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Using Simulation Modeling to Inform Resource Needs

Chuck Carter, Sandia National Laboratories (cmcarte@sandia.gov)

Andrew Romich, Sandia National Laboratories (aromich@sandia.gov)

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Introduction

- The quantity of items needed is typically a substantial factor in acquisition cost
- Determining the acquisition quantity is often difficult and there are significant impacts to an inaccurate quantity
  - Acquiring too few items can impact the mission
  - Acquiring too many can result in significant unnecessary spending
- Traditional spreadsheet analysis may not capture the variability and uncertainty associated with planned usage, and may not reflect the peak usage over an extended period of time
- This presentation will walk through a notional container acquisition analysis modeled after an actual analysis
  - Planned operations were simulated using FlexSim software
  - The analysis highlights key input and output considerations
- Options for incorporating simulation output into cost models are discussed

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Example Scenario (Fictitious)

1) Specialized containers are needed to support future planned operations

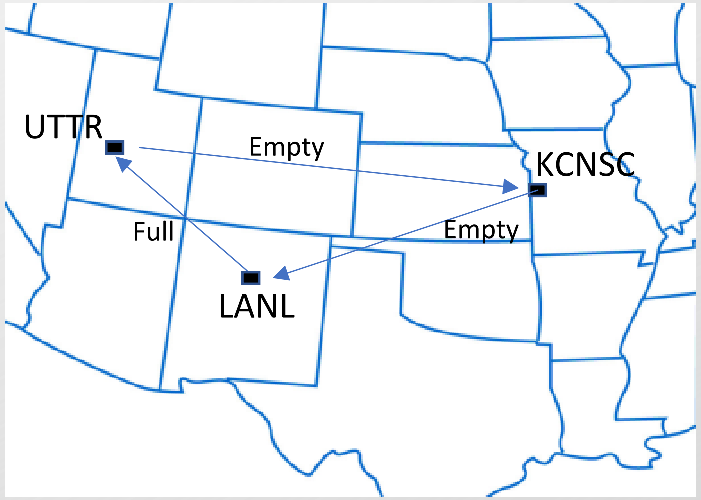
2) The containers will be built, stored, and maintained at the Kansas City National Security Complex (KCNSC)

3) Empty containers will be shipped as needed to Los Alamos National Laboratory (LANL) where that are loaded with contents

4) The containers are shipped to the Utah Test and Training Range (UTTR)

5) The containers are stored at UTTR until needed, then emptied and sent back to KCNSC

6) KCNSC Reaccepts the container and returns it to inventory



Scheduled of Shipments LANL to UTTR

Month	Quantity
Jan 2024	3
Mar 2024	7
May 2024	10
Jul 2024	10
Sep 2024	12
Nov 2024	12
Jan 2025	16
Mar 2025	14
May 2025	17
Jul 2025	12
Sep 2025	12
Nov 2025	16
Jan 2026	12
Mar 2026	12
May 2026	10
Jul 2026	6
Sep 2026	3
Nov 2026	2

Schedule Input Considerations

- The provided schedule refers to the shipment of the full container from LANL to UTTR
- Shipping considerations prior to the main shipment
  - What is the process at KCNSC to prep a container for shipping?
  - How long is transportation (KCNSC to LANL)?
  - How many days prior to loading should the container be on site prior to loading?
  - How many days is the loading process?
  - How long does a loaded container sit at LANL awaiting shipping?
- Shipping considerations after to the main shipment
  - How many days is a container stored at UTTR before being emptied
  - How long is transportation (LANL to KCNSC)?
- Returned item processing
  - What is the process at KCNSC to prepare the container for reuse and return it to inventory

