LMI

GOVERNMENT CONSULTING

THE OPPORTUNITY TO MAKE A DIFFERENCE HAS NEVER BEEN GREATER

An Introduction to Readiness-Based Sparing
(The System-Approach to Inventory)

Rob Kline & Dave Peterson

Mathematical Modeling Group

Overview

- Military logistics through the ages
- An overview of RBS principles
- Case studies

Supply Problems Have Been Around for a Long, Long Time

- "From time immemorial the problem [of supplying] troops had been solved simply by having troops take whatever they required.... plunder was the rule rather than the exception...."
- "As a result, the armies of this period [the 16th century] were probably the worst supplied in history...."
- "Commanders during the last few decades of the sixteenth century began to see the need to have the army furnish the soldier with at least his most elementary needs, including food, fodder, arms, and sometimes cloth."

Van Creveld
"Supplying War", p. 7

By the Revolutionary War, Troop Supply Was Becoming More Specialized

- State Issue
  - Suit of clothes
  - Felt hat
  - Two shirts
  - Two pairs hose
  - Two pairs of shoes
  - Blanket

- Government Issue
  - Musket
  - Bayonet & scabbard
  - Belt
  - Flints
  - Musket locks
  - Knapsack
  - Canteen
  - Ammunition

The beginning of repair parts.

Huston
"The Sinews of War", p. 25

Through Time, the Logistics Tail has Grown with Weapon System Sophistication

Revolutionary War	Civil War	World War II	
1 lb beef/day	16 oz hardtack/day	Rations	7 lbs/day
1 lb bread/day	20 oz meat/day	Clothing/ supplies	6 lbs/day
3 pts beans/week			
1 pt milk/day	1 pr shoes/2 months	POL	33 lbs/day
½ pt rice/week	1 uniform/4 months	Ammo	8 lbs/day
1 qt cider/week		Misc	13 lbs/day
3 lbs candles/100 men/week		Total	67 lbs/day
8 lbs hard soap/100 men/week			

In fact, the More Things Change...

- "I am getting thoroughly disgusted with the way the Curtis Company does business ... three of our machines have been out of commission ... due to lack of propellers and propeller bolts."

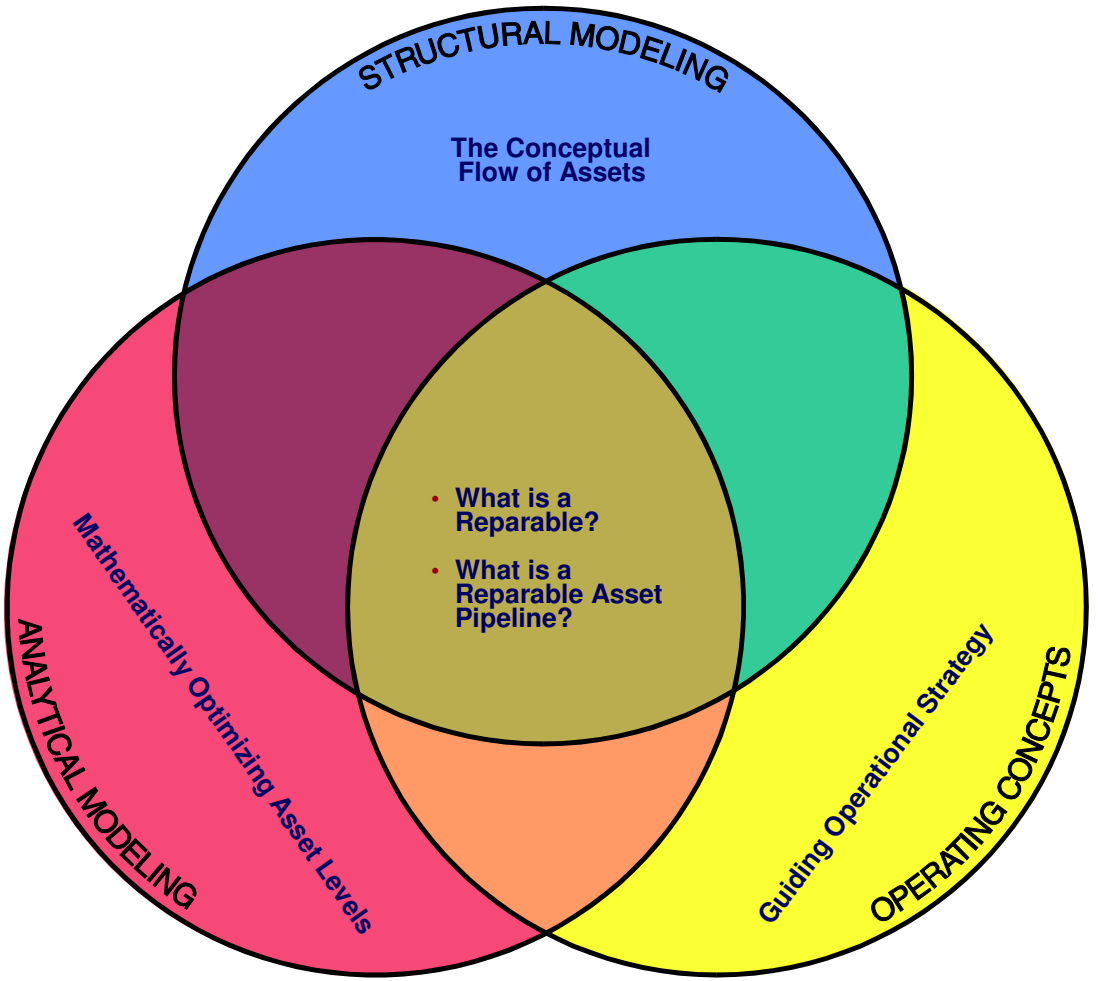
- "Five days later, he fired off another complaint, accusing the company of faulty motor crankshafts and main bearings, and of 'constantly delaying sending spare parts.'"

