

Maximizing effectiveness using a flexible inventory

“Uncertainty is the only certainty there is, and knowing how to live with insecurity is the only security.” ~ John Allen Paulos

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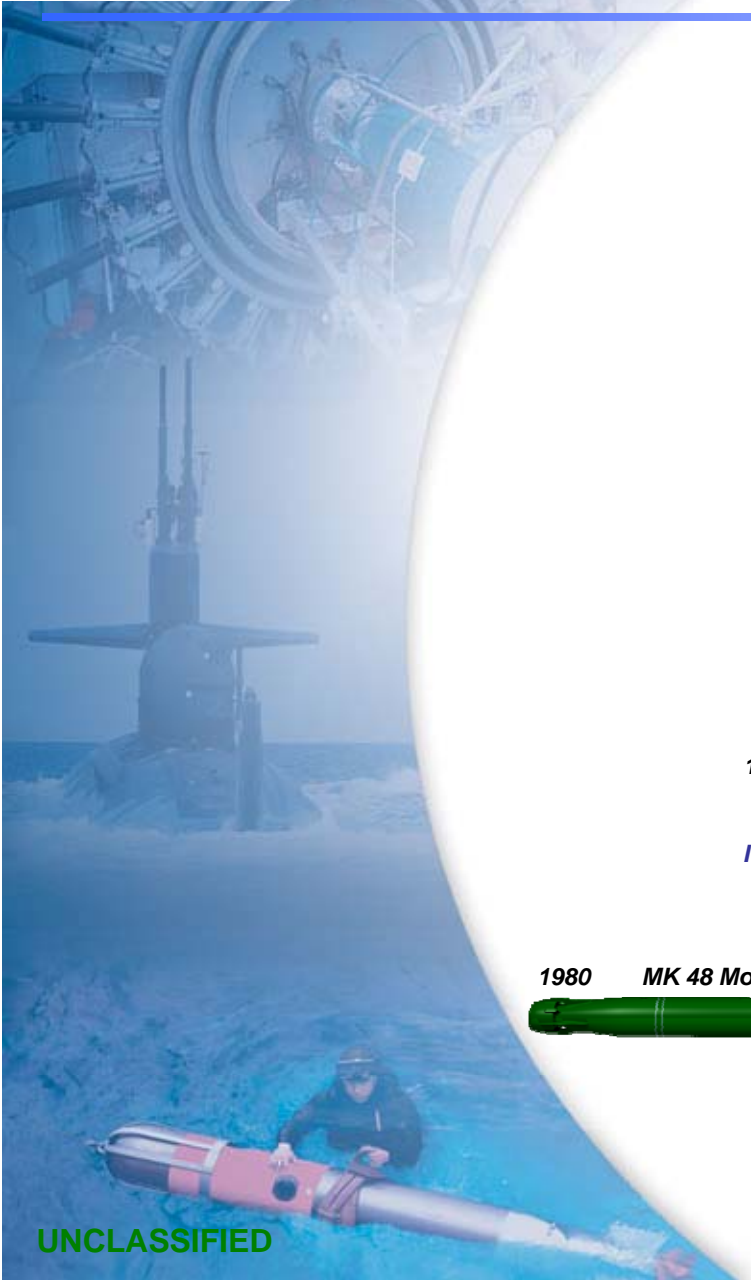
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- **Introduction**
 - Preliminary project funded by the Office of Naval Research & the Naval Postgraduate School
- **Costs involved in Defense Logistics**
- **Logistics Costs in the Torpedo Enterprise**
- **Modeling Inventory Effectiveness**
- **Flexibility Impact in a 2 Level System**
- **Lot Sizing Model**
- **Conclusion**

- In organizations responsible for the design, service, and management & distribution of products, acquisition decisions, and product upgrades must be synchronized with service tasks and fleet operations. In partnership with the US Navy's Torpedo Enterprise, the research will investigate operations and acquisition concepts for such organizations using mathematical and simulation models.