Other Model Inputs

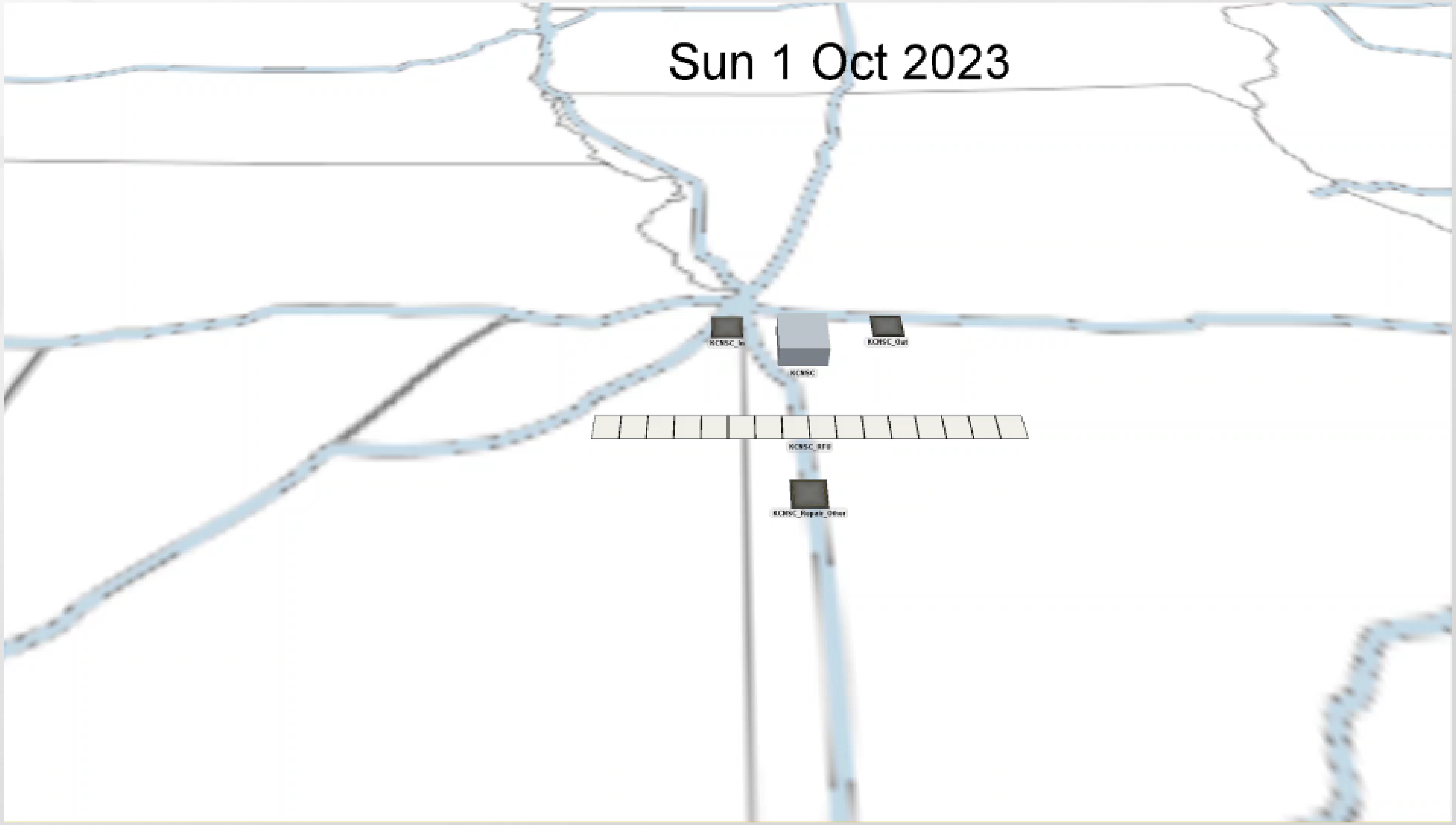
- What is the initial build schedule of the containers?
- Is there anticipated attrition due to use?
  - This can be captured as an expected percentage loss over time based on similar containers
  - May be implemented as a inspection fail/pass percentage after each use
- Is there any periodic maintenance required?
  - This is different that maintenance required for each use
  - May be time based such as 1 year or 2 years maintenance, or based on a number of usage cycles
  - What is the maintenance time
- What are the details of the transportation?
  - Are there empty post use containers returned immediately or are they shipped in batches based on a threshold quantity or return schedule?
  - Is there a limit on return container quantity in a shipment?

