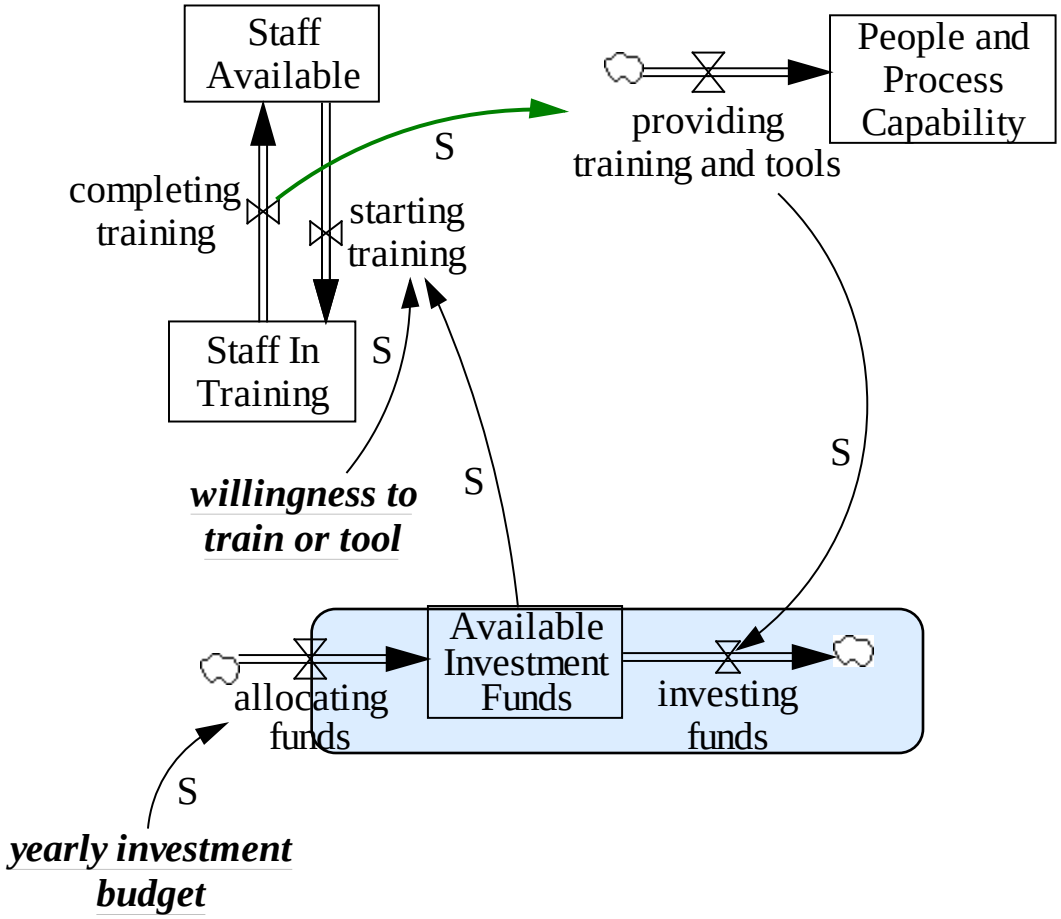


Funding

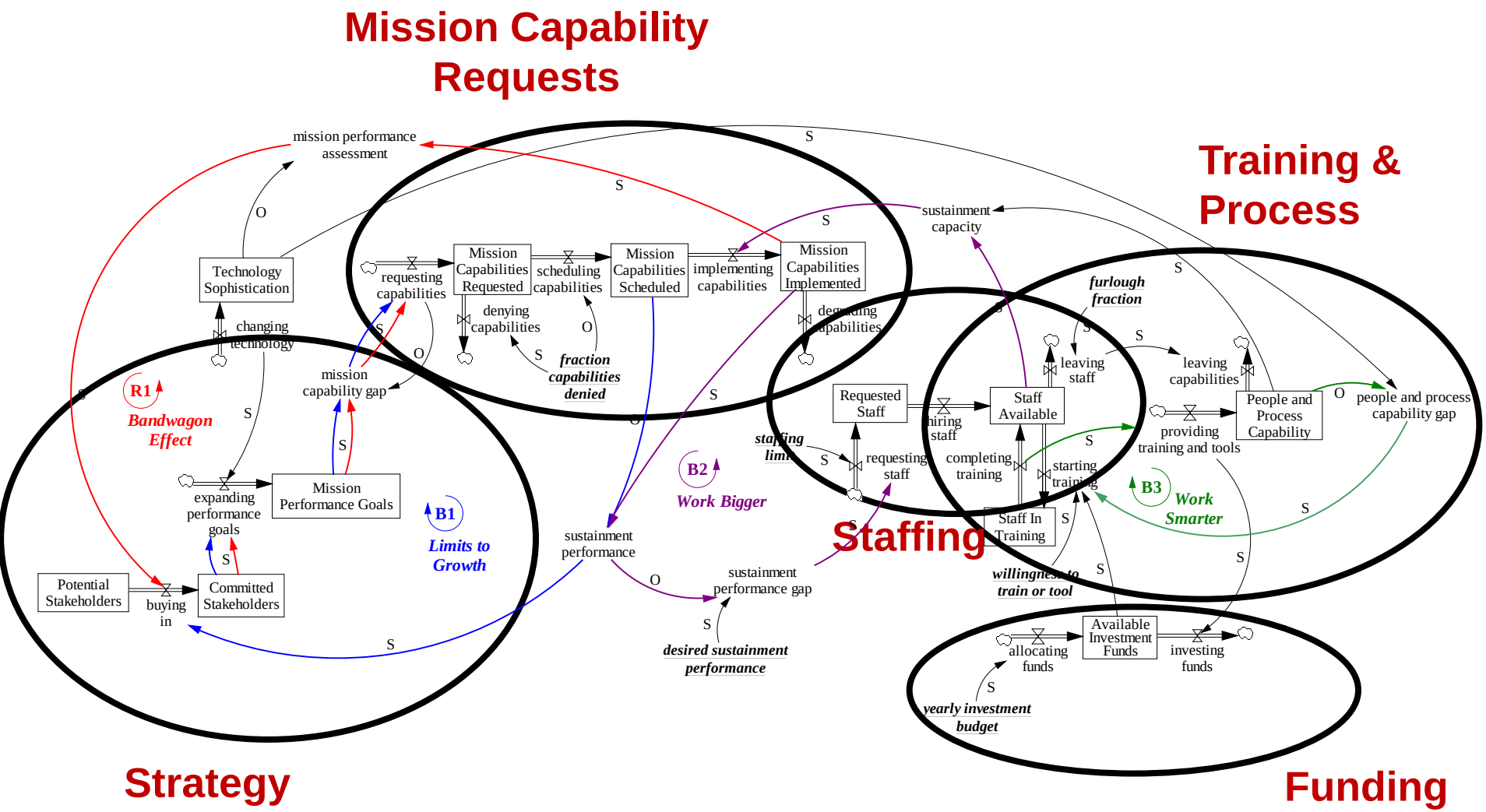
The Program Office releases (budgeted funds) to the sustainers. The rate of release affects the sustainers ability to deliver