- **Weapon System Characteristics**
 - Complex
 - Long Life Cycles
 - Evolutionary Updates
- **Inventory Characteristics**
 - Geographically Dispersed
 - Located based on operational area
 - Redeployment/movement based on need
- **Goal of Holding Weapons in Inventory**
 - Effective response to threats
 - “Keep the powder dry”
- **Comparable with heavy equipment lifelines**



TMU

2007 **MK 48 Mod 7**
Broadband Sonar
APB

2006 **MK 48 Mod 6 ACOT**
Next Gen COTS
APB

1997 **MK 48 Mod 6**
IOC 1997 TPU & COTS

1988 **MK 48 Mod 5**
IOC 1988 Digital ATIP

1980 **MK 48 Mod 4**
Analog

Commercial

- Objective
 - *Maximize Profit*
- Constraint
 - *Demand*
- Costs

Defense

- Objective
 - *Meet Demand*
- Constraint
 - *Annual Budgets*
- Costs

Commercial

- **Holding Cost**
 - Management
 - Overhead
 - Interest rate
- **Ordering:**
 - Overhead
 - Setup
- **Shortage:**
 - Lost sales & goodwill
- **Backorder**
- **Shipping**
 - Expedited/Regular modes

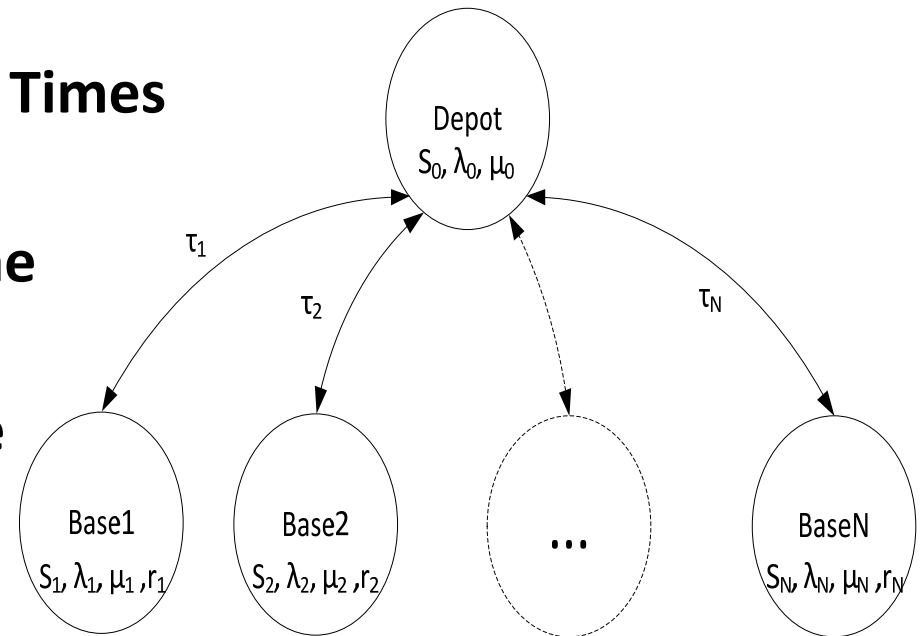
Defense

- **Holding Cost**
 - Management
 - Overhead
- **Ordering**
 - Overhead
 - Setup
- **Shortage:**
 - Decreased response capability
- **Backorder**
 - N/A
- **Shipping**
 - Same as commercial.

- **Intermediate Maintenance Activities & Depots**
 - Differing Cost Models
 - *Competitive Services Contract*
 - *Military Support*
 - *Government Civil Service Labor - DEPOT*
- **Legal Statutes**
 - Safety, Hazmat, RFID and UID
- **Demand Drivers**
 - Atlantic and Pacific Fleets
 - Torpedo Testing Exercises
 - Foreign Military Sales
- **Flexibility**
 - Utilization of “Moth Balled” Torpedo Configuration Hardware
 - Foreign Military Sales

- **2 Level Service Model**
 - 2 Bases
 - 1 Depot
 - 2 Products
 - Investigate the benefit of pooling inventories
- **Lot Sizing Model**
 - **Mathematical Programming Model**
 - *Minimizes Cost*
 - *Constraints*
 - Production, Set-Up, Holding, Transformation, and Movement Costs and Quantities

