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Supply chain design and production systems
Lesson 3: Logistics

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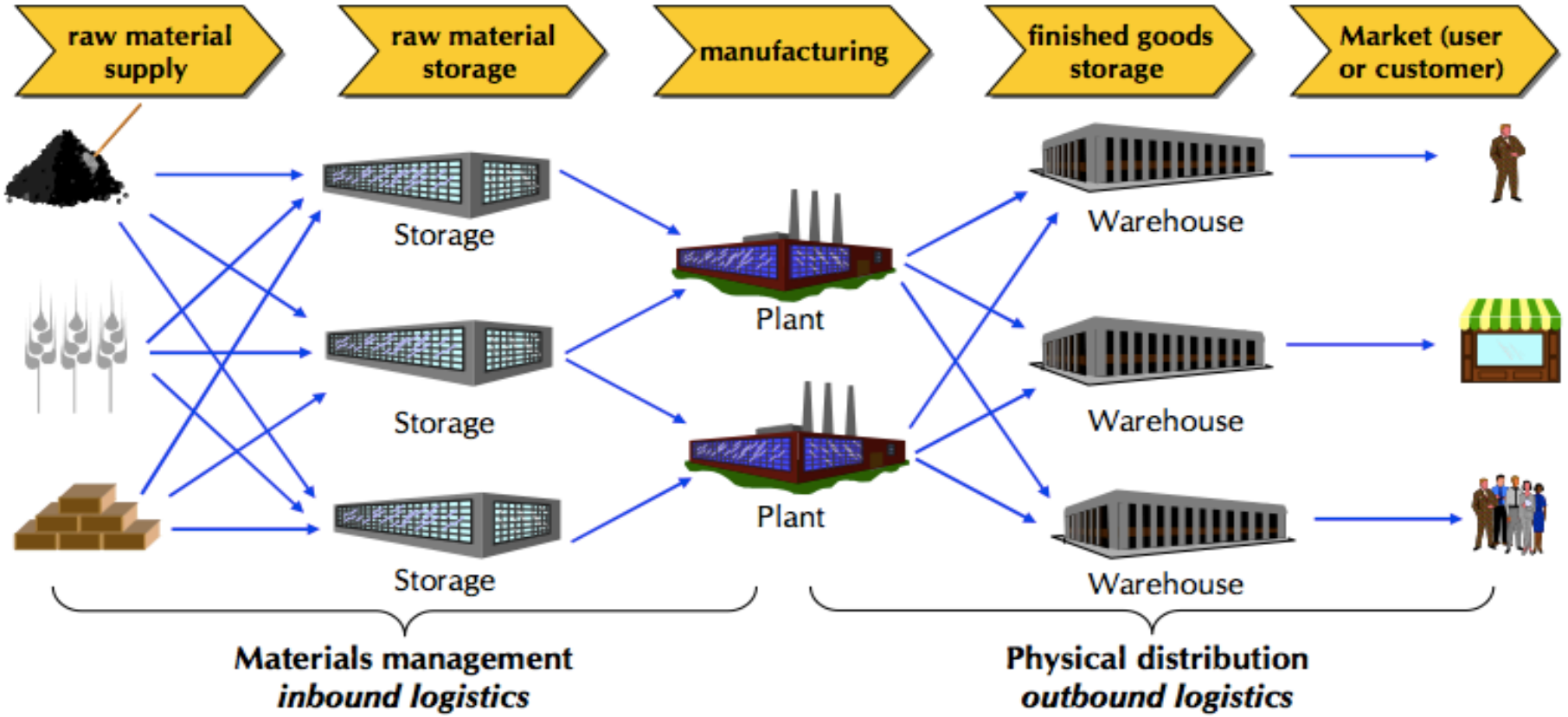
Agenda

- Logistics
- Warehousing
- Layout Design
- Profiling

Logistics

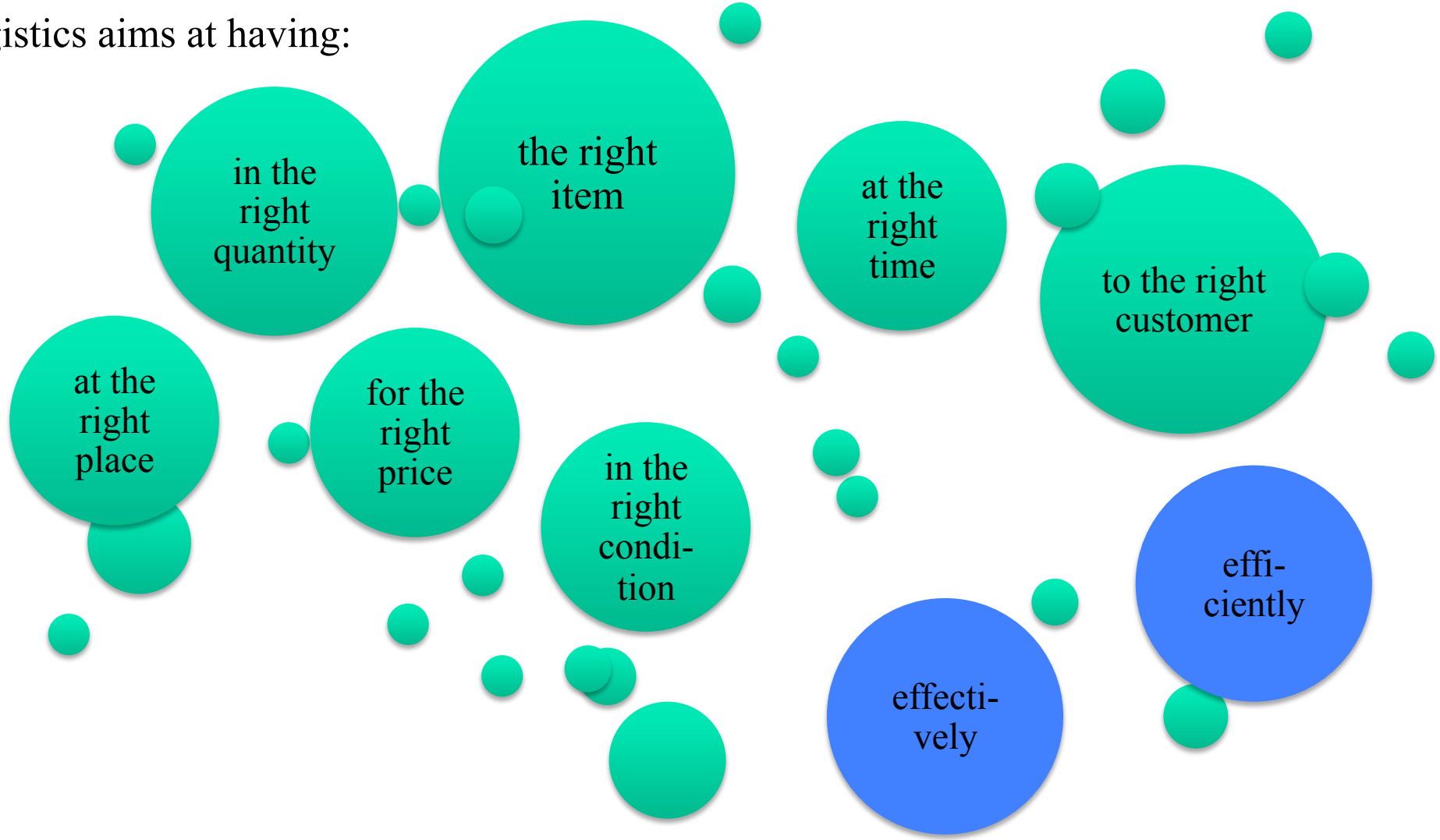
Logistics is the set of activities that manages the flow of materials and related information from suppliers to the delivery of finished products to customers and after sales service.



