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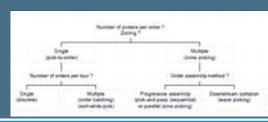
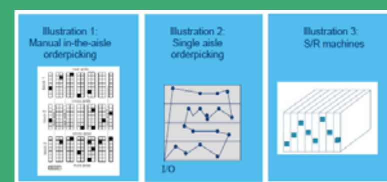
Order picking

Concepts



n

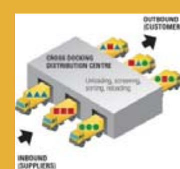
Algorithms



Case studies

CH1: CPI-MRO	CH2: DC sporting goods
CS1: XYZ company	CS2: e-conveyors

Trends



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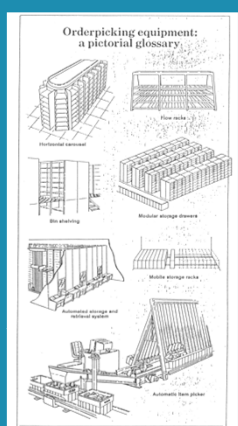
Concepts


Orderpicking equipment:
a pictorial glossary
Flow racks
Horizontal carousel
Bin shelving
Modular storage drawers
Mobile storage racks
Automated storage and
retrieval system
Automatic item picker

What is order picking?

Definition

- activity by which a small number of goods is extracted from a warehousing system to satisfy a number of independent customer orders

Reasons for order picking

- **buffer between production and demand** (time, quantity)
- consolidation of products in a single shipment

Importance

- plays a *key role* in distribution and manufacturing (!buffers)
- critical for internal productivity; for external delivery performancde
- *expensive*: either labor or capital intensive

Multi-objective

- resource utilization, service level, costs, flexibility, productivity, ….

Some *illustrative* numbers (Tompkins, 2016)

warehousing cost (average)

storage 14% - receiving 18 % - shipping 18 % - order picking 50 %

manual order picking time (example)

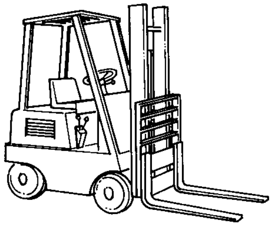
travelling (60%)

searching and identifying (10%)

extracting and counting (10%)

sorting (10%)

packaging (10%)



Operation types

revisited

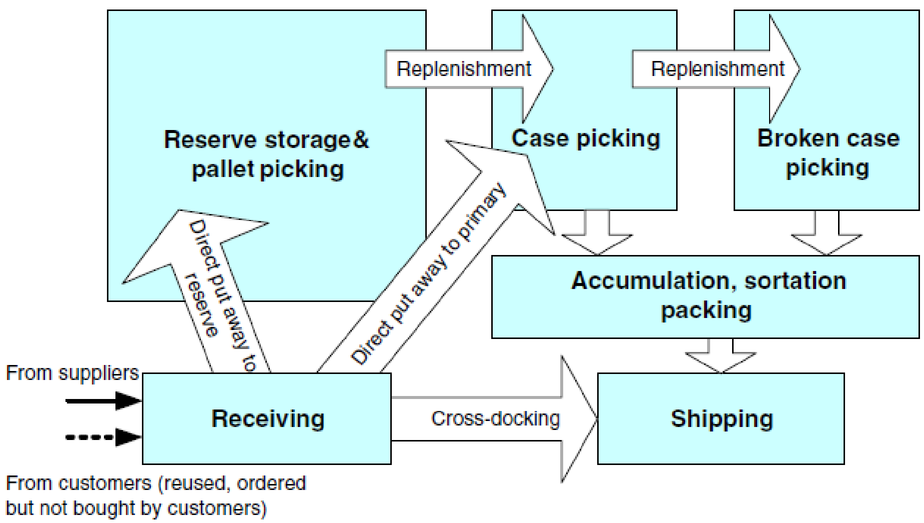


Fig. 1. Typical warehouse functions and flows (Tompkins et al., 2003).

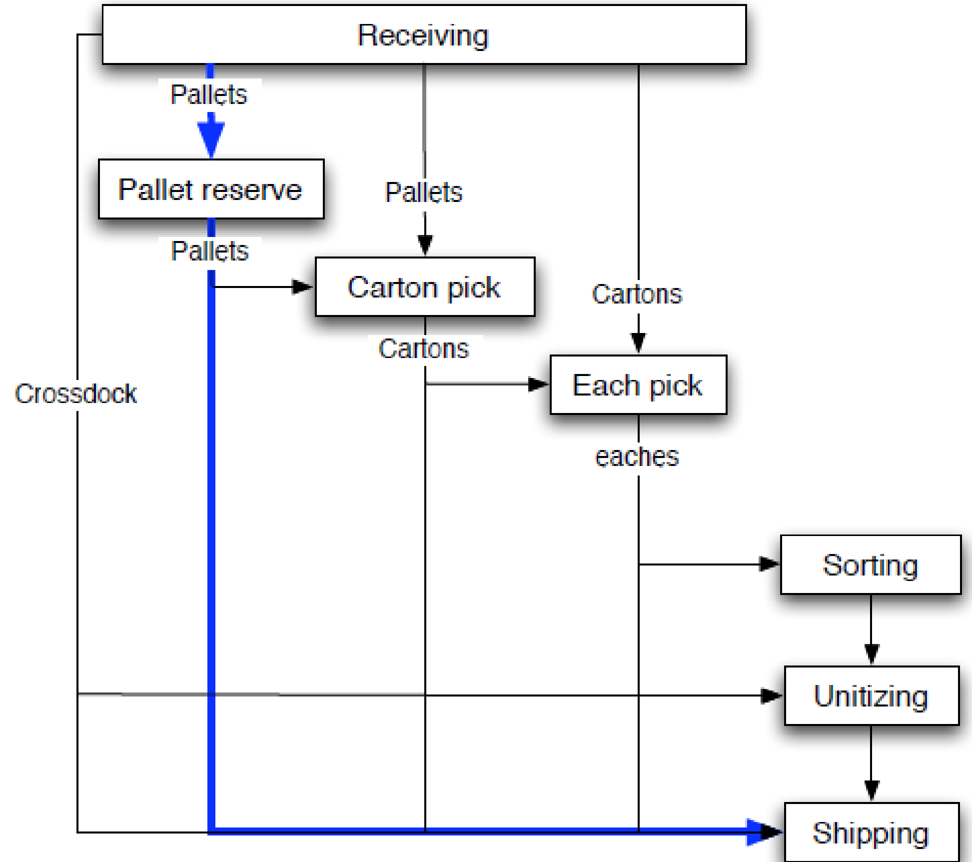


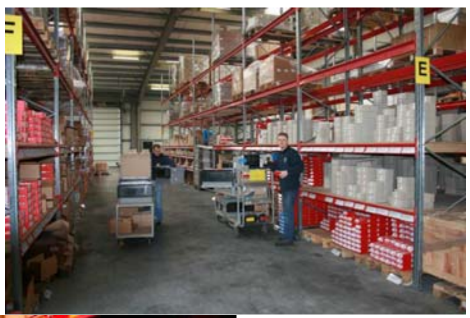
Figure 6.1: Flow of unit-loads through a typical warehouse

