

ISyE 8852 Topics in Logistics: Performance Analysis of Distribution Center Operations Outline - Spring 2002

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Prerequisite: ISyE 6202, Warehousing Systems (not enforced)

Description: A course that focuses on the analysis and design decisions that a planner might face in configuring a busy distribution center. Major focus is on operational performance of subsystems and the overall system. Particular attention is given to stochastic environments. Three software packages will be used, in demonstrations and in exercises. Course material may be tailored to suit interests of class.

1. Introduction - review of distribution center situation (1 - 2 hours)
 - a. Modern trends: faster response time, more products, smaller orders, higher accuracy
 - b. Description of overall system: receiving, bulk storage, replenish, pick, sort, unitize, marshal and ship, return stock, auxiliary operations
 - c. The retrieval process operations: pick, cycle count
 - d. Document processing, order profiles
 - e. Preprocessing of customer orders: single-item orders, multi-item orders
 - f. Classification of order pick systems by number of orders, order size, and extent of advance information

2. Subsystems for storage/retrieval - mainly review of technology (1 - 2 hours)
 - a. Conventional unit-load systems: floor stacking, single- and double-deep pallet rack
 - b. Gravity pallet rack, push-back rack, drive-in and drive-through rack, unit-load systems
 - c. Automated storage retrieval system (AS/RS)
 - d. Walk-and-pick, ride-and-pick (in-the-aisle, picker-to-part): rack, shelving, bin-shelving, storage drawers
 - e. Person-aboard (in-the-aisle, picker-to-part): simultaneous travel, sequential travel
 - f. End-of-aisle (part-to-picker): horizontal and vertical carousel, vertical S/R, miniload S/R
 - g. Special equipment: automatic item picker, satellite S/R systems, multi-shuttle devices, rotary racks, aisle-saver (movable shelves)

3. Operational decisions - mainly review except for g. (6 -7 hours)
 - a. Storage assignment: dedicated, random, time-based, activity-based
 - b. Space utilization in systems: losses due to geometry, usage patterns, lane depths
 - c. Reserve storage decision
 - d. Dynamic stocking: pick area contains only those products to be retrieved during next shift
 - e. Batching of customer orders, consequent sorting

- f. Batching without downstream sorting: sort-while-pick, kitting matrix, pick-to-pack
 - g. Reducing the retrieval process time: split time into two components, ergonomic improvements, golden zone, multi-count packaging, computer aided order picking
 - h. Experience with **software** for pick-versus-reserve decision making in a dynamic environment
4. Analysis of AS/RS (8 hours)
- a. Single- and dual-command cycle times for block- and L-shaped zones - review
 - b. Optimum number and sizes of zones, effects on cycle times
 - c. Conveyor input-output systems: dual-purpose and dedicated conveyor systems, system balancing
 - d. Vehicle input-output systems
 - e. Experience with PALLET **software** or web-based software for AS/RS analysis
 - f. Case study: Comparison of options for unit-load storage systems, using PALLET software, with time-phased expansion options
 - g. Deep - lane systems at Miele, from Retrotech
 - h. Case study - automated parking garage cycle times
5. Analysis of systems with linear travel plus retrieval (6 -7 hours)
- a. Sort-while-pick, expected travel time
 - b. Batching without order splitting: naive batching versus intelligent batching
 - c. Batching with zoning and time windows: tradeoffs among labor efficiency, response time, and system capability
6. Person-aboard systems analysis (6 hours)
- a. Two-band sequencing method
 - b. Other sequencing methods: convex hull, band/insertion, 2-opt improvement method
 - c. Effect of activity-based zoning
 - d. Sequential travel
 - e. Experience with **software** for system performance analysis
7. Carousel S/R systems analysis (2 hours)
- a. Single-item retrieval
 - b. Multi-item retrieval
 - c. Splitting the retrieval process time
 - d. Double carousel configuration
8. Miniload S/R systems analysis (2 hours)
- a. Description of two-position system
 - b. Analysis of single-aisle system
 - c. Design procedure for multi-aisle system
 - d. Activity-based zoning
9. Sorting systems (5 -6 hours)

- a. Description of loop conveyor system
- b. Operating characteristics of system for processing a small number of large orders
- c. Operating characteristics of system for processing a large number of small orders
- d. Analytical models for performance
- e. Other equipment types: carousel, flow rack, kitting matrix

10. Correlated (product family) storage assignment (4 -5 hours)

- a. Problem description and specification
- b. Solution approaches: clustering, MIP ?
- c. Applications: end-of-aisle system, person-aboard system, walk-and-pick system
- d. The ultimate data preprocessing system: correlated and activity-based storage assignment combined with intelligent batching
- e. Relation to pick-versus-reserve problem

References: Mainly recent literature - list to be supplied later

At least one site visit will be arranged.

Grading: Based on 5 exercises or mini-projects, plus class participation.