Lt. Foulois
Commander 1st Aero Sqdn
1915

Smith
***AFJOL*, 1987**

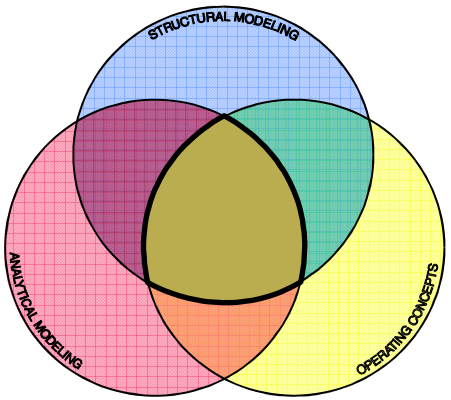
An Overview of RBS Principles

Necessary Decisions for Managing Reparable Assets



The Reparable Triad

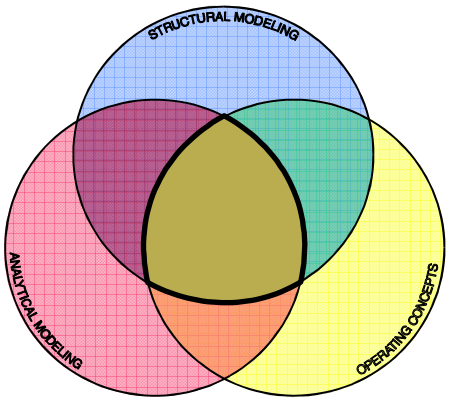
Core Concepts – What is a Reparable?