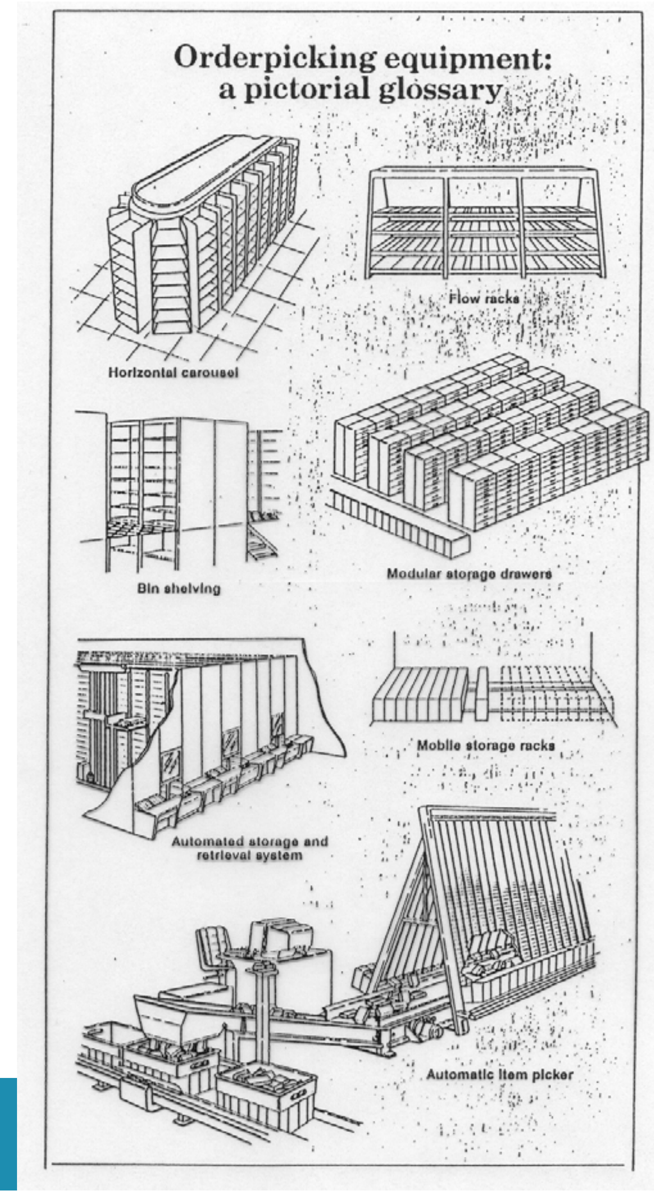
Equipment

Two basic types:

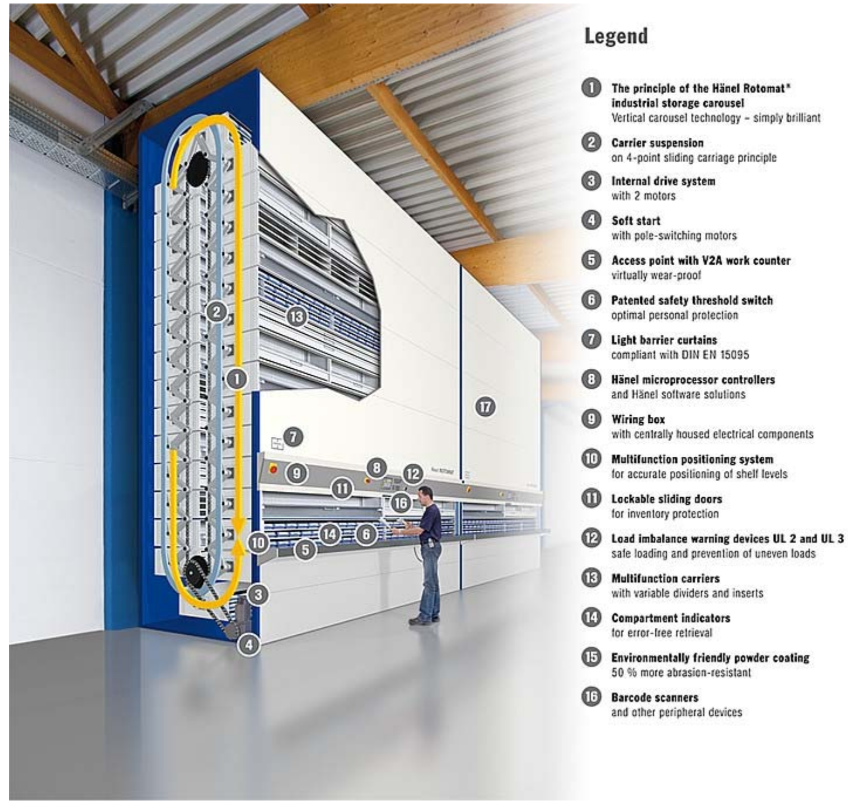
part-to-picker (end-of-the-aisle)

picker-to-part (in-the-aisle)

