The Management of Logistics in Large Scale Inventory Systems to Support Weapon System Maintenance

Eugene A. Beardslee, SAIC
and
Dr. Hank Grant
Department of Industrial Engineering, University of Oklahoma
Briefing Overview

- Problem Definition and Scope
- Background
- Challenges
- Solving the problem
Problem Definition

- Classic inventory problems
  - How much to stock?
  - When to order?
  - How much to order?
- Difficult problem without demand data
  - When will the stock location run out of inventory?
- Multiple Consumers, Multiple interrelated maintenance tasks
- No access to planning and production data
- Multiple-criteria optimization problem
Minimize Inventory Management Cost

- Holding Cost
  - Parts
  - Physical Space
  - Stocking Labor

- Penalty Cost
  - Idle workers
  - Delayed tasks

- Order Cost
  - Inventory Review
  - Shipping
  - Receiving
  - Forward Locating
Maximize Performance

- Inventory Bin Fill Rate
- Service Rate
- Inverse Waiting time
Background

- Bench stock inventory
- More than 400,000 stock locations
- More than 100,000 inventory items
- Over 1.8 million transactions over three years
- Multiple weapon systems: F-15, F-16, C-130, C-141, C-5, KC-135, B-1B, B-52, B-2, E-3, E-6A, FA-18, P-3, H-60, AV-8, and others.
- Multiple Sites: OCALC, OOALC, WRALC, JXNADEP, NINADEP, CPNADEP
Challenges

- Detecting stock-out conditions
- Forecasting demand
- Identifying inventory policy errors
- Compensating for variability of the maintenance environment
- No access to planning and production data
More Challenges

- Exact item count in inventory location is unknown
- Accurate inventory review is not economically feasible
- Reorder level is an estimate
- Reorder quantity is fixed
- Items removed from the stock locations for direct use
Insights: Inventory Segmentation

**High value** parts with **highly variable** and **high volume** demand would benefit from demand forecasts based on anticipated needs to minimize the value of stock on hand.

**Low value** parts with **highly variable** and **high volume** demand can have high reorder thresholds (safety stock) to avoid stockouts without incurring excessive inventory costs.

**High value** parts with **highly variable** and **high volume** demand would benefit from demand forecasts based on anticipated needs to minimize the value of stock on hand.

**Low value** parts with **low variability** and **high volume** demand could be "auto-replenished" based on historical demand patterns – lowering inventory review costs.

**High value** parts with **low variability** and **high volume** demand could be forecasted to assist suppliers, but should be reviewed more frequently to minimize overstock conditions.
Stock Out Triggers

- Unanticipated Demand
  - Surge in requirements
  - New Part
  - Increasing trend

- Policy Failure
  - Replenishment Quantity too low
  - Threshold too low
  - Review Policy problem

- Supply-side Failure
  - Vendor Stock-out
  - Long lead time
  - Delivery delayed

Stock Out
Solving the problem: Daily

- Unmanned Bench Stock Location
  - Material is placed in a bin and mechanic takes what he needs
  - If a bin is empty, inventory manager is notified and generates an emergency PR to Vendor
  - Conduct physical review of each bench stock location twice per week to create routine replenishment

- Emergency Requirements Management
  - Each emergency requirement is tracked from birth to death

- Stock outage Management
  - Intensive management to ensure parts are in the bin
  - Focuses manager on potential problems

- Web based asset visibility

- EDI Ordering and Invoicing
Enterprise Supply Chain System: SCOPTIMA™

- Oracle DBMS with custom user and system interfaces
- User-friendly interface for management queries
- Maintains record of supply chain events
  - Bin scan to generate potential order (hand-held device)
  - Order generation based on rule set (automated)
  - EDI order placement to vendor(s)
  - Order receipt and replenishment (physical inspection and confirmation)
  - EDI invoicing
- Supports analysis to identify historical demand patterns and relationships through simulation and data mining
Applying Technology

- Data Warehousing
- Data Mining
- Simulation
- Time-series Forecast modeling
- Dynamic data display
Key Transaction Events

<table>
<thead>
<tr>
<th>Demand</th>
<th>Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scan Order</td>
<td>Manual Order</td>
</tr>
<tr>
<td>Scan no order</td>
<td>OS</td>
</tr>
<tr>
<td>Manual Order</td>
<td>OZ</td>
</tr>
<tr>
<td>Zero Bin No Order Scan</td>
<td>ODR</td>
</tr>
<tr>
<td>Receipt</td>
<td>OO</td>
</tr>
<tr>
<td>Receipt</td>
<td>RS</td>
</tr>
<tr>
<td>RR</td>
<td>RZ</td>
</tr>
<tr>
<td>RO</td>
<td></td>
</tr>
</tbody>
</table>

Supply chain segment view
Integration of SLAM and SCOPTIMA™

- Automatically run simulation of Bin Q,r strategy to verify results
- Support SCOPTIMA decision making using simulation
  - Verification of Q,r changes when bin agent determines need for change
- “Agent” based approach
- Automated
Integration

- Spawn process from SCOPTIMA to invoke AweSIM model
- Interface via Data Files or Database
- Results returned to SCOPTIMA via Data Files or Database
Conclusion

- Challenging Supply Chain Problems
- Complex inventory model
- Integrated Enterprise System
- Advanced technology solutions
Dr. Grant joined the faculty at the University of Oklahoma in December of 1993 as Director of the School of Industrial Engineering and Southwestern Bell Professor. He is currently Director of the Center for the Study of Wireless Electromagnetic Compatibility and Dugan Professor of Industrial Engineering. Prior to joining the University of Oklahoma, he was with the National Science Foundation in Washington, DC, where he directed programs in Production Systems, Engineering Design, and Operations Research. Dr. Grant was instrumental in the startup and development of two Industrial Engineering software companies: Pritsker Corporation and FACTROL. Dr. Grant is a Fellow of the Institute of Industrial Engineers and is a member of the following societies: INFORMS, Tau Beta Pi and The Institute of American Entrepreneurs. Dr. Grant received his Ph.D. from Purdue University in Industrial Engineering in 1980.
Eugene Beardslee

Eugene Beardslee is the software system architect of the Industrial Prime Vendor (IPV) project’s enterprise system: SCOPTIMA Supply Chain Software. For the past five years, Mr. Beardslee has managed and directed the design, development, implementation and maintenance of all aspects of this logistics support software. Recipient of the 2003 SAIC Achievement Award for Excellence in Program Performance: Technology Development and Analysis, he has guided three successful Manufacturing Production and Engineering research projects focused on improved inventory and replenishment process performance. Mr. Beardslee has over 18 years experience in the production of software systems with over 12 years designing Oracle software systems. He is a member of the IEEE Computer Society, the Association for Computing Machinery and the Institute of Industrial Engineers. Mr. Beardslee received his Bachelor of Science degree in Computer Science in 1988, and his Master of Arts in Computer Resources and Information Management in 1997.