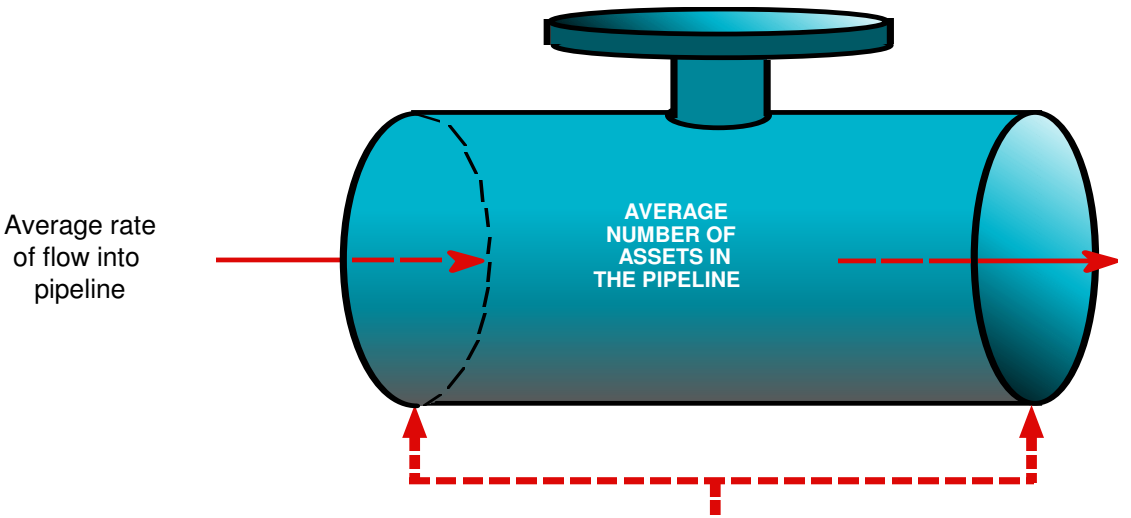


- Reparable assets are typically:
  - Complex, high cost and low demand items
- They are not consumed in use
- Reparables are designed to be technologically and economically feasible to repair upon failure
- Examples
- Synonyms:
  - Exchangeables, recoverables, rotables, repairables, etc.

Core Concepts

What is a Reparable Asset Pipeline?

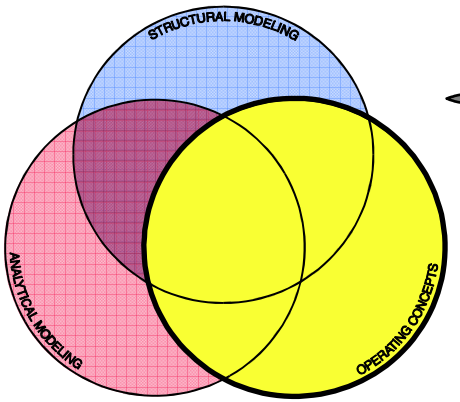


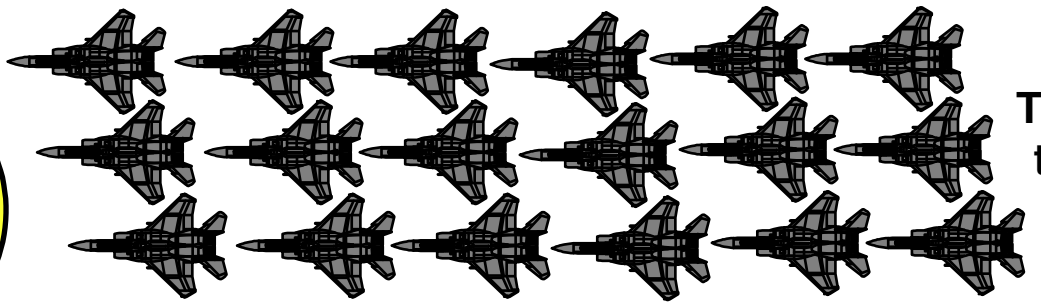


- A system of:
  - supply, repair, and transportation forming a distribution network for reparable spares
- All pipeline models share common characteristics:
  - Flow into the system, flow time through the system, and volume
- What's the average number of assets in a pipeline?

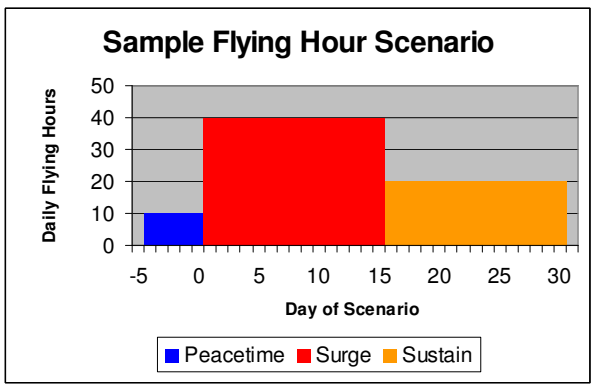
Operating Concepts

Guiding Operational Strategy





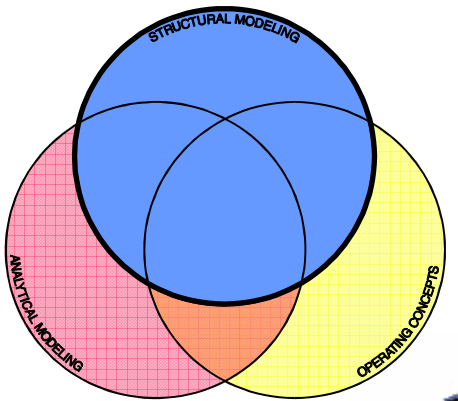
The number and type of aircraft supported