Notional Input Used

Step	Location	Duration/Value
Pull Item from Inventory and Prep for Shipping	KCNSC	7
Wait for Transportation	KCNSC	3
Transportation KCNSC to LANL	Transit	3
Store ready for use container until loading	LANL	Normal (45, 4.5)
Load	LANL	1
Store loaded container awaiting transporation	LANL	14
Transportation LANL to UTTR	Transit	2
Receipt Processing	UTTR	2
Store loaded container awaiting emptying	UTTR	Triangular (30, 45, 90)
Post Use Shipping Prep	UTTR	2
Store empty container awaiting shipping	UTTR	Uniform (0,30)
Transportation UTTR to KCNSC	Transit	3
Reacceptance	KCNSC	14
Reacceptance Fail Percentage		0.5%

Analysis assumes all containers are in place at KCNSC prior to first usage
Durations are in days

Simulation



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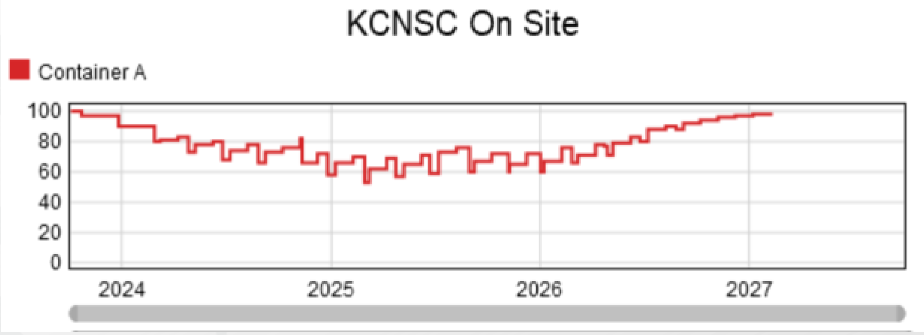
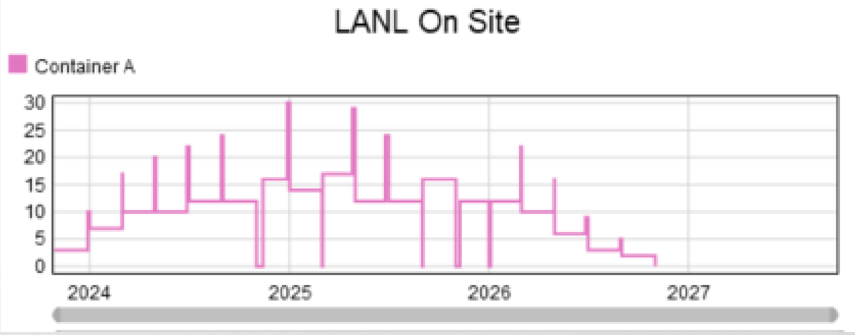
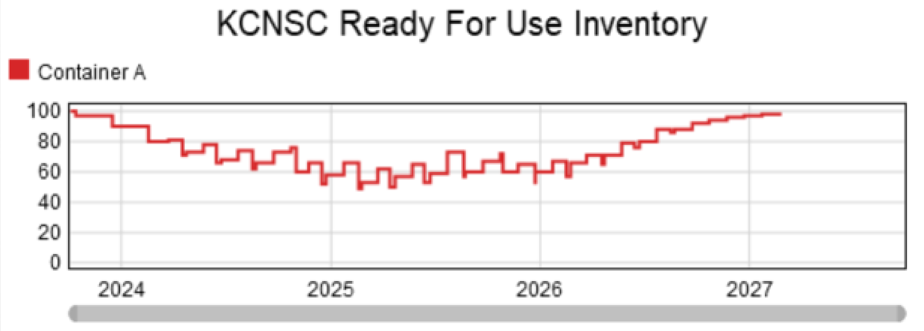
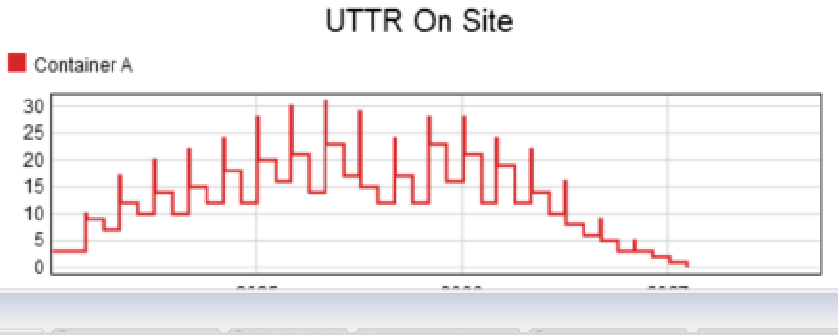
Dynamic Inventory Plots