Logistics

Seven R's of Logistics

Logistics aims at having:

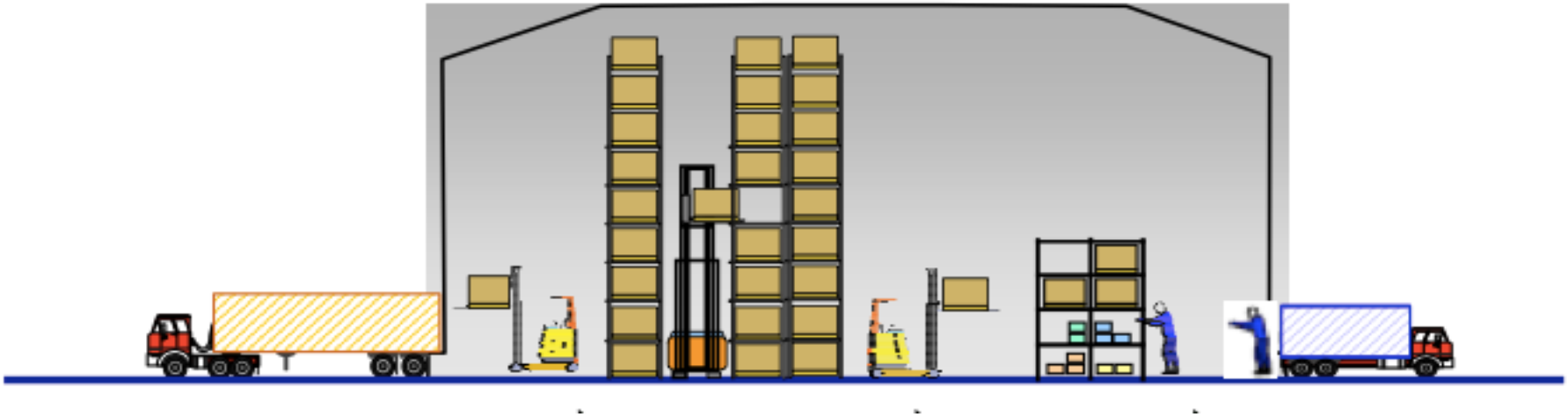


Warehousing

Warehousing is the set of activities that manages the flow of materials and related information within the production site/warehouse boundaries

Physical distribution three primary concerns:

receiving → storing → delivery

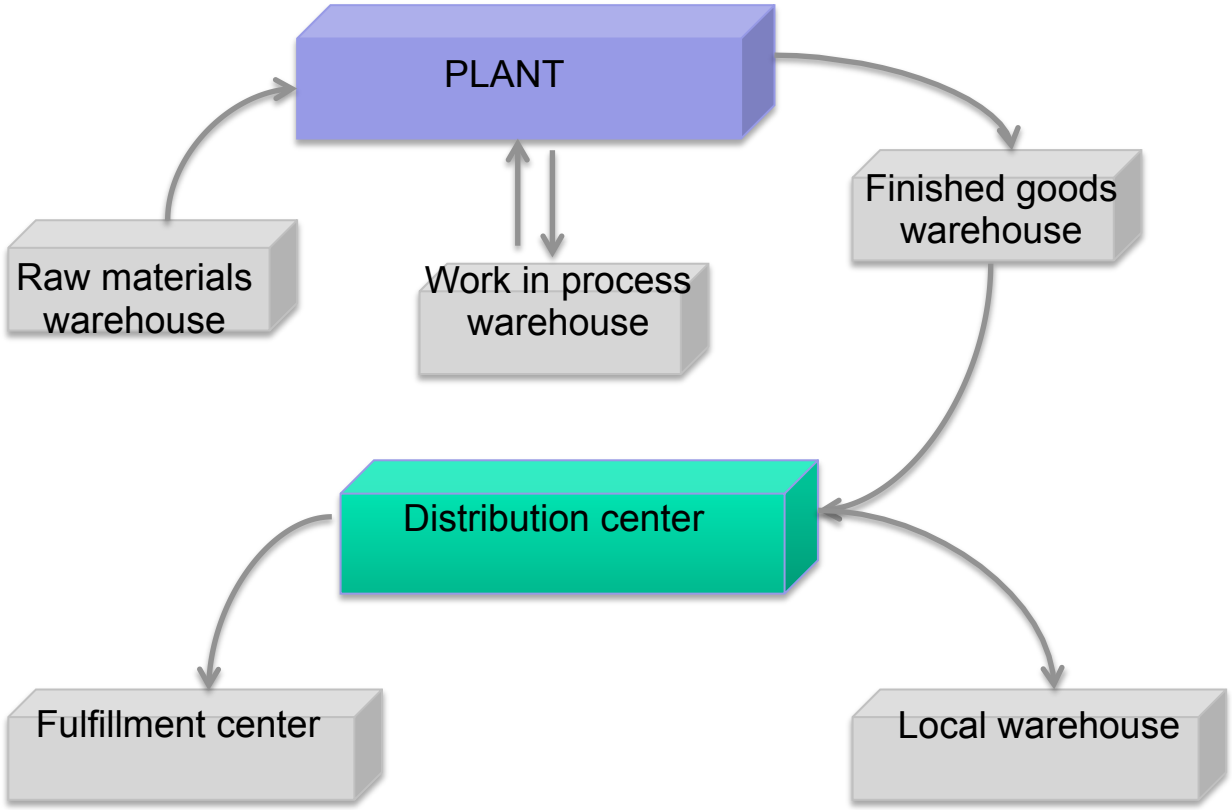


Warehousing

Warehousing functions

- Protect the goods in stock
  - keep the materials and components used in production, those made during the cycles of production (WIP) and finished goods
- Ensure continuity of flows
  - materials must be available for the production and sale, in order to ensure uninterrupted production flows and deliveries
- Transform flows
  - the assembly of the unit loads for the cycles of production and deliveries must be done efficiently

Warehousing



Warehousing

Inter-operational warehouses (work in process warehouse)

Constitute points of decoupling of the different phases of the production cycle and logistics of supply holding partially completed assemblies.

Storage terminals

- **Raw material and component warehouse**

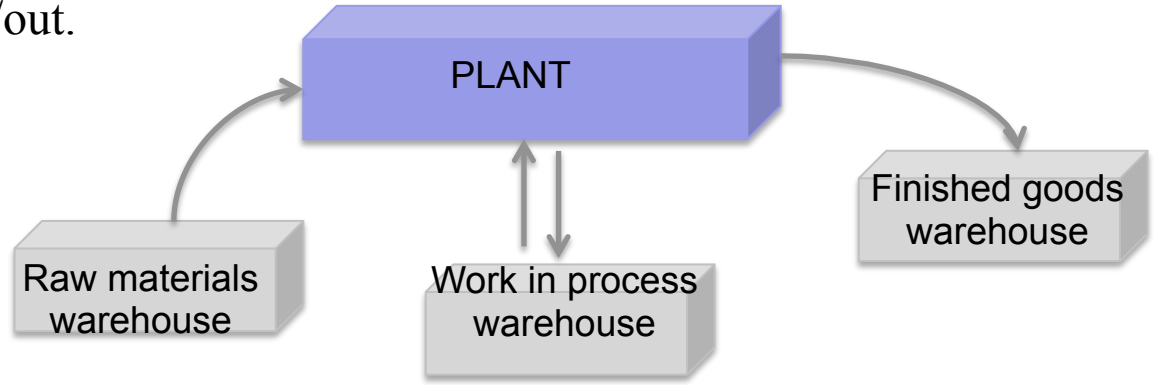
Hold raw materials at or near the point of introduction into a manufacturing process

- **Finished good warehouse**

Hold inventory used to balance and buffer the variation between production schedules and demand.

Located near the point of manufacture.

Characterized by the flow of full pallets in/out.



Warehousing

Distribution warehouses

Accumulate and consolidate products from various point of manufacture.