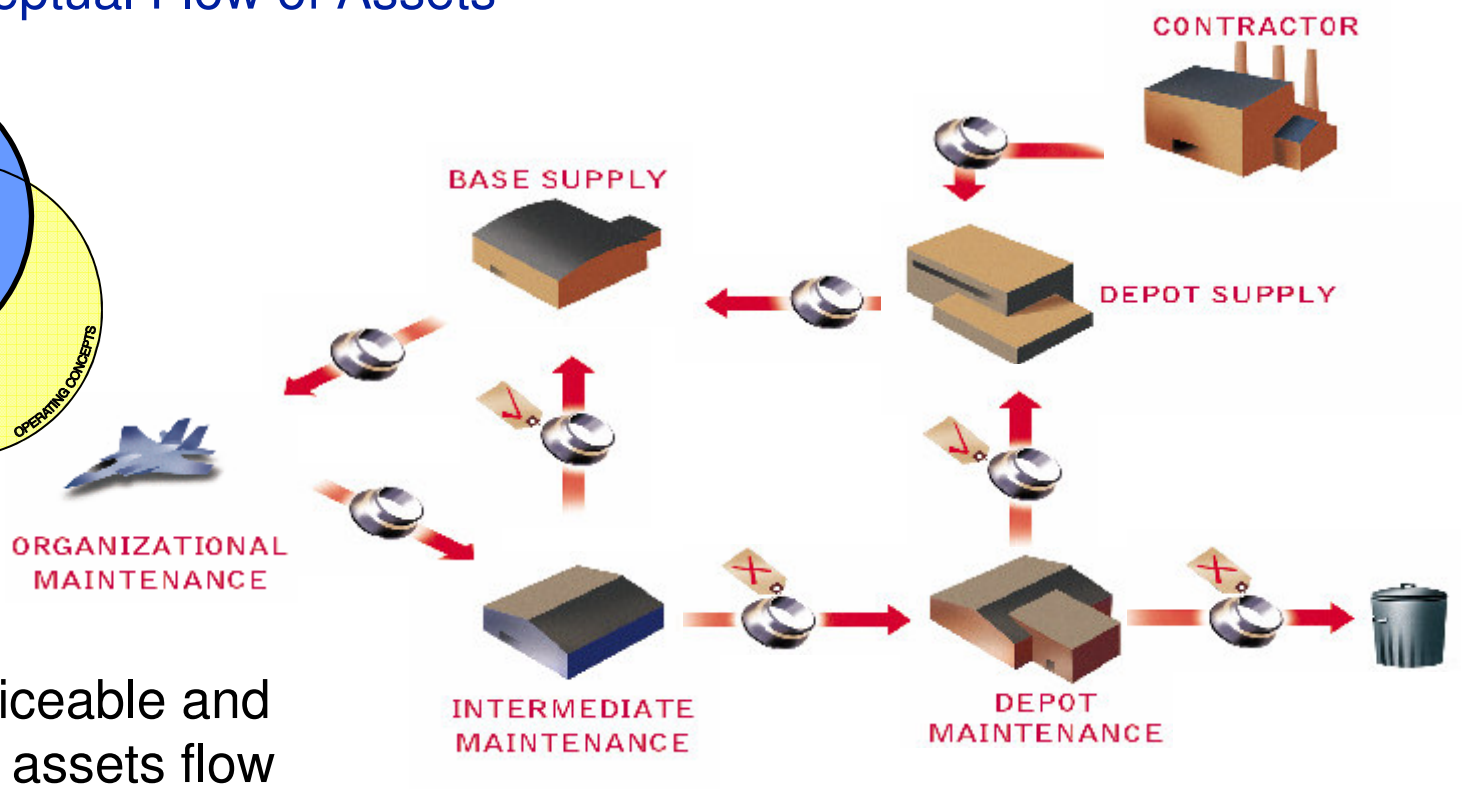


The planned flying program

Structural Modeling

The Conceptual Flow of Assets



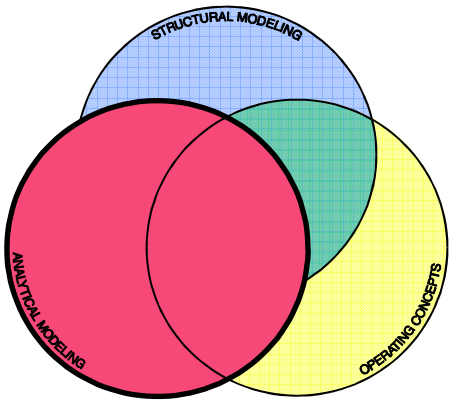


- How do serviceable and unserviceable assets flow flow though the base and depot pipelines?

- How does information flow through these pipelines?

Analytical Modeling

Mathematically Optimizing Asset Levels



- Three key concepts:
  - Taking an item versus system orientation
  - A relevant measure of system performance
  - Building an efficient spares shopping list

Item vs. System Orientation

- The system approach to sizing inventories goes beyond specifying desired levels of item performance

- The system approach
  - Links item to system performance
  - Presents a range of possible solutions
  - Optimizes spares mix giving the most efficient performance per dollar