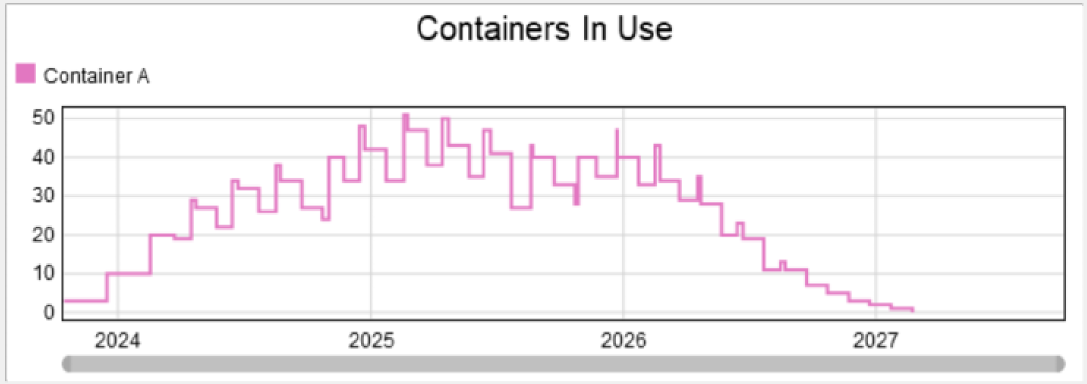




- Initial runs performed with more containers in inventory than likely needed, assumed 100 containers
- KSNSC has a ready for use inventory, which is slightly less than the total number on site
  - Make sure that ready-for-use (RFU) inventory does not run out
  - Chart shows RFU inventory never went below the high 40s.
- LANL and UTTR do not store ready for use containers

