# Order Picking

- A classical problem in warehousing and distribution is the order picking problem.
- Picking several different items to compose an order.
  - Could be a customer order, delivery for a retail store, kit for manufacturing or assembly, etc.
- Strategies
  - Part to picker
    - » AS/RS; miniload; carousel
    - » Use adaptation of previous unit load AS/RS analysis
  - Picker to part
    - » Person-aboard system; floor level picking





# Picker to Part Methods

- Single Order Picking
  - Must sequence orders and items within orders
- Multiple Order Picking (Batch Picking)
  - Single Picker per Order
    - » Sort while pick
      - Pick into separate containers
    - » Pick then sort
      - Put everything into a large batch then sort
        - High volume
        - No order sequencing required
  - Multiple Pickers
    - » Sequential picking
      - Container travels from zone to zone
      - Assembly line; bucket brigade
    - » Simultaneous picking (Pick waves)
      - Each picker confined to a region of the warehouse
      - Batch of orders released to the warehouse
      - Each picker picks items from batch in their region
      - Items must be accumulated and sorted into orders





# Order Picking Problems

- Batching
  - Group orders into pick lists
  - Based on priority or item similarity between orders
- Sequencing
  - Sequence items in the pick list
  - Based on item locations to minimize expected travel distance in picking tour (total pick time)
  - Picking tour is a specification of the sequence in which items in a specific order will be "picked"
  - This problem is prevalent where items must be picked from both sides of an aisle and the picker cannot reach items on both sides without changing position
    - » Wide aisles are common to allow two-way traffic, turning around in the aisle, or product storage with fork lifts





# Order Picking Tours

- Two Basic Problems
  - Within Aisle Sequencing
  - Between Aisle Sequencing
- Policies for Picking Within an Aisle
  - Traversal
  - Split Traversal
  - Return
  - Split Return
- Between Aisle Sequencing Problem
  - Similar to a traveling salesman problem
  - For high order density (> 15% of the slots visited), there is little difference between the optimal tour and the all traversal tour.





# Order Picking

- Traversal policy
  - "Z-pick" heuristic
    - » Each slot is picked in a fixed sequence which remains the same for all orders.
    - » "Best" Z-pick
      - $X^* = (W^2 + 1)/2$
  - Optimal policy
    - » Can be solved by finding the shortest path in an appropriately constructed network.
    - » See Goetschalckx and Ratliff, 1988, "Order Picking In An Aisle," *IIE Transactions*, vol. 20, no. 1, pp. 53-62.