Combined shipments

Weekly orders

Fulfillment Centers

Receive

Pick

Ship for individual customers

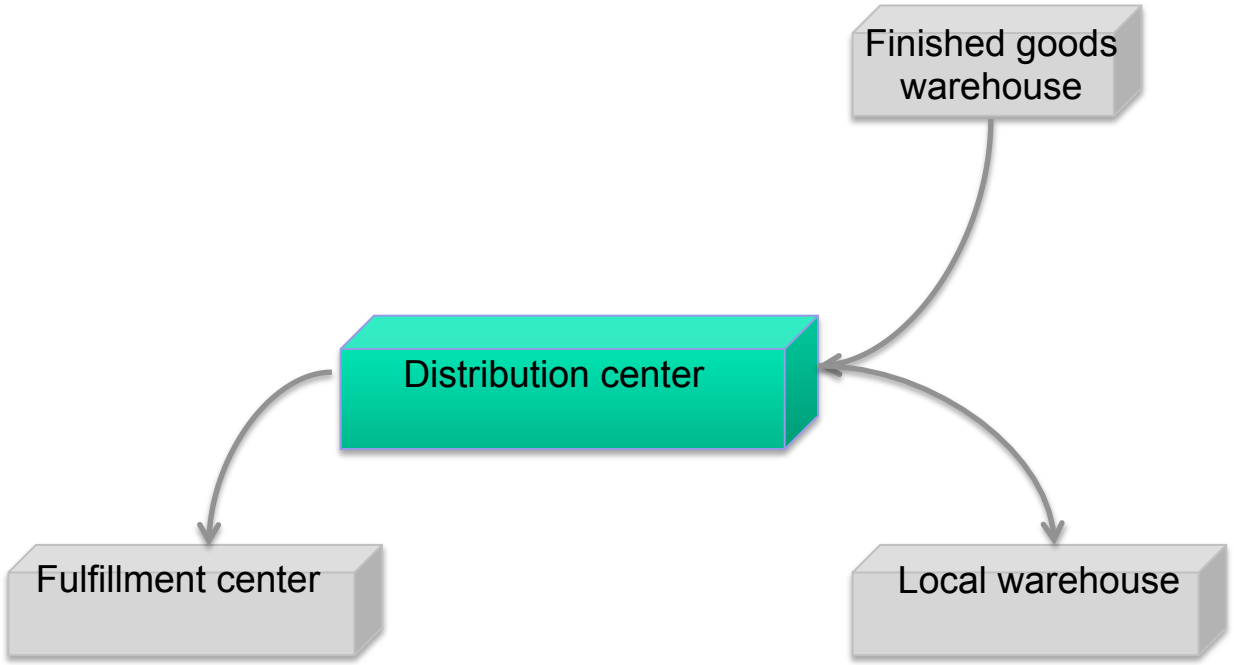
Local warehouses

Distributed in the field

Rapid response

Daily orders

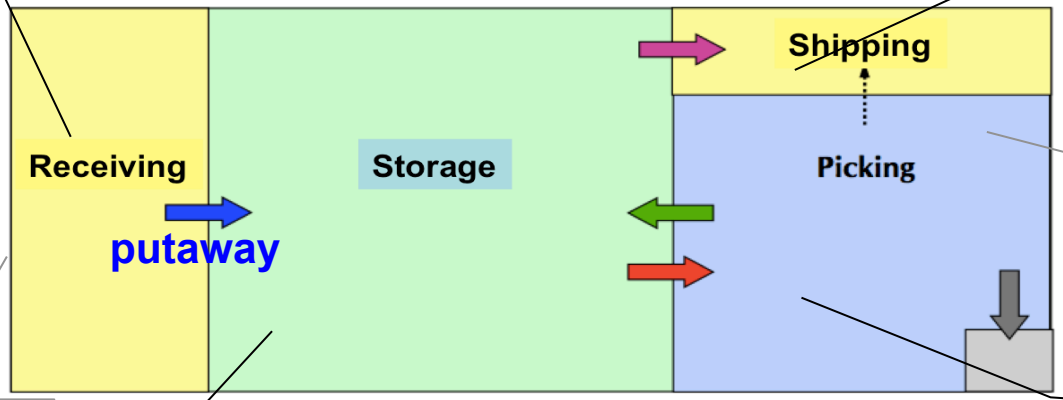
Single units



Warehousing

unloading, record, inspection, unit load unitization activities

check, documents preparing, grouping by carrier, loading activities



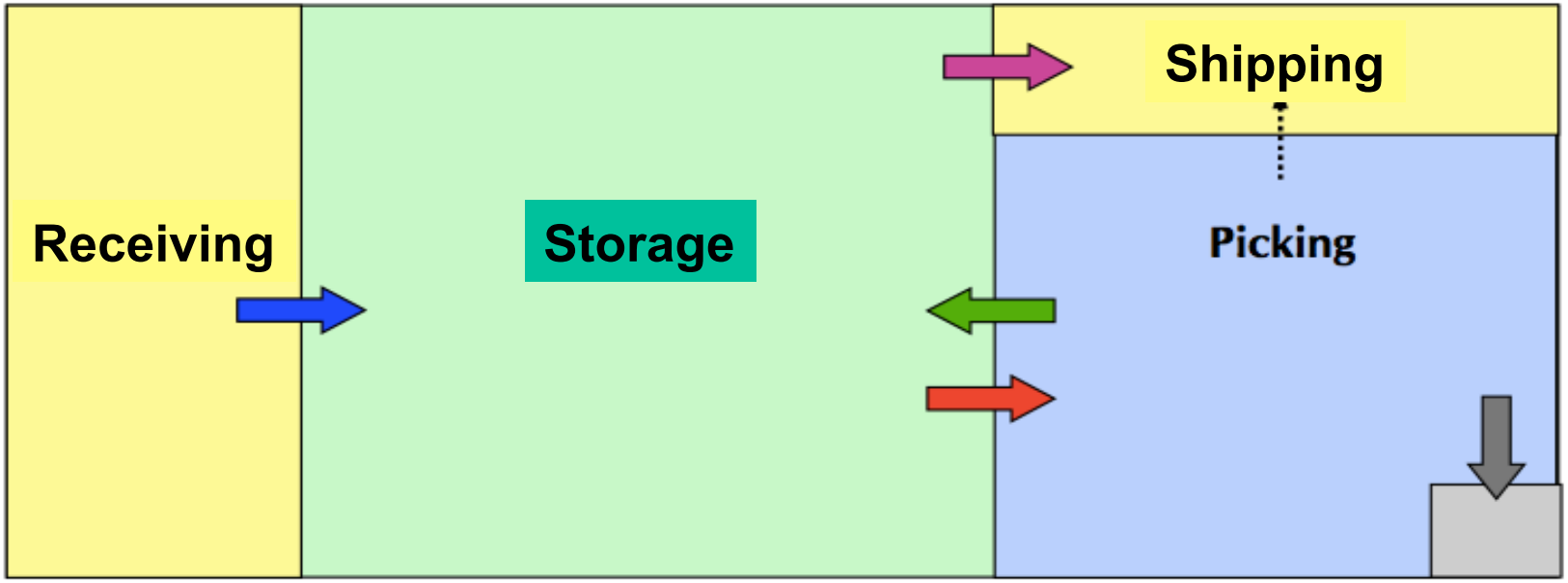
packaging and pricing can take place here

prepackaging can take place here

physical containment in storage

sortation, order consolidation, packing activities

Warehousing



F_{INPUT}

F_{ext} = inbound flow (unit loads)

F_{back} = flow from picking area (unit loads broken apart)

F_{OUTPUT}

F_{pick} = flow to picking area (unit loads can be broken apart)

F_{sped} = flow to shipping area (unit loads)

F_{end} = outbound flow (unit loads)

Design

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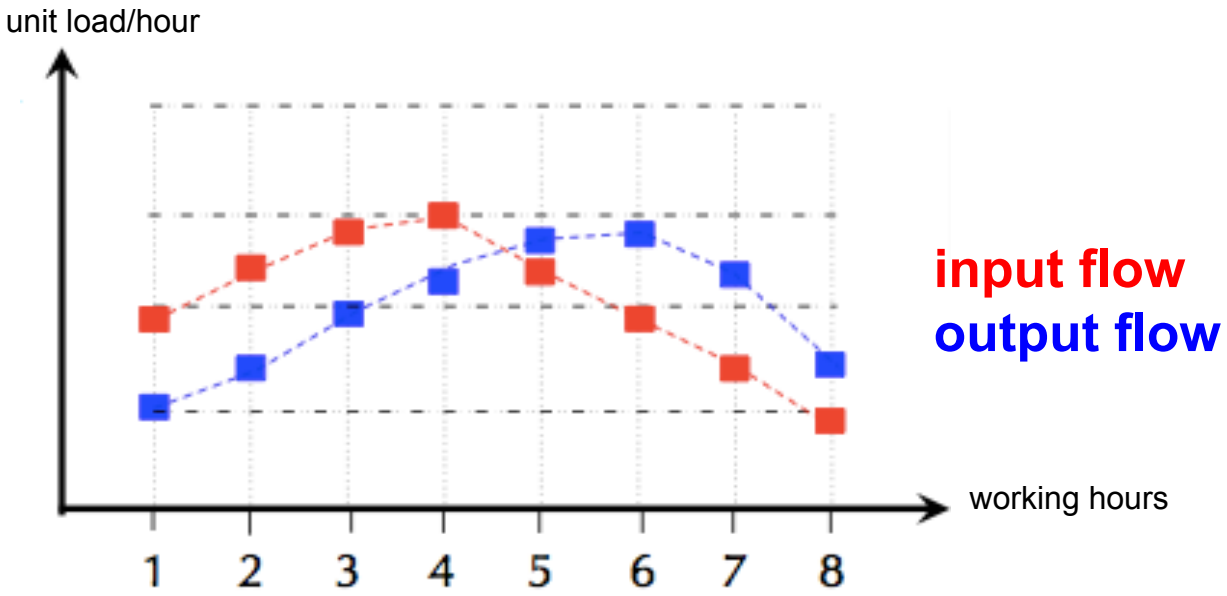
1 space requirements planning