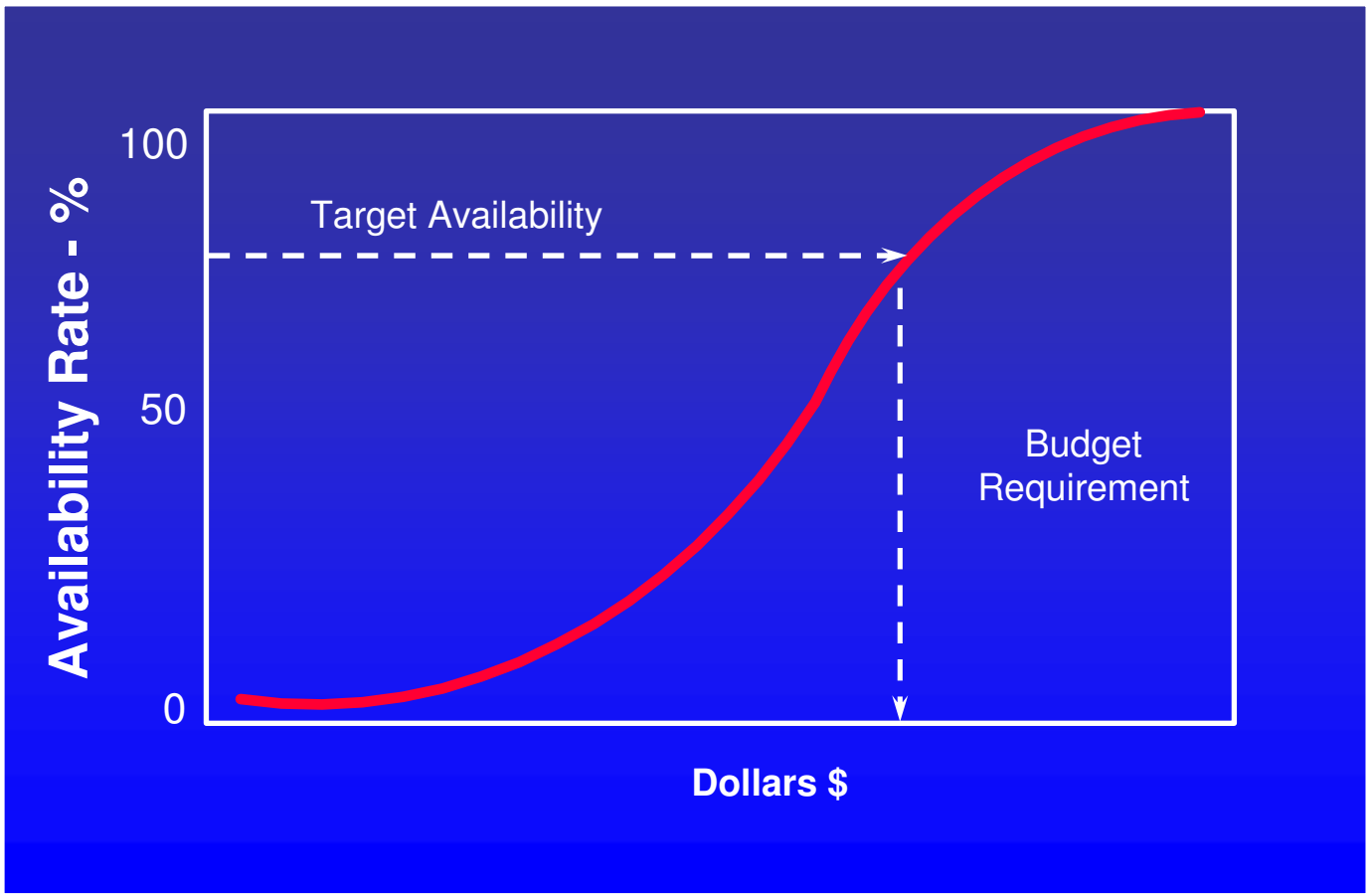
Measuring System Performance

- Aircraft availability
  - The percentage of “available" (mission capable) aircraft (i.e. not lacking any spare)
  - Example: an 80% availability rate means that 20% of the fleet is inoperable for parts

- The spares selection method
  - Choose spares that provide the greatest marginal improvement in aircraft availability per dollar