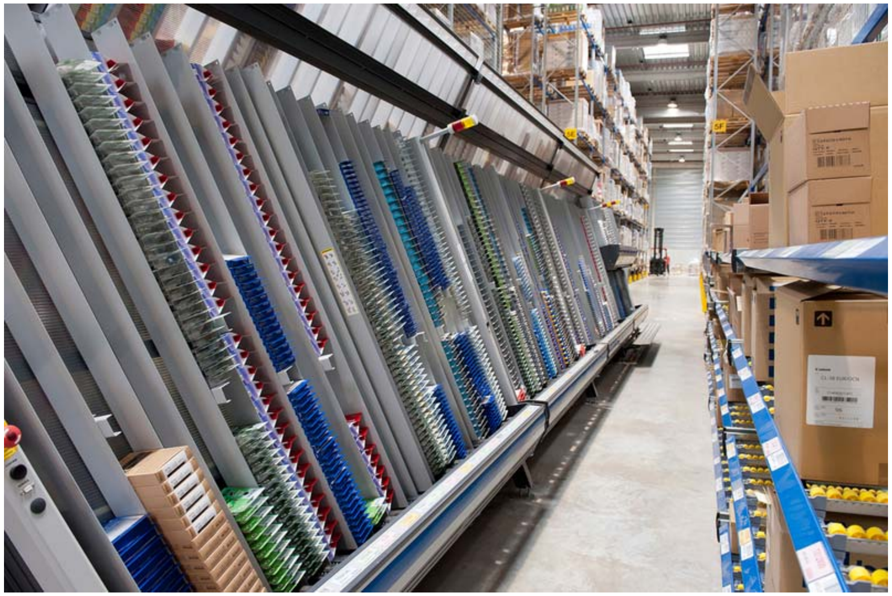




Horizontal caroussel

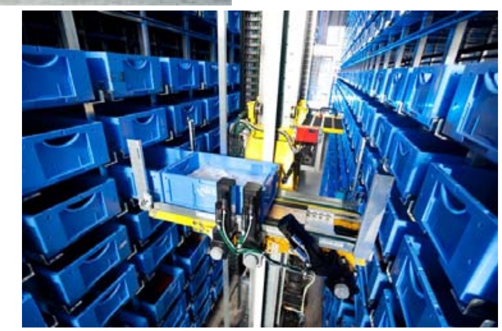


Vertical caroussel

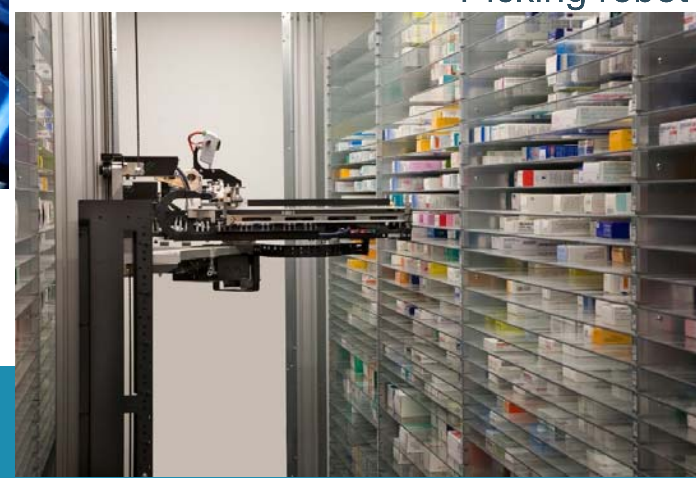


A-frame

Mini-load system



Picking robot



Bin shelving (picker-to-part)

Simple racks - shelves

Mechanized picking

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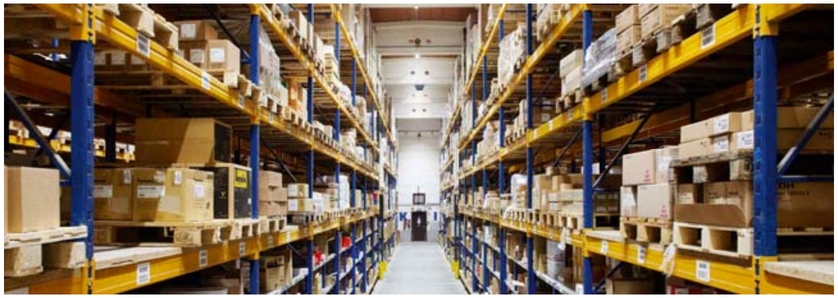
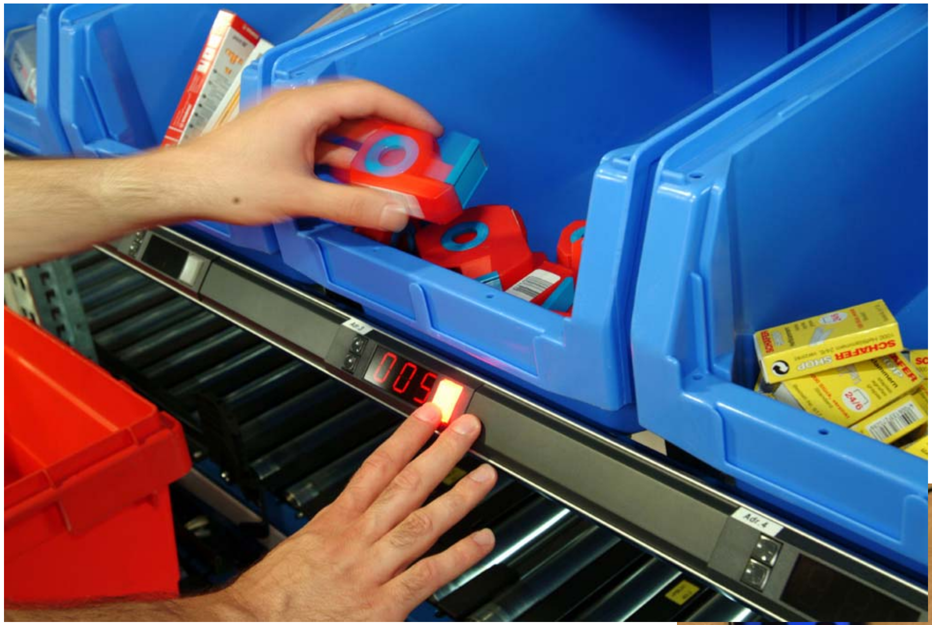
Robots/cobots



In-the-aisle order picking

Narrow-aisle order picking



Pick-to-light systems

Voice picking systems

AR/VR - wearables

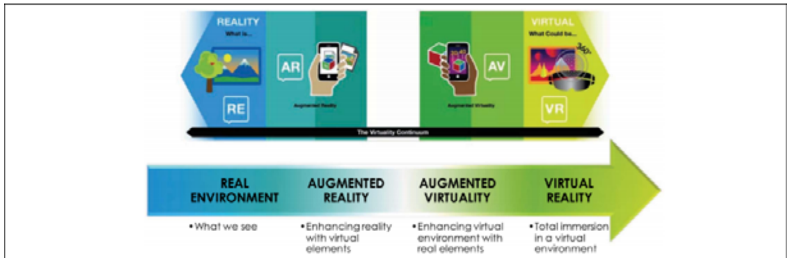
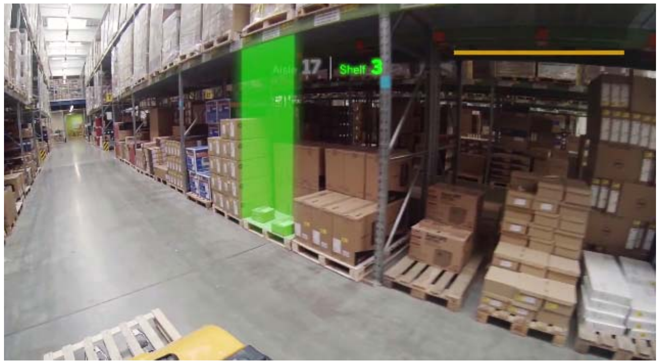
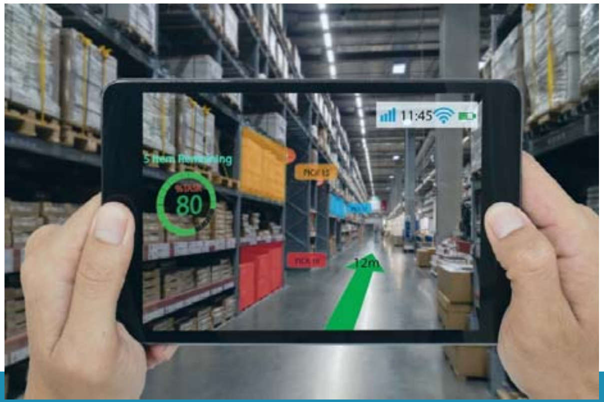


Fig. 11. Augmented and virtual reality as part of the virtuality continuum introduced in [166]. Image adapted from http://smartideasblog.trekk.com/augmented-or-virtual-how-do-you-like-your-reality.





Exoskeletons

2019

De opkomst van bionische technologie zoals o.a. 'wearables' en 'exoskeletons' verlegt de grenzen van de huidige fysieke barrières van de mens.
Slimme kleding, smart glasses, bionische armen en zelfs slimme contactlenzen hebben het potentieel om logistiek personeel te ondersteunen op het vlak van communicatie, procesuitvoering of optimalisatie en tevens ook gezondheids- en veiligheidsrisico's te minimaliseren.
Exoskeletons kunnen worden beschouwd als draagbare robotpakken die het menselijk lichaam een boost geven m.b.t. kracht en uithoudingsvermogen. Tegenwoordig worden ze reeds ingezet bij revalidatieprocessen (in de gezondheidszorg) en ook in de industrie bij het hanteren van zware gereedschappen.