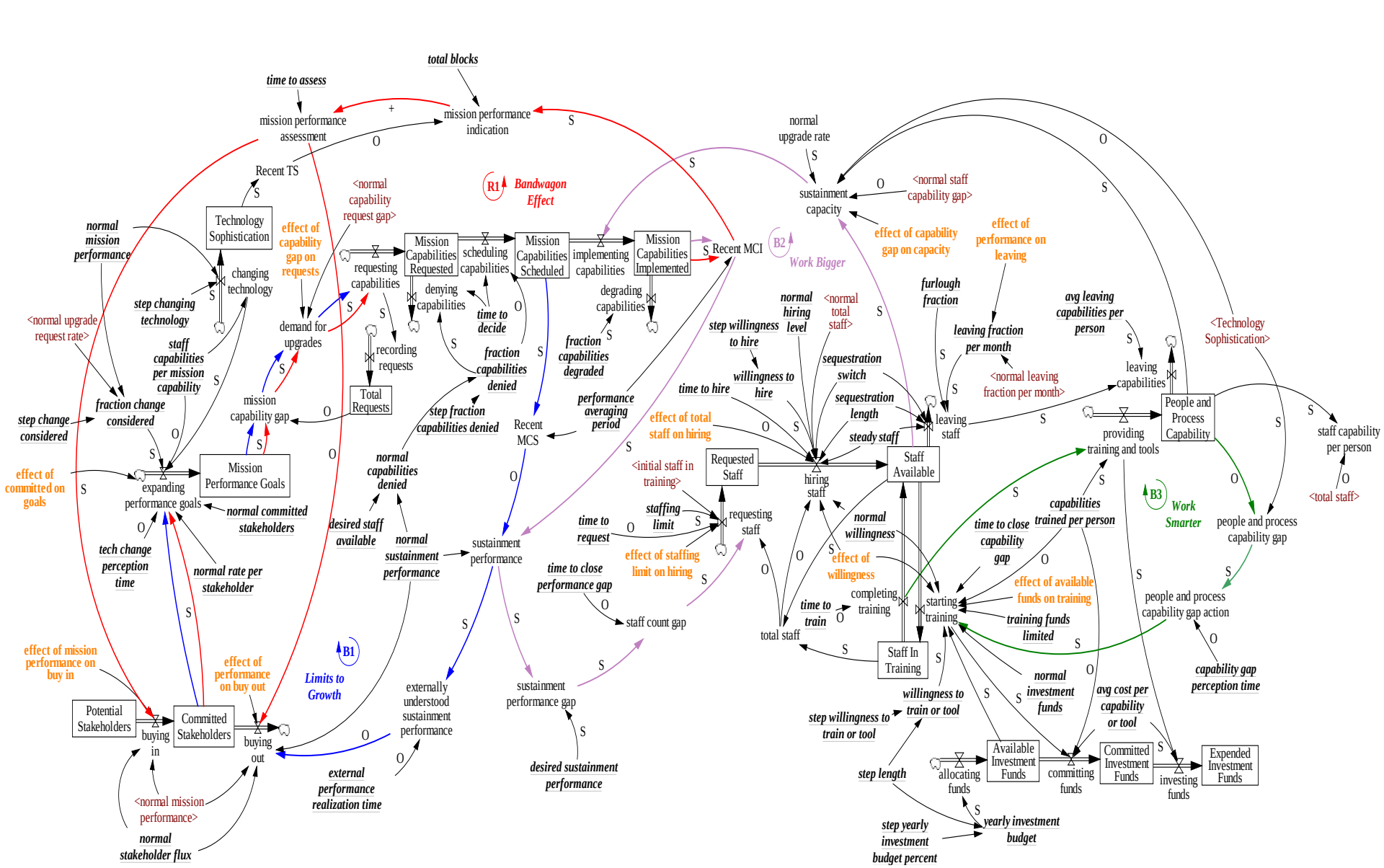
The program office may allocate the budget.

Not all the funds come at one time so the stock is used to model effects of delay.