Warehouse activity profile



Storage requirements as input and output flows are asynchronous

How big should be the portion of peak storage requirement to accomodate?

Design

Layout

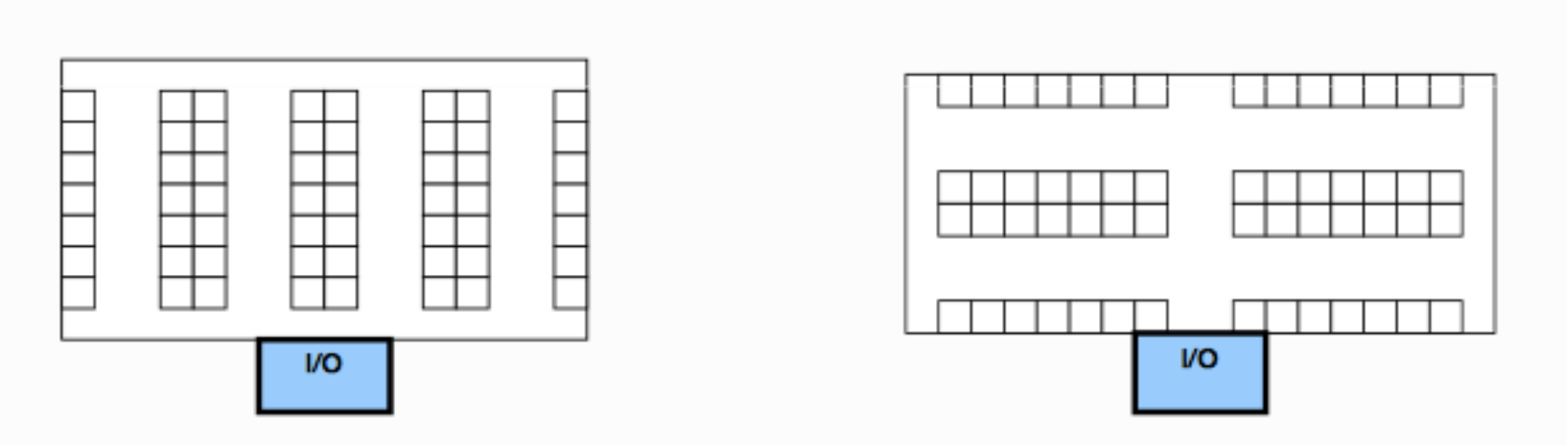
Determine the aisle structure of a storage department in order to minimize the material handling cost.

Decision includes:

- aisle orientations
- number of aisles
- length and width of aisles
- door locations

Design

Layout – aisle orientation



longitudinal

Variety of routes
Lower traffic congestion

transverse

No corridor along the longer side
Area exploitation

dimensional constraints

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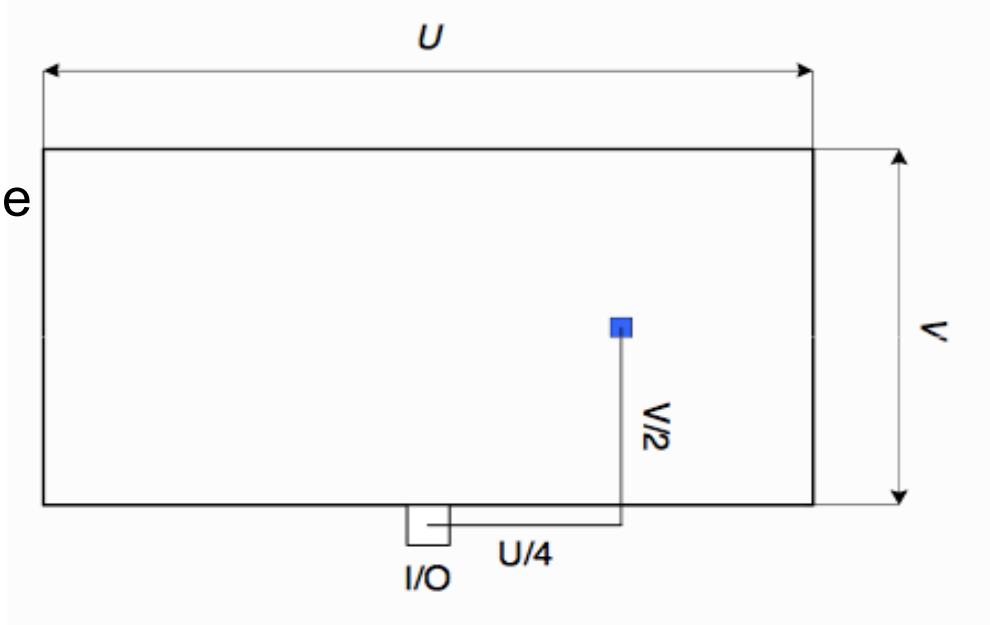
Layout – door location



As no dimensional constraint is registered, the optimized design is the one reducing the moving distances.