OPPORTUNITEITEN

- Verminderen van fysieke belasting bij meerdere manuele handelingen (orderpicking, verpakken of stapelen van collies, laden en lossen van vrachtwagens). Fysieke overbelasting kan leiden tot lichamelijke klachten, resulterend in minder productiviteit, lagere motivatie en finaal tot ziekteverzuim.
- Ondersteunen van oudere operatoren bij fysiek belastende taken.
- Verhogen van de productiviteit bij handelingen met zware lasten of bij repetitieve activiteiten.

RESULTATEN

- Exoskeletons zijn nog volop in ontwikkeling voor toepassingen in de industrie. Ze zijn vooral gericht op statische (permanent ondersteunend in een bepaald gewricht) en repetitieve belastende taken, bijvoorbeeld montage langs de assemblagelijn in de auto industrie.
- Exoskeletons dragen positief bij in een beperkte reductie van de belasting, maar bij verschillende taken treden nadelige ongewenste effecten op (verschuiving van belasting, extra rotatie en/of overstrekking van de rug).
- Bij respecteren van de preventiehiërarchie, kan overwogen worden om een passief exoskelet in te zetten om het restrisico aan te pakken.
- Twee vragen zijn van groot belang voor wie exoskeletten wil inzetten in de logistiek: blijven bepaalde logistieke (deel)taken voldoende lang in de ondersteunde zone (werkgebied) van het exoskelet? Heeft het exoskelet voldoende bewegingsvrijheid (vrijheidsgraden), noodzakelijk voor de logistieke deel(taak)?
- Naast het analyseren van de juiste match tussen taak en exoskelet dient de gebruiker ook ondersteund te worden met training, gewenning en begeleiding bij het invoeringsproces.
- VIL werkte voor dit project een helder stappenplan uit.

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(Re)design issues

Market
- Current situation, trends
- Order patterns
- Service requirements

Business strategy
- Marketing (e.g. channel)
- Inventory/production policy

Warehouse management
- Layout
- Storage
- **Order picking**

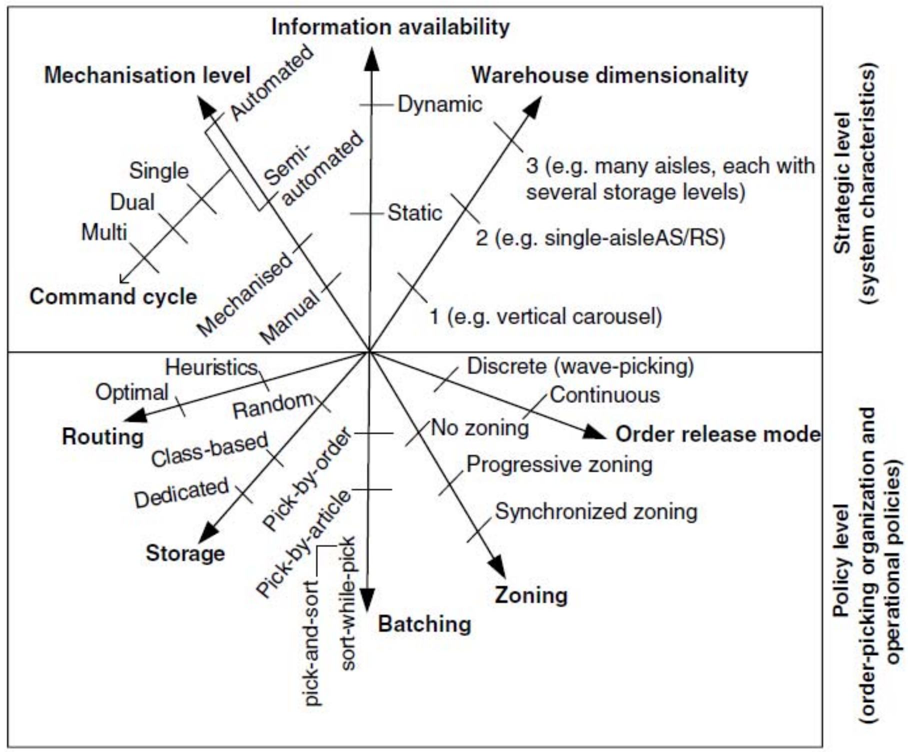
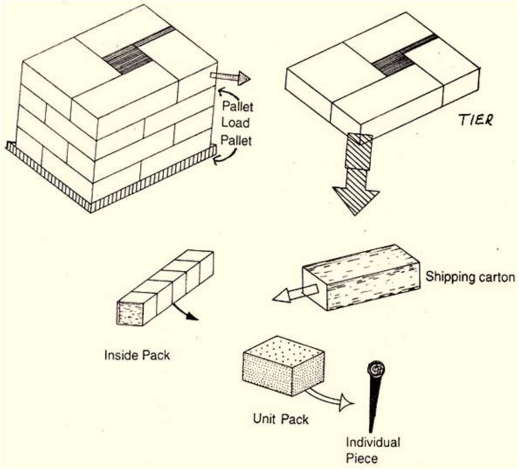


Fig. 3. Complexity of order-picking systems (based on Goetschalckx and Ashayeri, 1989).

Data

Type of information/tools	Example
General	sales figures, # SKU, inventory turnover
Customers	service goals (service level, flexibility, lead time, …)
Volume	units & orders picked/day, /year
Variety	order profiles: unique or recurrent, full or broken case, # lines (picks)/order, …
Inventory	on-hand/SKU, replenishment, ...
Physical characteristics	dimensions, environment, fragile, perishable, ...
Unit loads	receiving → shipping
Time standards	reach, grasp, ...
Standard costs	labor, space, equipment, …
Tools	Pareto analysis, flow diagrams, ABC (costing), TCO, time and motion studies, optimization algorithms and heuristics, ...

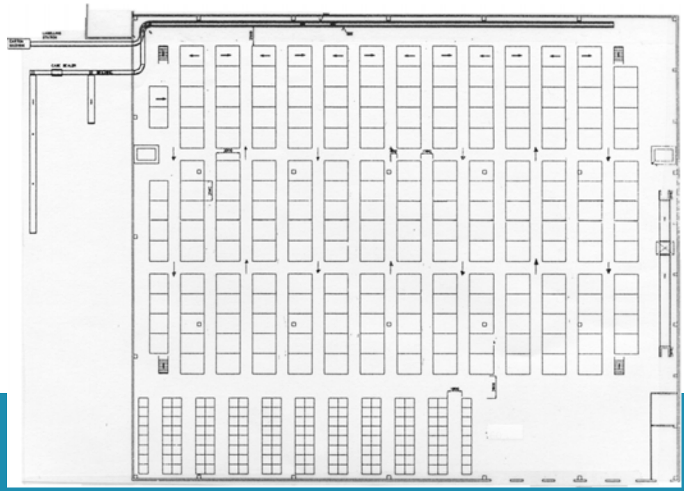


Interactions

Layout

Material handling

Ergonomics

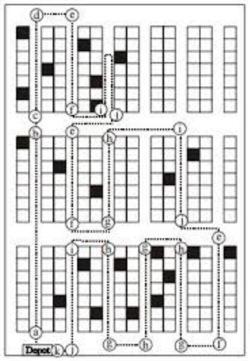


Exercise:

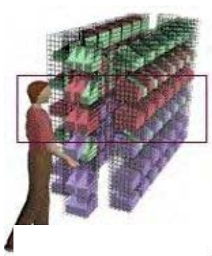
Consider a manual order picking process. Think about a method to eliminate or reduce the different work elements. Each time indicate which equipment, if any, is required.