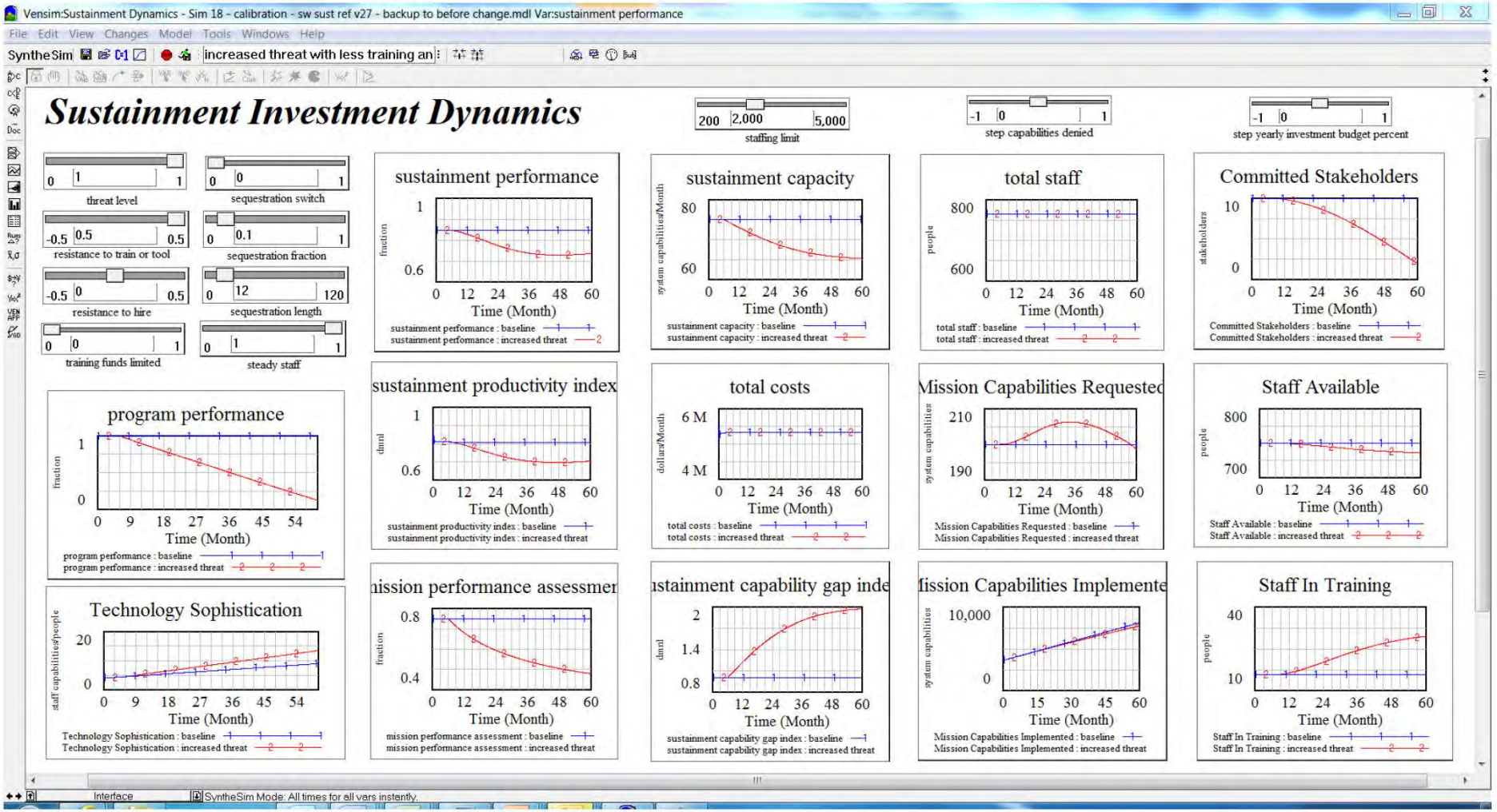


All the Model Parts, Together





Simulation Interface: Slider bars control behavior



Precision and Accuracy

Model Precision and Accuracy

- Simulations are often not very precise. We may not be able to tell whether something will cost $10 or $12 with this type model.
- A complicated model like this requires some formal investigation to determine whether it properly and accurately represents real system behavior.
- Once we have confidence in the behavior, we can evaluate whether we want more data (at a cost) to improve the precision.

How do we validate system behavior?

We use scenarios and prior history.

Agenda

Sustainment Overview

Understanding Our Simulation

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Results and Challenges

Writing a Scenario in 4 Parts

1. Context

Describe what is happening today (regular sustainment, limitations on development staffing, limitations on decision space?).

2. Stimulus

An external event necessitates a decision to reassign staff, adjust schedule priorities or invest in new people-skills and processes.

3. Responses

How would we reallocate funding/staff? How can priorities be adjusted?

4. Outcome

How does the system respond to our decisions?

- Do we lose productivity? Staff? Harder to train?
- Do we lose customers? Sponsorship?
- Are we taking longer to deliver?
- How did the various stocks and flows perform and does this behavior match history?

Sequestration Scenario: Evaluate Effects

Context

Normal sustainment work at a weapons test facility.

Stimulus

Congress decides that Federal workers should work only 4 days/week to reduce costs by 20%.

Responses

Test effects of staff furlough with and without continued training.

Outcome

Depends on duration and number of personnel affected.

- If sequestration lasts for 12 months and 100 people are affected then 120 FTE (months) personnel is the total effect on productivity.
- Avoiding training adds back total of 12 FTE months (approx. 5%). Attrition may increase effects because “no training and lower pay” is a demotivator.

New Threat, No Budget

Context

Operational capability is currently in use in the theater.

Stimulus

Mission effectiveness is challenged by a new threat.

- The threat warrants an upgrade to the system capability. The cost of the upgrade is approximately $100M if performed by the sustainment organization and is estimated to take 12 months to deliver. The budget is limited.

Responses

Add feature to current release or wait to add features when budget increases?

Outcome

- Adding feature delays current release by 24 months even with additional funding.
- Delaying additional feature until next release takes only slightly more than 24 months and results in better performance for both sustainers and warfighter.

Agenda

Sustainment Overview

System Dynamics (SD) Modeling

Understanding Our SD Model

Using Scenarios to Apply the Tool

Results and Challenges

Value of Using the Simulation

From the model, we can see certain cause-and-effect relationships.

- **If** we are requested to develop a capability based on new technology,
  then we must develop internal capabilities to meet that demand,
  else we will not achieve the same level of sustainment performance and will require longer schedules to perform block releases.
- Longer schedules will also increase costs.

We use the model to show others that

- re-tooling the organization saves more time and money than
- simply working harder and OJT to develop internal capabilities.

Using the model lets us show how the negative consequences might affect development schedule and mission performance.