Hypotheses:

- rectangular layout
- surface A = U x V
- the I/O door is positioned centrally on the front of the store
- each pallet rack is accessed randomly
- the average path (r) is the sum of the way along the front of the warehouse aisle and along the corridor to access the compartment (longitudinal layout)

$$r = 2(U/4 + V/2) = U/2 + V$$

$$r = U/2 + (A / U)$$

$$dr/du = 1/2 - A/U^2 = ½ - V/U$$

$$U = 2V$$

$$V = U/2$$

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Layout – door location

Average path = 2 (U/k + V/2)

k depends on I/O door location

k=2 if I/O door in the apex of the front

k=3 if I/O door distributed along the front of the warehouse

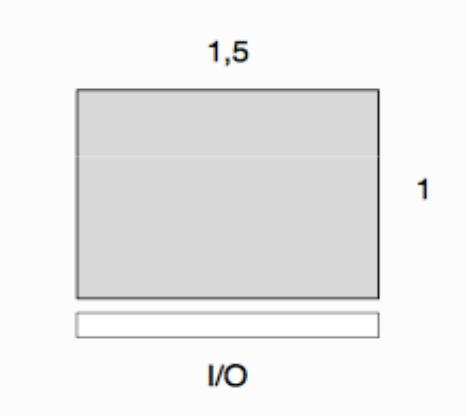
k=4 if the I/O door is positioned centrally on the front of the store

optimum: d path/d u : optimal U = k/2 optimal V

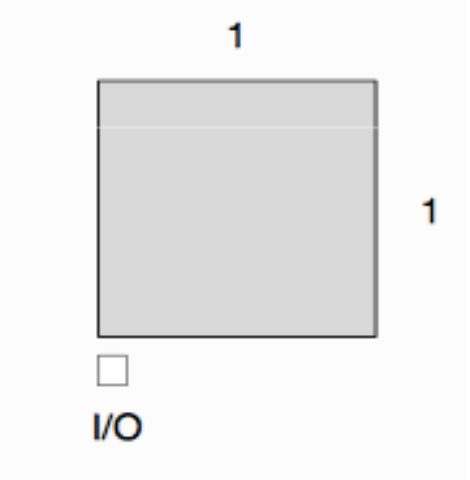
Design

Layout – door location

I/O door distributed along the front of the warehouse
U = 1,5 V



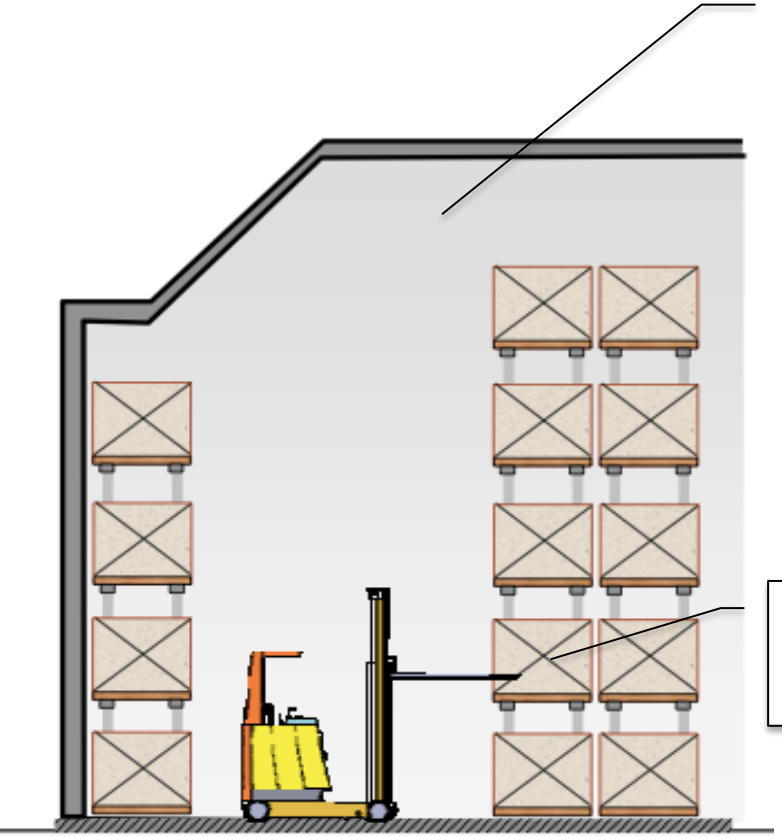
I/O door in the apex of the front
U = V



Design

Layout – number of levels

The maximum number of storage levels due to forks lifting height and storage height



pallet rack: horizontal rows and multiple levels

Pallet rack is a material handling storage aid system designed to store materials on pallets. Although there are many varieties of pallet racking, all types allow for the storage of palletized materials in horizontal rows with multiple levels

forklift

powered industrial truck, integral part of any pallet rack system as they are usually required to place the loaded pallets onto the racks for storage