Work element	Method to eliminate or reduce	Equipment required
Traveling		
Documenting		
Reaching		
Sorting		
Searching		
Extracting		
Counting		

Optimize the routing (TSP)

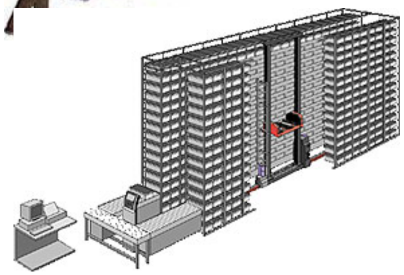


Invest in part-to-picker equipment



Horizontal carousel

Vertical carousel



Miniload AS/RS

Basic order picking patterns

How to decide …?

www.trifactor.com – white paper

TriFactor
Distribution Solutions

Formerly Advanced Handling Systems

TriFactor Home > TriFactor Learning Center > White Papers > Critical Factors when Choosing an Order Picking System

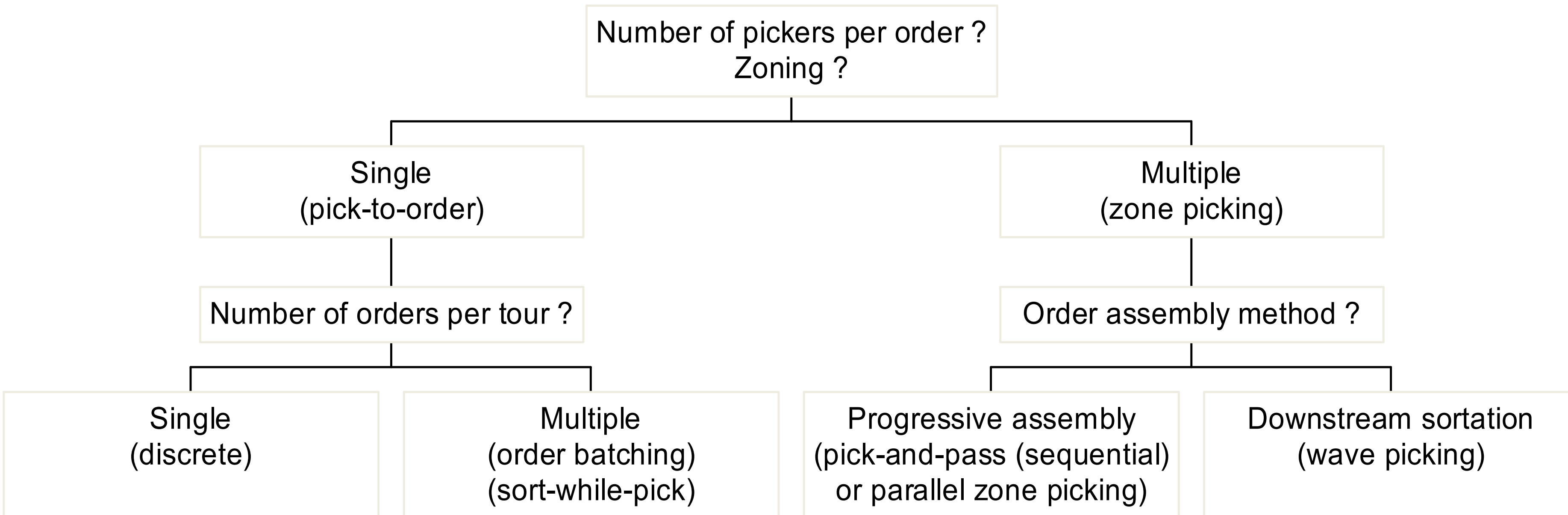
Choosing an Order Picking System

Critical Factors when Choosing an Order Picking System

By Richard Gillespie

"What do I need to know about my operation before choosing the order picking solution that is right for my company?"

Types of picking systems



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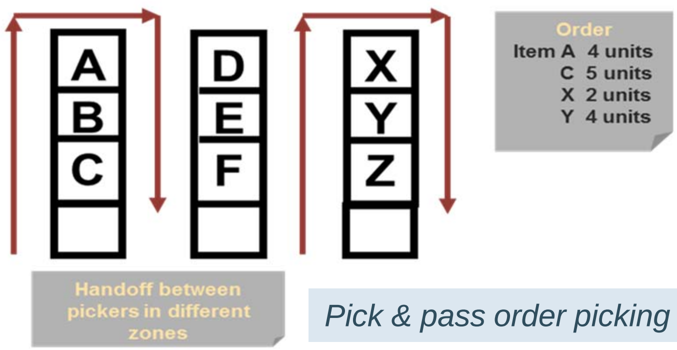
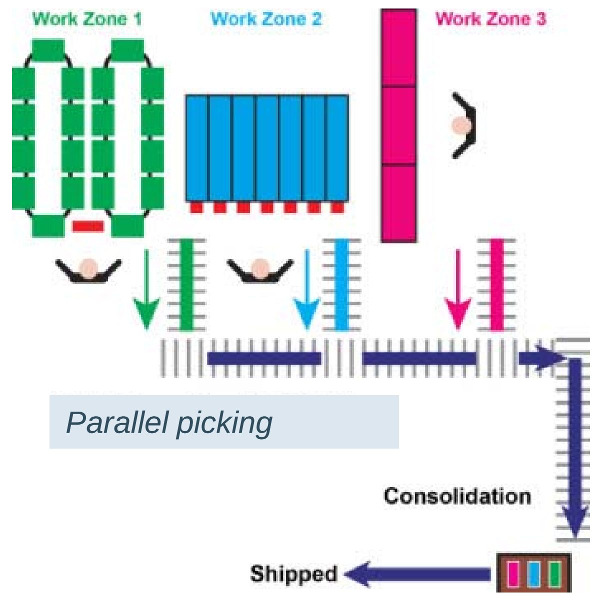
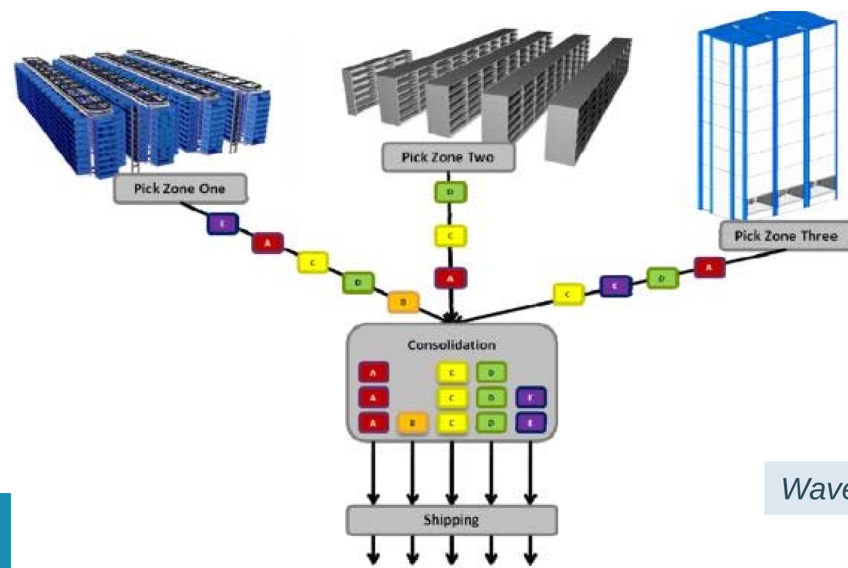