  - Benefit-to-cost ratio: The improvement in aircraft availability per dollar of inventory investment

The System Approach:

(Marginal Analysis – Or Bang for the Buck)



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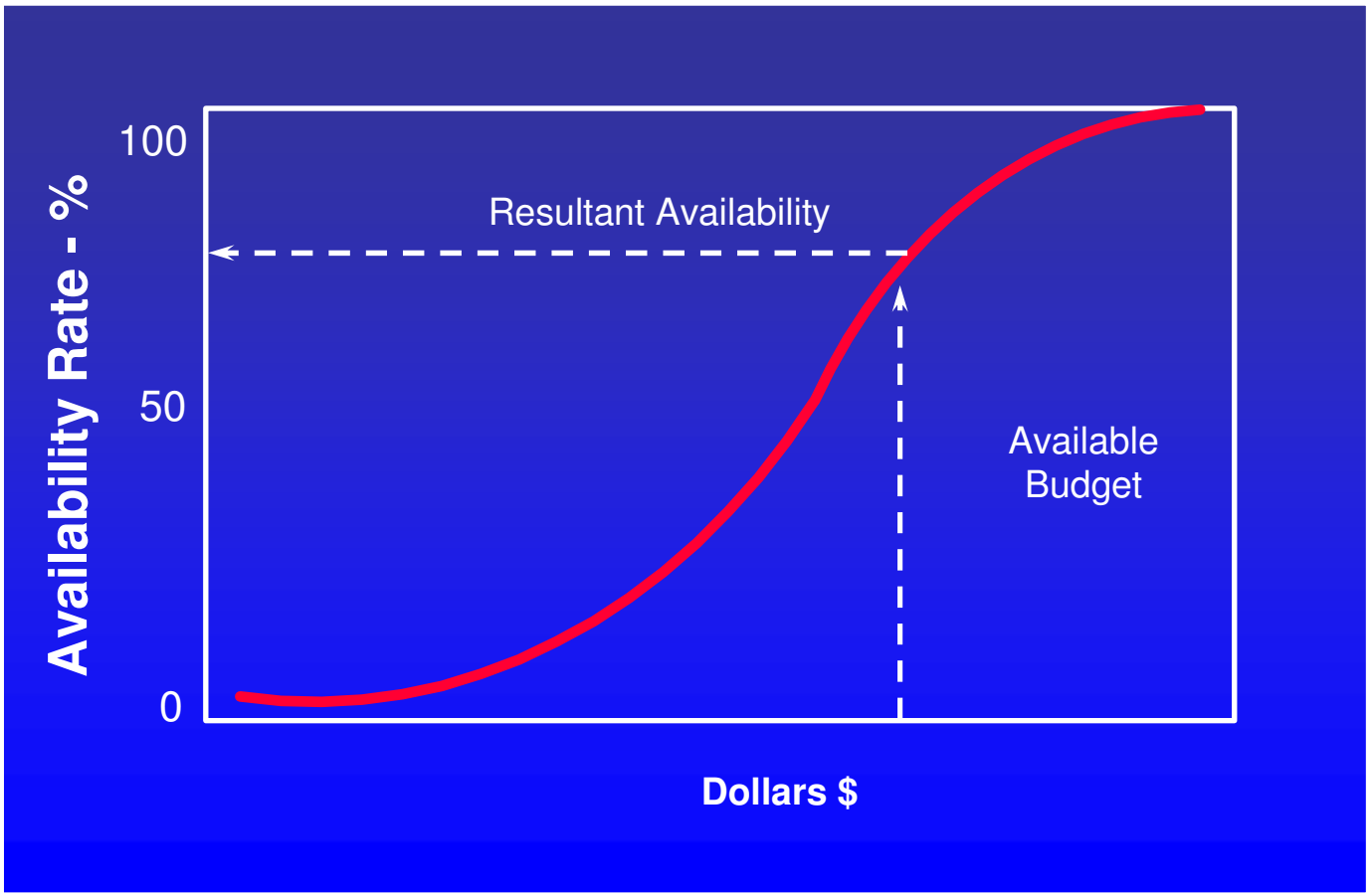
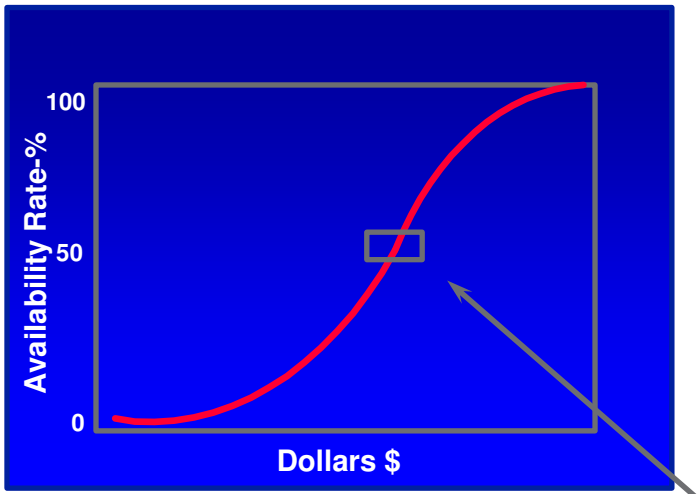