Delivery Schedules and Mission Performance are more important than costs to mission leaders who may ignore requests for funding.

Challenges

Analyzing the 3 “gaps”

- Each gap compares performance to a goal. The performers measure their performance for reasons differently from the goal-setters. Since the measures don’t match, there must be a discussion of the meaning of any gap.

Calibration

- Calibration is always imperfect because of abstraction, but there will be reasons to make it better. What is the “economic value of the information?”
- As decision-making processes are changed, the model will need updates.

Validation

- Historical data and improvements in the monitoring of system behavior will provide supporting information for scenarios.
- Better model results will come from comparing “demand” and “outcome” data than can be obtained by looking at the process from the inside of the box alone.

Summary

Model behavior appears to match fairly well to the available information.

The amount of data required so far has been reasonable.

- We have been able to use existing sources. We have not examined all the available data.

The concept of measuring “capabilities” is not sufficiently addressed.

- Sizing or counting capabilities for both customer demand and sustainment capability (processes and people) needs some work. The current proxies might not be sufficiently accurate.

The Vensim™ (modeling tool) capability makes it fairly easy to test several possible allocation decisions very quickly.

- If we can reasonably validate the model so that managers have confidence in system behavior, then it will empower managers to make stronger recommendations about allocating funds and accepting work.

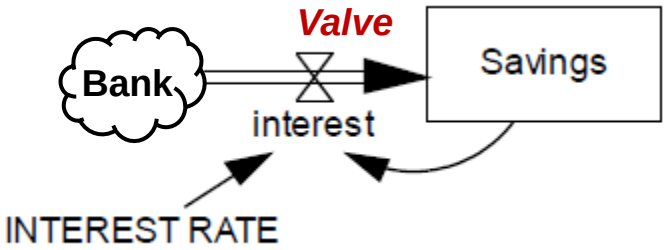
BACKUP

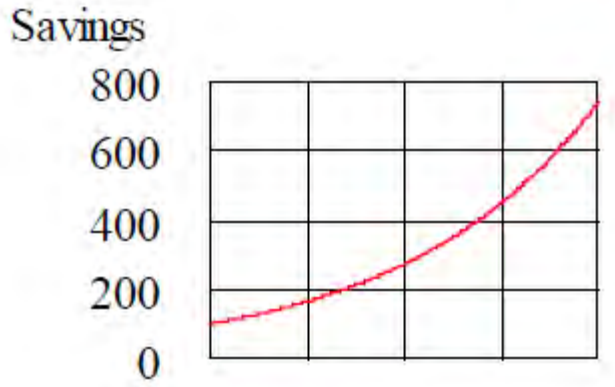
Stocks and Flows: The Building Blocks

Stocks hold things and **Flows** with **Valves** fill or empty stocks.

Arrows are inputs to calculations and valves.

A simple model with positive feedback causes an “exponential growth.”





A $100 initial value for savings, with a positive interest rate, exhibits the effects of compound interest.

The arrows show Savings$$ and InterestRate are used to calculate input to savings. The Stock acts as an “integration engine”.

Check units of measure to make sure equations work..

Calibration Questions

How would you size a new mission capability request?

How would you size sustainment capability requests?

Mission Capability Size Requires Knowledge of System

- Use {common, uncommon, innovative} as words to classify the capability request.
- Partition the capability into requirements at the component (CSCI) level and do the same thing again. (Use “new AESA radar”)
- Use {common=1, uncommon=3, innovative=9} for size of each component.
- Use SUM(all requirement in the enhancement) to get the relative size.
- *This relative sizing will have a consistent correlation to effort. Using any analogy or size estimate with this basis will be effective.*

People/Process Capability Size

- Can be estimated by #training days per capability per person.

Assessing Gaps

Gap Definition

- The performance goal is identified by one stakeholder.
- Actual performance is measured by a different stakeholder.
- The Gap is the difference.

Stakeholder differences

- The measures will not match so the definition of the gap and its significance must be a discussion in order to make a decision about the gap.
- The simulation cannot have a perfect definition of the gap as a forcing function on the simulation.

Representing the Decision

- Is actually important to the overall process definition.
- Delaying these decisions may costly in many ways.

Customizing the Model

Easy

- Selecting results to show, Changing reporting charts
- Running new scenarios
- New formulas from stocks or flows for reporting only

Moderate

- Re-calibrating with new data
- Tweaking timescale and some formulas

Difficult

- Re-definition of measure of stock or flow
- New feedback
- New stocks and flows
- New timescales