Pick & pass order picking

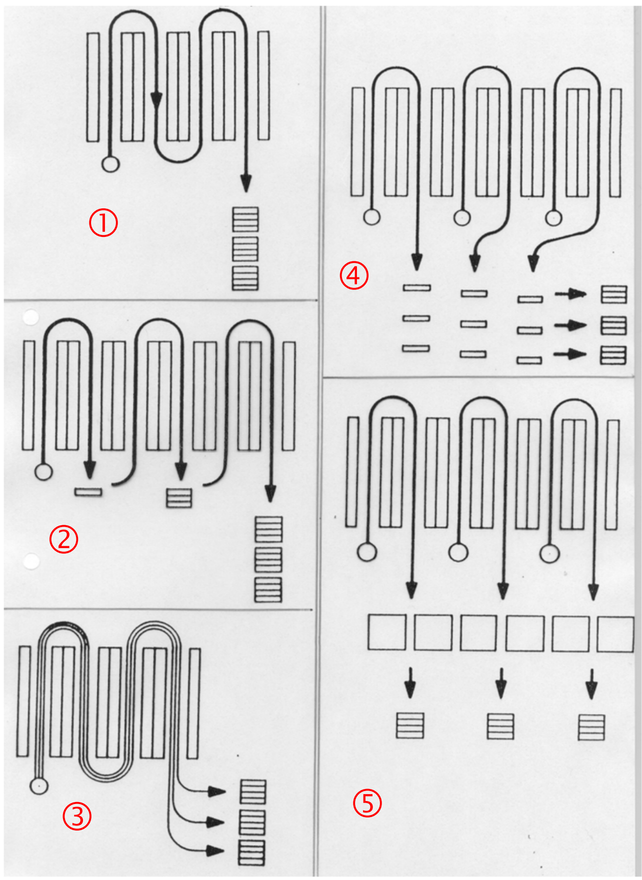


Parallel picking



Wave picking

Examples of patterns



IDENTIFY

(1) single order picking

(2) sequential zone picking

(3) batch picking

(4) parallel zone picking

(5) wave picking

COMPARE

basic characteristics

pre-picking operations

post-picking operations

performance

- accuracy
- travel time
- search time

other

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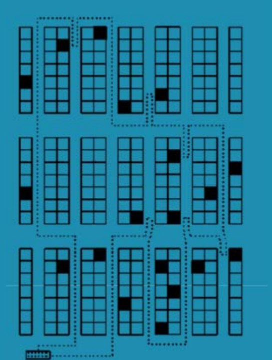
Algorithms



Algorithms

A lot of research on order picking optimization on the topic, research results are implemented in software packages

Routing is main component in most algorithms – sequencing of picks is very important; other elements are order clustering/batching, location policies, ...

Approaches are either simulation, mathematical programming and analytical models.

A lot of different situations to model …

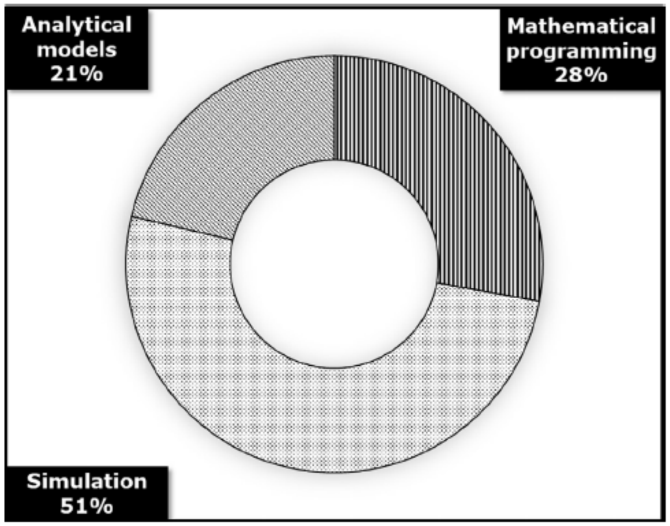


Fig. 4. Research method used to analyze the combination of order picking planning problems.

(Van Gils, 2019)

European Journal of Operational Research 267 (2018) 1–15

Contents lists available at ScienceDirect

European Journal of Operational Research

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Invited Review

Designing efficient order picking systems by combining planning problems: State-of-the-art classification and review

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ARTICLE INFO

Article history:
Received 13 April 2017
Accepted 1 September 2017
Available online 8 September 2017

Keywords:
Logistics
Order picking
Planning problem interactions
Joint optimization
Literature review

ABSTRACT

Warehouses deliver labor-intensive services to customers. Underperformance may result in high costs and unsatisfied customer demand. New market developments force warehouses to handle a large number of orders within tight time windows. To cope with this, order picking operations need to be optimized by solving a wide range of planning problems. Optimizing order picking planning problems sequentially may yield a suboptimal overall warehouse performance. Still, previous warehouse planning reviews focus on individual planning problems. This literature review differs by investigating combinations of multiple order picking planning problems. A state-of-the-art review and classification of the scientific literature investigating combinations of tactical and operational order picking planning problems in picker-to-parts systems is presented with the aim of determining how planning problems are related. Furthermore, this literature review aims to find excellent policy combinations and to provide guidelines how warehouse managers can benefit from combining planning problems, in order to design efficient order picking systems and improve customer service. Combining multiple order picking planning problems results in substantial efficiency benefits, which are required to face new market developments.

Int. J. Production Economics xxx (xxxx) xxx

Contents lists available at ScienceDirect

International Journal of Production Economics

journal homepage: http://www.elsevier.com/locate/ijpe

Review

Order picker routing in warehouses: A systematic literature review

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ARTICLE INFO

Keywords:
Order picking
Order picker routing
Routing policy
Warehousing
Systematic literature review

ABSTRACT

Order picking has often been described as one of the most labor- and time-consuming internal logistics processes. In manual picker-to-parts order picking systems, order pickers often spend a significant amount of time on travelling through the warehouse to reach storage positions where required items are stored. To reduce the cost of order picking, researchers have developed various optimal and heuristic routing policies in the past. This paper presents the results of a systematic review of research on order picker routing. First, it identifies order picker routing policies in a systematic search of the literature and then develops a conceptual framework for categorizing the various policies. Order picker routing policies identified during the literature search are then descriptively analyzed and discussed in light of the developed framework. The paper also derives insights into the frequencies of usage of the different routing policies available in the literature and applies a citation analysis to identify seminal works that shaped the literature on order picker routing. The paper concludes with an outlook on future research opportunities.