Key Results

Single Run Output

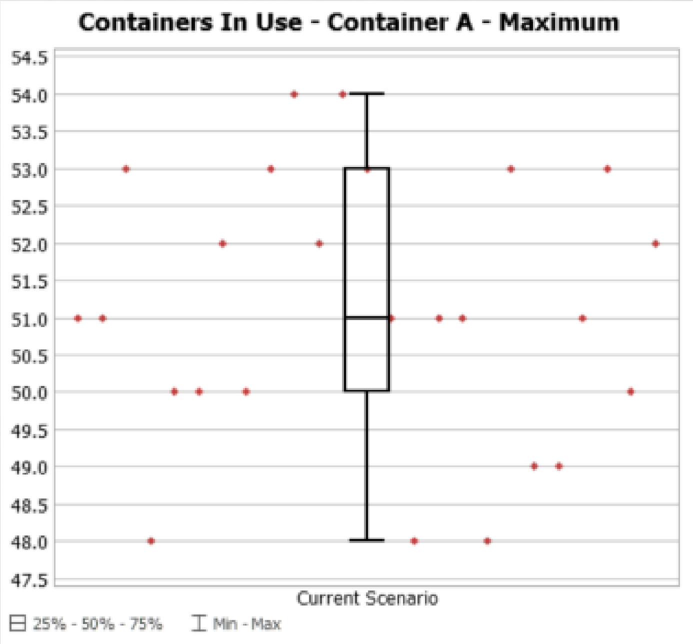


In Use Statistics

Partition	Current	Minimum	Maximum	Average
Container A	0	0	51	21.62

Containers Lost to Attrition: 1

Multi-Run Output



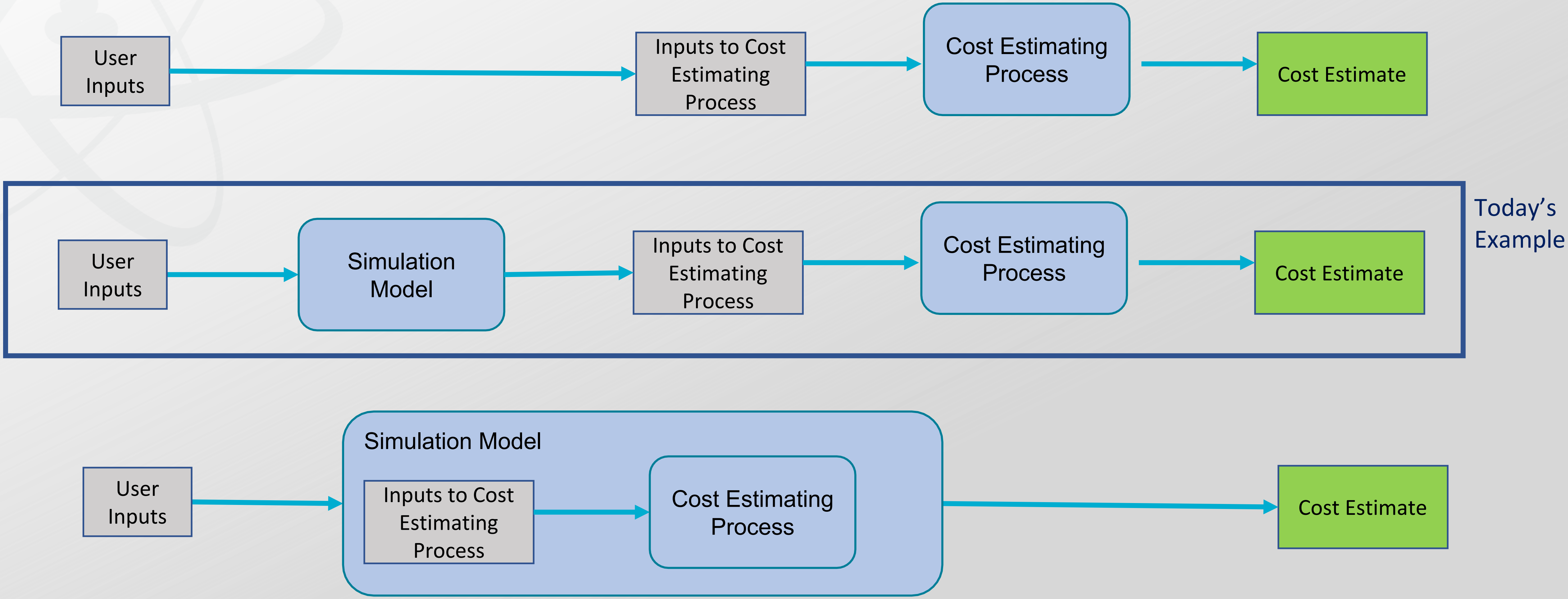
- Each run will produce a slightly different in-use chart
- The maximum in-use in this run is 51

- Number of runs needed is dependent on variability present

Data to Decisions

- Model results inform acquisition quantity decision
- Interpretation and best judgement still involved
  - Model Box plot 75th percentile is a good starting point for quantity
    - Accounts for known variability inherent in the system (statistical variability)
    - 75th percentile is 53
- Attrition
  - Minimal losses expected due to wear and tear
  - Model only averaged 1 retired container during the use period (+1)
- Additional Margin - Usually around 10% (+6)
  - Typically additional items are acquired to plan for unknown events (accidents, labor strikes, higher than anticipated attrition)
  - Especially important if acquiring additional items later will be costly
- For this example, the average maximum number of containers in use is 51, but the recommended purchase quantity is 60.

Several Paths Toward Cost Estimate



Cost model data feeding

- Acquisition quantity
  - Total quantity
  - Need dates to meet build schedule (ramped up in-use chart may allow spreading out acquisition)
- Maintenance
  - Number of repairs
    - By FY
- Storage quantities
  - Inventory over time by location
  - Loaded vs Empty storage (sometimes equates to classified vs unclassified storage)
- Transportation
  - Number of transportation events
    - By FY
    - By type (SGT, classified courier, unclassified)
  - Alternate container return strategies can be tested (time based return of empties vs level based)
    - Changing return strategy may decrease transportation cost but increase quantity needed
    - Optimize cost using simulation

Summary

- Cost estimations involving acquisition quantities and logistics often involve statistical variability that is not easily captured using equation-based tools
  - Calculations based on point estimates likely will not adequately capture peak usage
- Simulation provides a method to mimic future operations virtually while tracking key system performance metrics over time
- Model can provide key input in several other cost estimation categories including maintenance cost, resource needs, and transportation
- Model data can be used to compute cost directly in the model or used to feed an existing cost model
  - Models can be used to test various operating strategies and their effects on cost