Building an Efficient Shopping List



- The cost vs. availability curve is built incrementally

- At each stage, the item with the greatest benefit-to-cost ratio is purchased next

Shopping List

Item (A,B,C...)	Unit cost $	Added end items per $10K	Total cost $	Availability rate %
6th A	1,600	0.388	101,600	66.67
11th B	2,300	0.352	103,900	66.69
2nd C	10,400	0.312	114,300	66.74
12th B	2,300	0.283	116,600	66.76
1st D	13,800	0.154	130,400	66.78
7th A	1,600	0.144	132,000	66.79

What is the Aircraft Sustainability Model™ (ASM™)

- The ASM is a tool that illuminates the implications of a wide range of inventory (spare parts) decisions
  - Initial sparing, replenishments, and deployments
- Typical ASM implementations results:
  - Save 20 to 30% on your spares investment while maintaining system availability, or
  - Comparable improvements in system availability while maintaining spares investment level
- These results achievable for many complex systems
  - Aircraft, electronics, communications networks, ground vehicles, robots, spacecraft ...

** Aircraft Sustainability Model and ASM are trademarks of the Logistics Management Institute*

The ASM's Core Capabilities

- Optimal spares requirements for a single aircraft type (reparable and consumable items)
- Multi-echelon (depot with different size bases) and multi-indenture (LRU/SRU) tradeoffs
- Steady state and/or dynamic scenarios
- Flexible with respect to resupply, maintenance (with or without cannibalization), and other parameters
- Common component considerations across different systems
- Multi-year spares and repair budgets
- Evaluation of existing spares mix
- Interface designed for complex spares analysis

Typical Spares Analyses

- **Initial Provisioning** – Estimate what spares requirements (cost of deliveries) for a specific period (months, quarters, years)
  - Aircraft delivery scheduled entered by period
  - Typically steady-state operations though can include a dynamic period
  - Total budget, year by year budgets, budgets by lead-time
- **Replenishment** – Estimate what spares requirements (cost of orders) by period (similar capability to initial provisioning)
  - Example: given existing assets, determines procurements in coming year.
- **Deployment Spares** – Estimate what spares needed if aircraft brought to new location (e.g., Iraq)
  - Usually dynamic conditions with cannibalization
- **Evaluation** of spares mix by day over a dynamic period (availability and sortie generation).