- Inventory Held at Bases and Depot
- Repair Probability (Base Only)
 - r_N
- Inter-Arrival Times
 - λ_N
- Transfer Time
 - τ_N
- Service Time
 - μ_N
- Stock Level
 - S_N



S_j : Stock Level
 λ_j : Mean Arrival Rate
 μ_j : Mean Service Time
 r_j : Fraction of parts repaired at base

Pooled vs. Non-Pooled Inventory Systems

Each item has its own “shelf” at the bases, and the depot.

Items arrive at the base and may be repairable there, or may have to be sent to the depot for repair (with some probability)

Items are shipped from inventory (if any) from the depot to the base, or wait to be repaired.

The goal is to keep the number of items waiting for repair to a minimum.

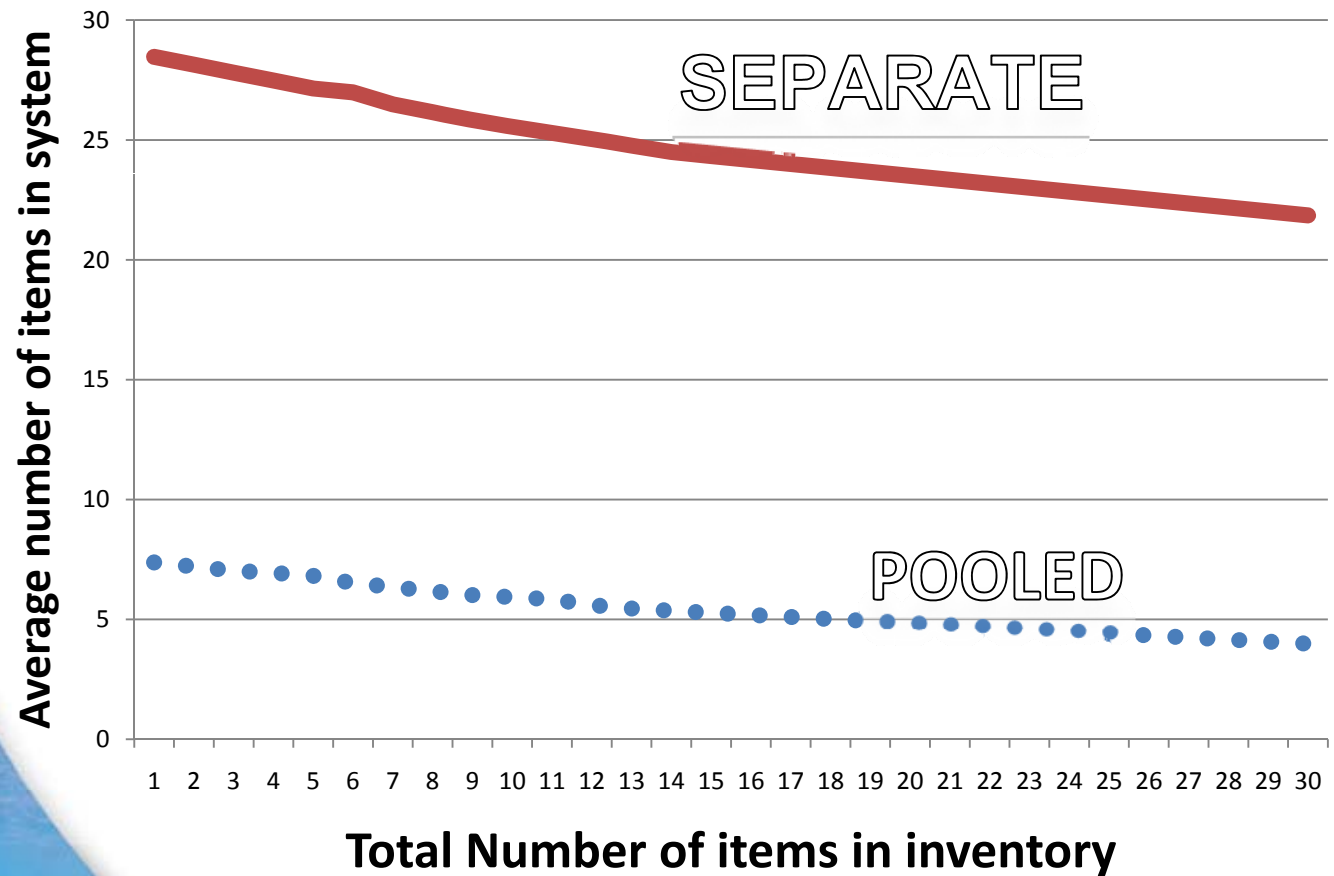
- **Non-Pooled**

- Items have their own “shelves” and there is no interchangeability between the parts.

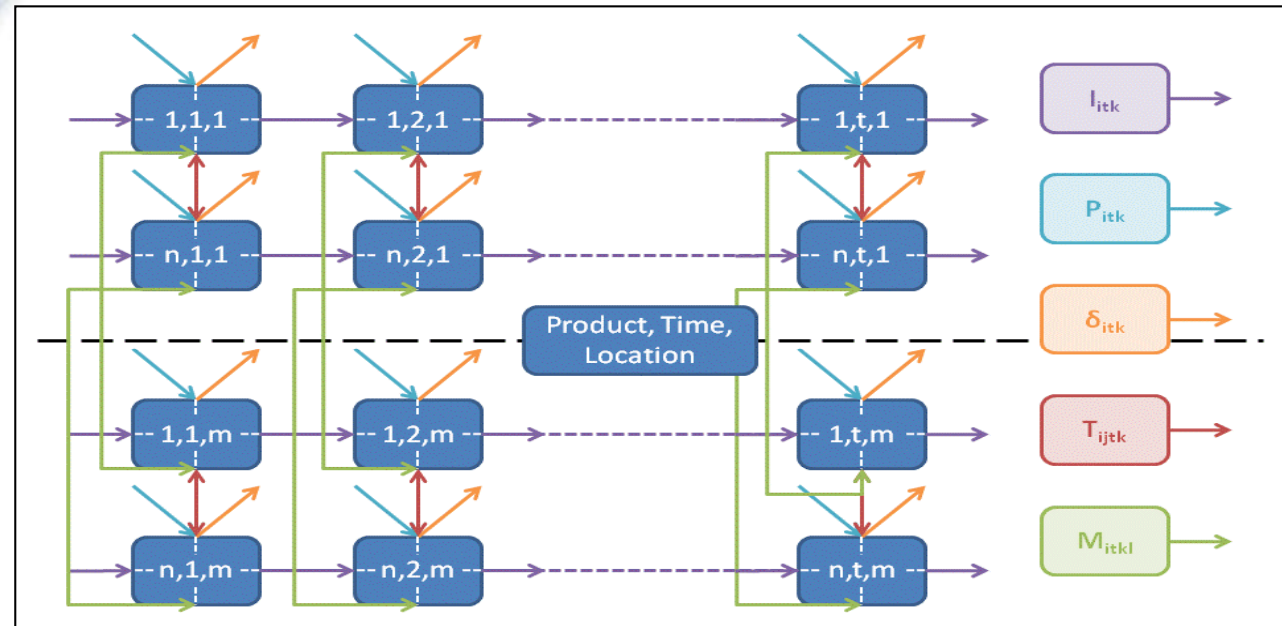
- **Pooled:**

- Items are pooled together at the depot and the bases, and inventory of one can be used to supply the other.

- Inventory Decreases by roughly a factor of 4 when inventory for the two items is pooled.