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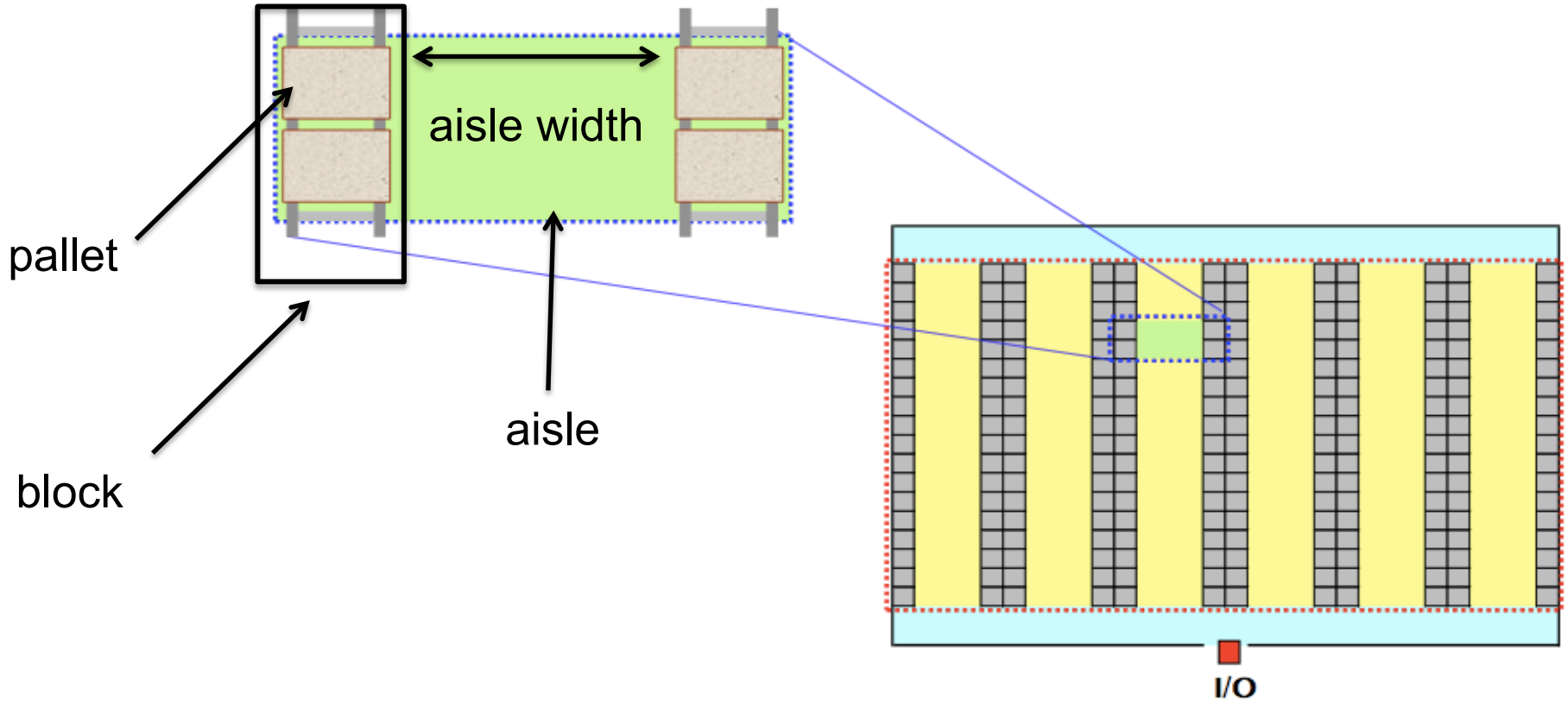
Layout – pallet raks

Single deep pallet rack



Design

Single-Deep Pallet Rack

Single-deep pallet racking provides access to each pallet stored in the rack. This gets around the issues of stacking frames and block stacking. When a pallet is removed the space is immediately available for a new pallet to be placed in that space. This type of racking can be configured in any number of ways with various heights. Most warehouses today have this type of racking in use. The major disadvantage is that the racks require significant floor space for suitable aisles.

Double-Deep Pallet Rack

The double-deep pallet rack is a variant on the single-deep rack that incorporates two single racks that are placed together. This reduces the number of aisles required but this type of racking may not be as efficient as single-deep racking. In addition a double-reach forklift is required to place and remove pallets from the racking.

Drive-In Rack

Drive-In racks provide five to ten pallet load spaces similar to the double-deep racking. The drive-in lanes provide access for the forklift to place and remove stock. However the forklift has a limited space to maneuver and this increases the time required to place and remove pallets. The drive-in rack is similar to

Design

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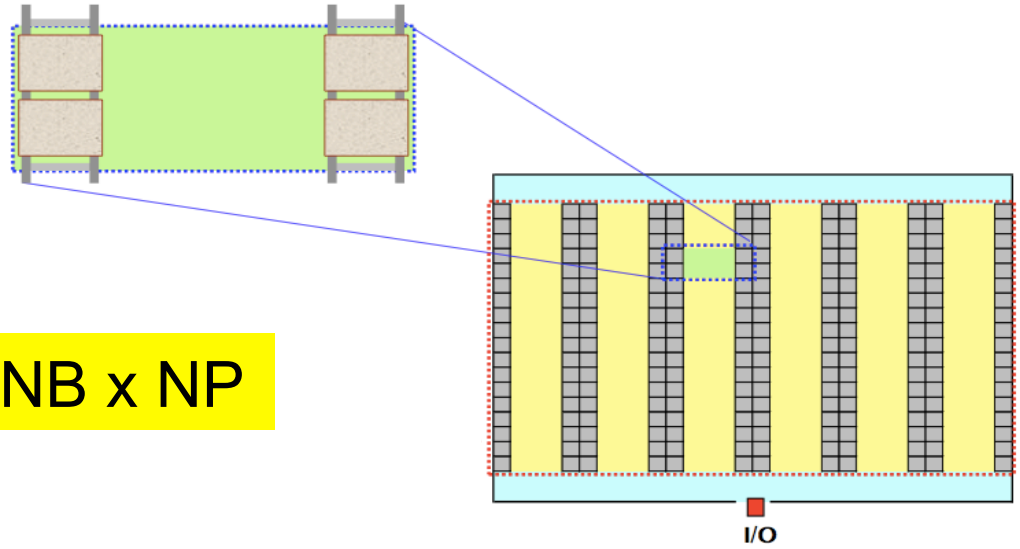
Storage capacity



Storage Capacity = 2 x NA x NL x NB x NP

NA = number of aisles
NL = number of levels
NB = number of blocks
NP = number of pallests per bock
2 : two-faced rack

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Handling capacity

Material Handling is concerned with the movement process.

Handling Capacity = NF x SHC

SHC = UF x 3600/CT

due to handling system

CT = variable cycle time + fixed cycle time

due to layout

NF = number of forklifts
SHC = single forklift handling capacity
UF = use factor
CT = cycle time

Profiling

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Item activity profiling
(a step backword)

- what storage mode the item should be assigned to
- how much space the item should be allocated in the storage mode
- where in the storage mode the item should be located

Includes activity distributions:

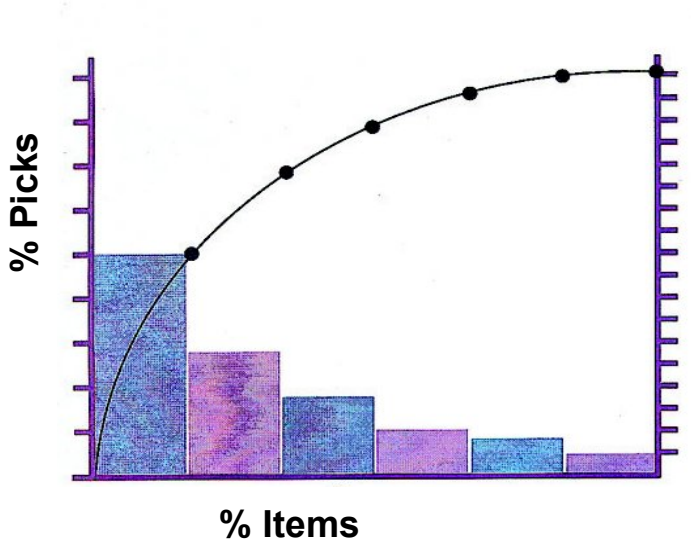
- popularity distribution
- volume/cube-movement distribution
- popularity-volume distribution
- order completion distribution
- demand correlation distribution
- demand variability distribution

Profiling

Item activity profiling

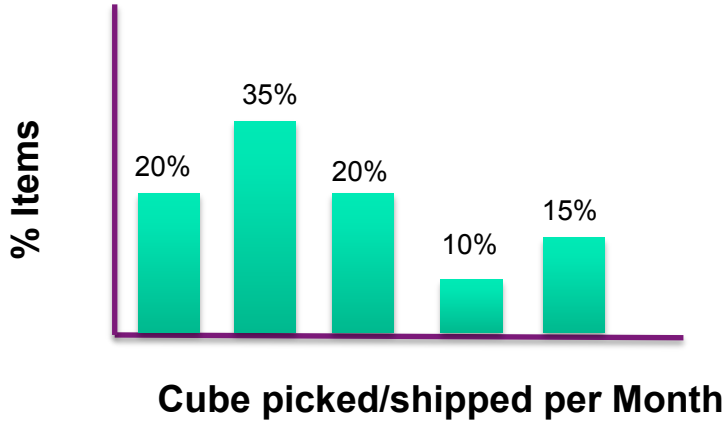
- **item popularity distribution**

Pareto law to identify the 20% of the items that generates the majority of pickings



- **volume distribution**

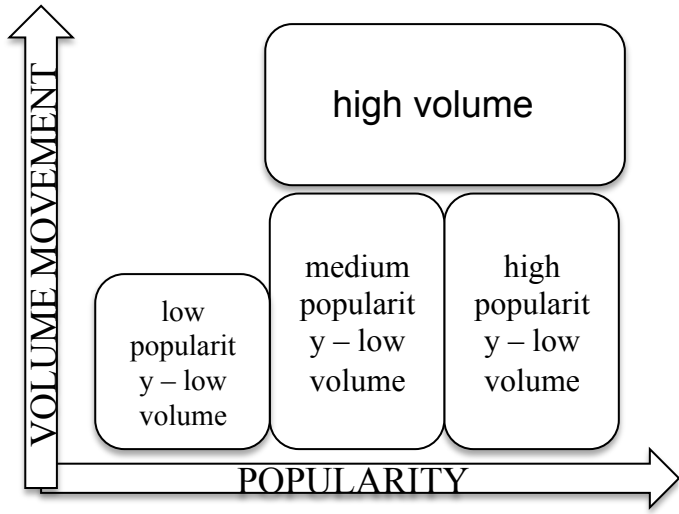
indicates the portion of items that fall into prespecified cube-movement ranges
in the diagram the 20% of items ships less than a certain quantity of cubes per month



Storage systems

Item activity profiling

- popularity-volume distribution
- picking activity generation per unit of occupied space in the storage
- define which items should be assigned the position in the golden/silver zone
- items in the bottom right-hand portion should be assigned positions in the golden zone
- those in the upper right-hand and lower left-hand generate a moderate number of picks per unit of space hence they should be assigned positions in the silver zone
- those in the upper left-hand the least accessibly zones
- high volume movement need to be restocked frequently and need a larger storage location comparing to items with a medium-low volume movement
- high popularity – low volume need highly productive picking mode
- low popularity – low volume do not justify being housed in an expensive storage mode



Profiling

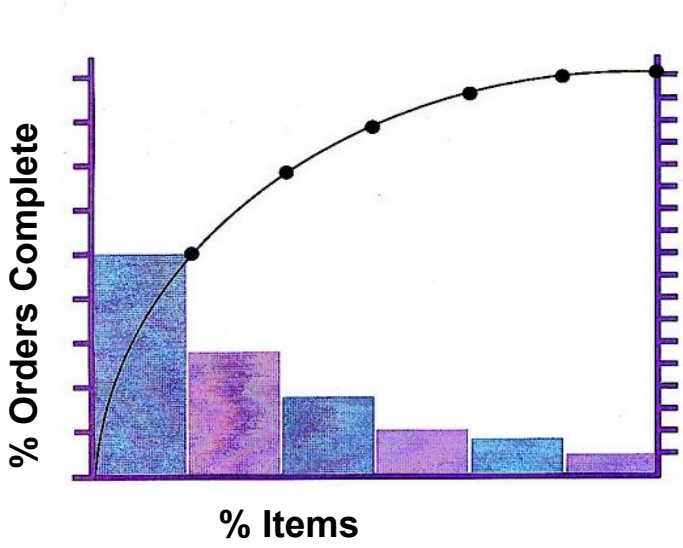
Item activity profiling

- **item order completion**

identifies small groups of items that can fill large groups of orders

those small groups of items can be to assigned to small order completion zones

item-order completion distribution is constructed by ranking the items from most popular to least popular, beginning with the most popular item, then the two .. the items are put against the order set to determine what portion of the orders a given subset of items can complete



Profiling

Item activity profiling

- **demand correlation distribution**

indicates the affinity of demand between individual items and families of items, as certain items tend to be requested together
ranking pairs of items based on their frequency of appearing together on orders

How do we take advantage of demand correlation information in slotting the warehouse? We should look for the denominator of correlation
we then zone the warehouse by this factor

- **demand variability distribution**

indicates the standard deviation of daily demand for each item
why is it important? to size the pick faces along a case picking line such as it held a day's worth of stock
- the objective is to make sure there is no need to restock

must size to accommodate the avg day's demand + enough to cover 1 or 2 stnd deviation