Exemplar Benefits of the System Approach

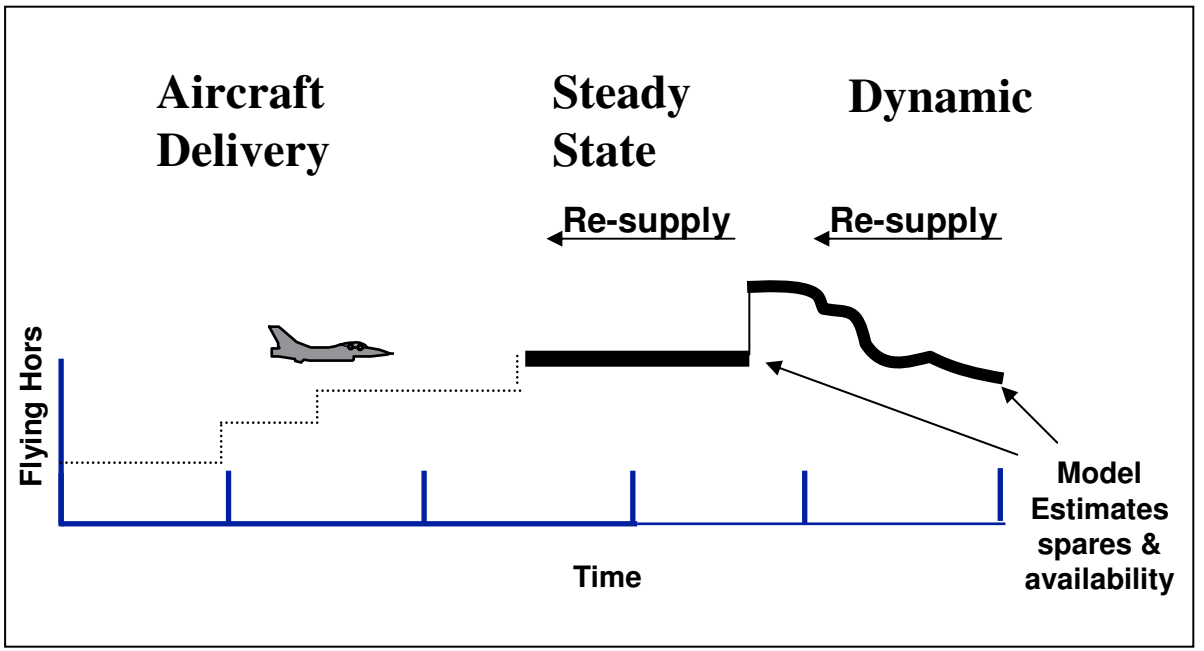
(Sample results for aviation spares)

	Percent improve-ment of System over Item approach	***Factors compared***
Initial provisioning (reparables)	30%	Cost savings for the same performance
Annual Replenishment (consumables)	18%	Cost savings for same performance
Depot repair (reparables)	40%	Backorder reduction for same cost

RBS over the Product Life Cycle

- *Design*
  - NASA Human Exploration Missions
- *Development*
  - Joint Strike Fighter examine maintenance policies
- *Provisioning*
  - F/A-22 examine Multi-year deliveries and budgets
  - Commercial Airlines buy or pool spares with others
- *Replenishment*
  - Israel Air Force integrate Peace and War computations
  - *Evaluations*
    - Space Shuttle assess launch schedules
    - USAF determines war readiness

Three Possible Operating Periods



Conclusion

- By relating performance to cost (assets), RBS answers a range of key questions.
- RBS applies to many different applications, issues, and life cycle phases
- All applications used the Aircraft Sustainability Model. This is a COTS product that requires experience, adjustments, integration, and understanding for each application.

"...for want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the rider was lost."

Benjamin Franklin
Bartlett's Familiar Quotations

Contact Information

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