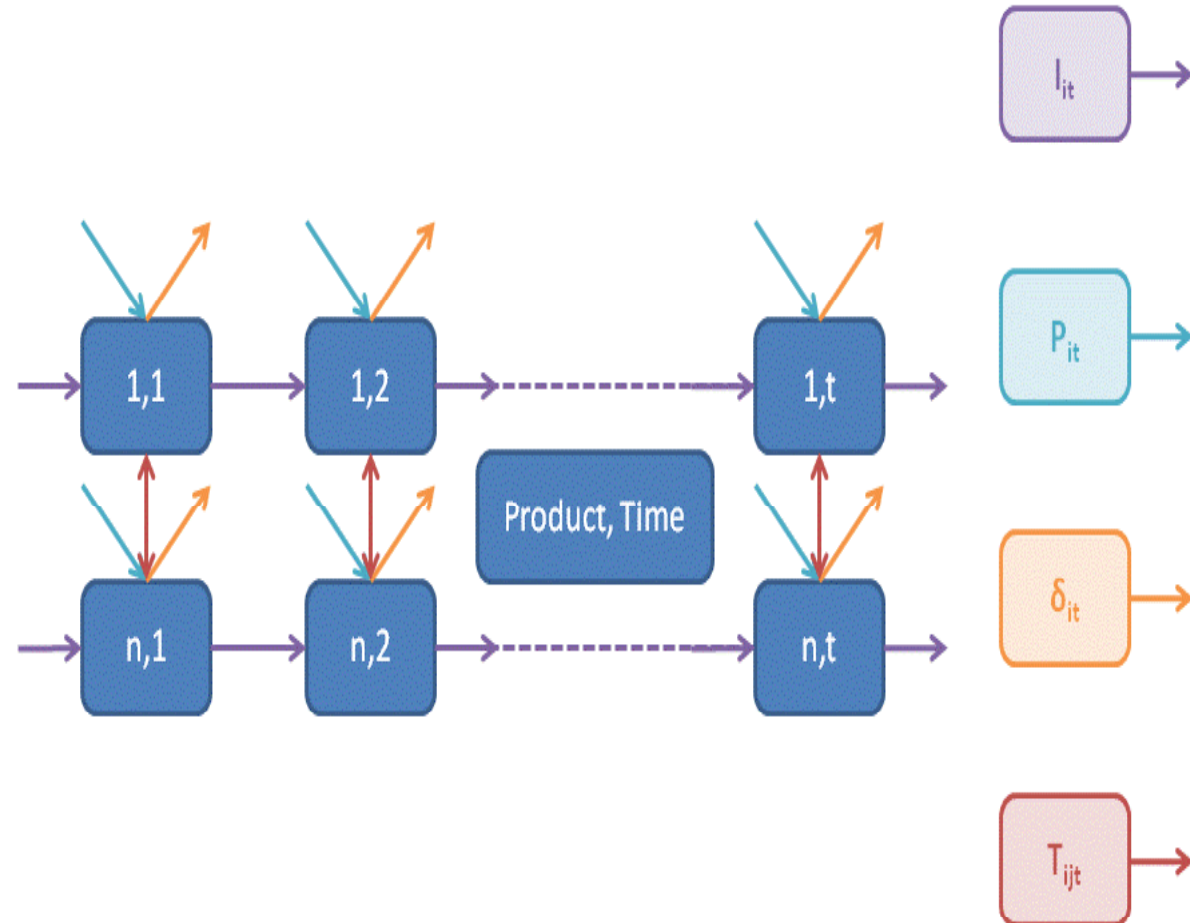


- Preliminary lot sizing model with pooling:



- Considers transformation of one product type into another, for a cost.
- Can be extended to consider “movement” of parts from one base to another, either directly or via a depot.
- Finally, a multi-level product structure is considered in the formulation.

Lot Sizing with Transformation



- **Argument**
 - Defense Inventories and Commercial Inventories have differing objectives, and therefore should be modeled differently
 - *Profit vs. Demand*
- **Models**
 - 2 Level Service Model
 - *Pooling Benefits Investigated*
 - Lot Sizing
 - *Transformation and Movement Costs Integrated*
- **Goal**
 - Manipulate
 - *production*
 - *rapid re-location of inventory*
 - *technology upgrades*
 - *level and location of assembly storage*
 - *quantities and ratios of product types*
 - Optimize
 - *Inventory Effectiveness of meeting Fleet Demand*

Questions/Comments/Feedback