Illustration 1:
Manual in-the-aisle orderpicking

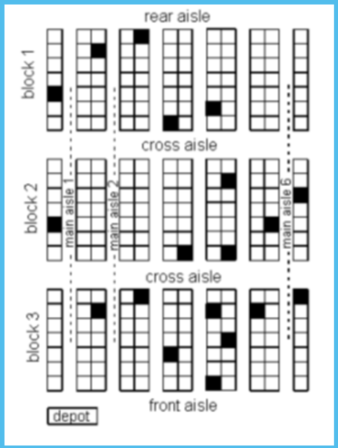


Illustration 2:
Single aisle orderpicking

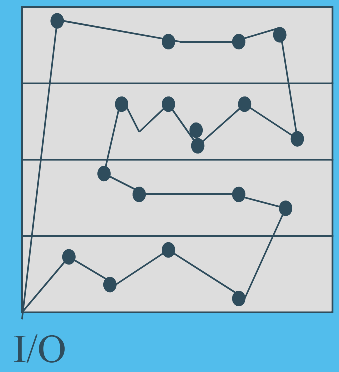


Illustration 3:
S/R machines

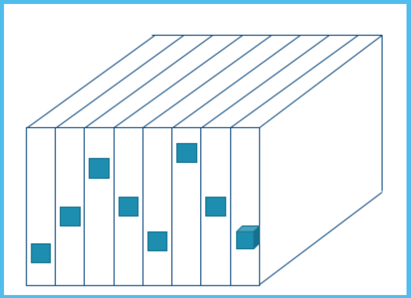
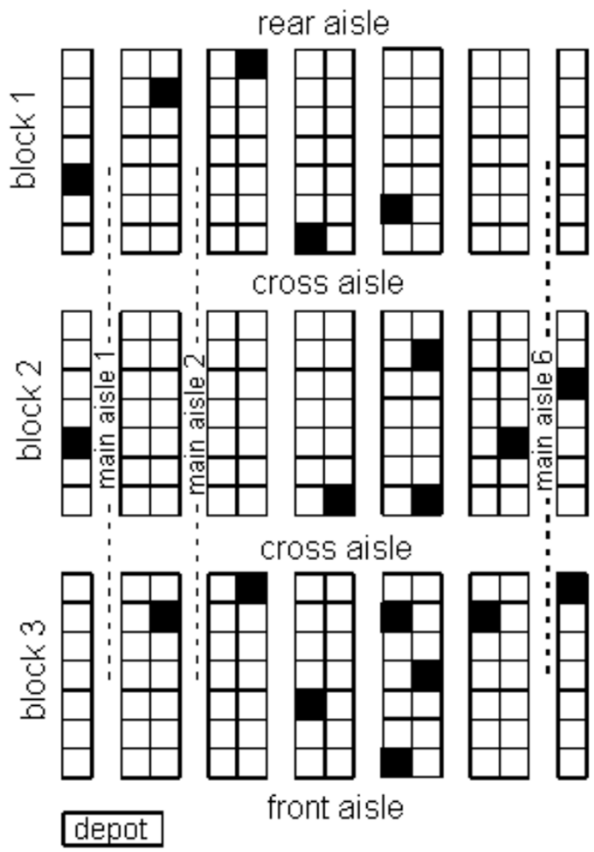


Illustration 1: manual in-aisle-order picking

Situation

- Pickers are used to retrieve items stored in a *rectangular warehouse*.
- The items are stocked in aisles that are *perpendicular* to the front of the warehouse.
- Each picker route includes a *longitudinal component*, in which the picker travels along the front and the back aisles to access the stocking aisles and a *lateral component*, in which the picker travels along the stocking aisles.
- Stocking aisles allow travel *in both directions*, and the picker can, if desired, pick from *both sides* of the aisles in a single pass, i.e. aisle width is "negligible".
- Each route begins and ends at the *P/D point*.

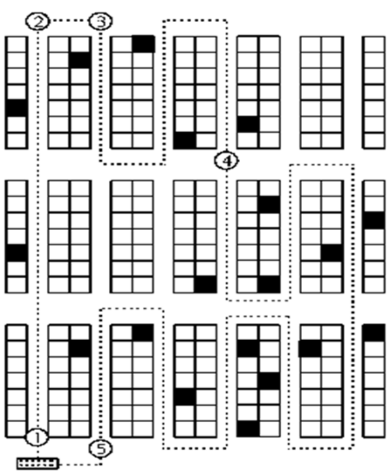
How to solve ?



http://www.roodbergen.com/warehouse

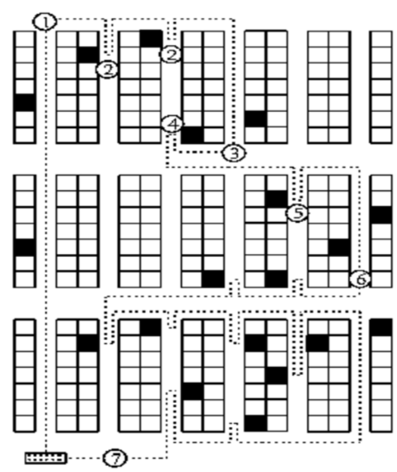
Transveral strategy or S-shape heuristic

The picker enters only those aisles containing picks from one end of the aisle and exits through the other end of the aisle



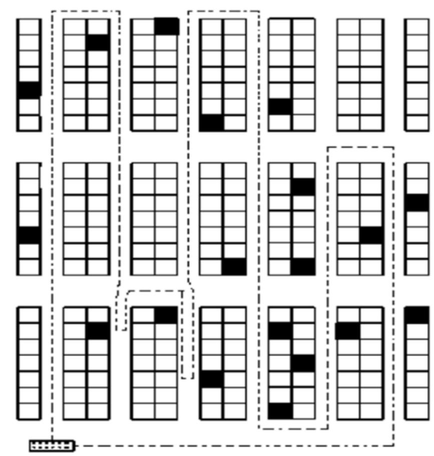
Largest gap or return heuristic

The picker enters an aisle only as far as the start of the largest gap within an aisle. The largest gap represents the separation between any two adjacent picks, or between the first pick and the front aisle or between the last pick and the back aisle. The largest gap within an aisle is therefore the portion of the aisle that the picker does not traverse.

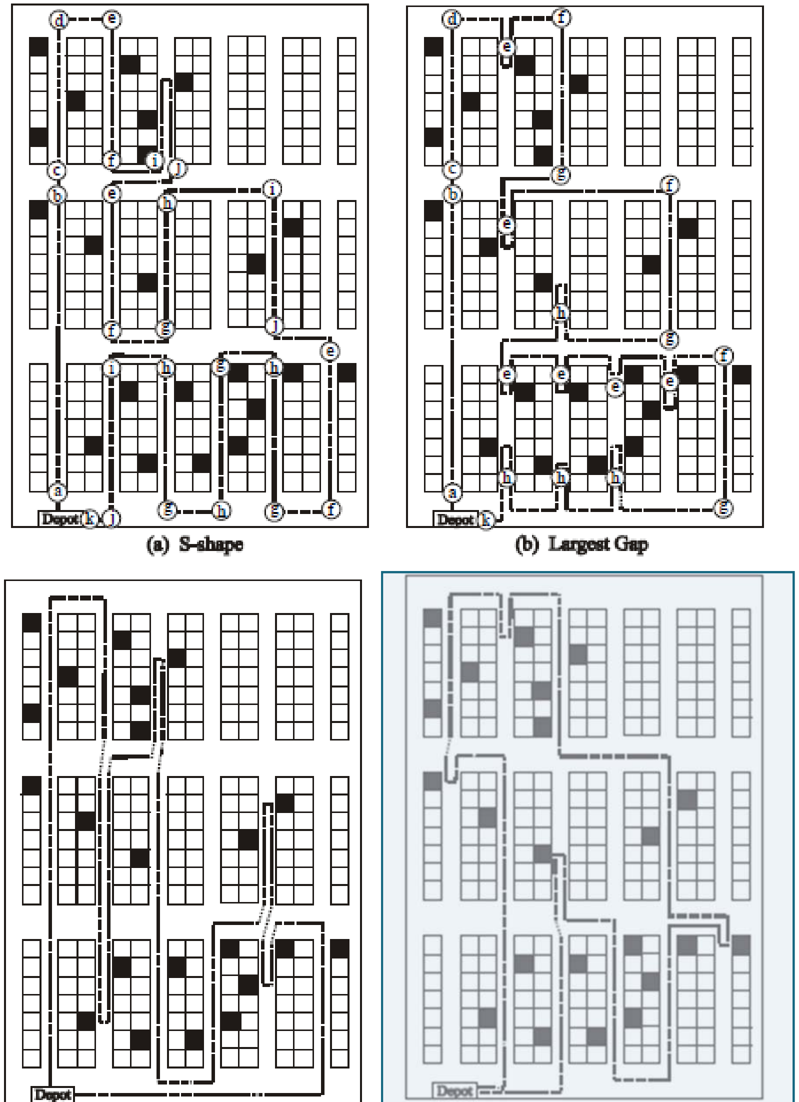


Aisle-by-aisle heuristic

The order pickers starts at the depot and goes to the left most aisle containing items. All items in this main aisle are picked and a cross aisle is chosen to proceed to the next main aisle. Again all items in this main aisle are picked and the order pickers proceeds to the next main aisle. The aisle-by-aisle heuristic determines which cross aisles to use to go from one aisle to the next in such a way that the distances traveled are minimized



Heuristics



(a) S-shape (b) Largest Gap

(c) Aisle-by-aisle (d) Optimal

Optimal

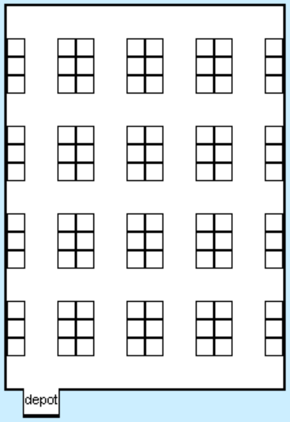
- Set layout
- Create an order
- Create a route
- Routing methods
- Results

Set layout

Fill out this form, then click on "show warehouse".

number of blocks	4
number of aisles	4
number of locations per aisle	3
depot location	1
aisle length (optional)	
crossover length (optional)	

show warehouse



- Set layout
- Create an order
- Create a route
- Routing methods
- Results

Create an order

First type the number of products you would like to pick. Then click on the "set order" button to create a random order.

8 set order

You can also create an order yourself, by clicking on the locations of the warehouse. To clear all locations, click this button:

clear order

- Set layout
- Create an order
- Create a route
- Routing methods
- Results

Routing methods

Click on any of the following buttons to display an order picking route corresponding to that routing method.

Optimal

S-shape

Combined

Largest Gap

Aisle-by-aisle

Combined +

- Set layout
- Create an order
- Create a route
- Routing methods
- Results

Results

route 1	101
route 2	73
route 3	
your best route	73
Optimal	
S-shape	46
Combined	42
Largest Gap	42
Aisle-by-aisle	52
Combined +	40

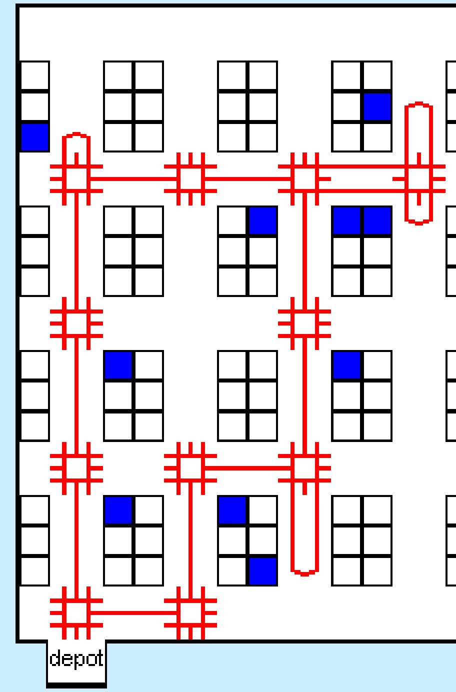


Illustration 2: In-the-aisle order picking (single aisle picking)

Situation

The pickers starts a the *P/D station*, *visits* the appropriate containers in the rack, returns to the *P/D station* and discharges the parts before starting the next trip.

Examples

- walk-and-pick system where each order picker is assigned just one aisle
- person-on-board AS/RS

How to solve ?

The *throughput capacity* of such a system, i.e. the number of picks performed per hour, depends on the expected time it takes to complete one trip.

The *time required per trip* depends on

- travel speed of the S/R machine
- rack size
- rack shape

scale and shape factor !

- time it takes to complete one pick
- time it takes to discharge the parts at the P/D station
- number of containers to be visited
- sequence in which the containers are visited (TSP !)

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The expected time required to travel from the P/D station, make n stops (picks) in the aisle and return to the P/D station can be estimated by

$$E[P, n\ picks, D]$$
$$= T\left[\frac{2n}{n+1} + 0.114703n\sqrt{Q} - 0.074257 - 0.041603n + 0.459289Q^2\right]$$

$$for\ 3 \le n \le 16,\ u\sin g\ \ Chebyshev\ \ metrics$$

Example

Consider a storage rack that is 360 ft long and 60 ft tall. Suppose that the S/R machine travels at a constant speed of 400 fpm and 80 fpm in horizontal and vertical direction, resp. Further suppose that 10 stops are made during each order picking trip.

Compute **E[P,n,D]**

(answer: 2.4245 min)

Compute the **maximum throughput** if it takes the picker on average 15 sec to pick one or more items from each container and if, between successive picks, he/she spends 1.2 min at the P/D station (to discharge the parts picked and to prepare for the next trip)

(answer: 98 picks/hour)

Solution

$n=10$

$h_v=400$ fpm, $L=360$ ft, $v_v=80$ fpm, $H=60$ ft

$t_h=360/400=0.9$ min, $t_v=60/80=0.75$ min

$T=\max(t_h,t_v)=\max(0.90,0.75)=0.90$ min

$Q=\min(t_h/T,t_v/T)=\min(0.9/0.9,0.75/0.9)=0.8333$

E[P,n,D]=**2.4245 min**

total approximate time to complete a trip is given by

2.4 min + 10 picks*(15 sec/60(sec/min)) + 1.2 min = 6.1 min

and 6.1 min for 10 picks,

1 min for 10/6.1 picks

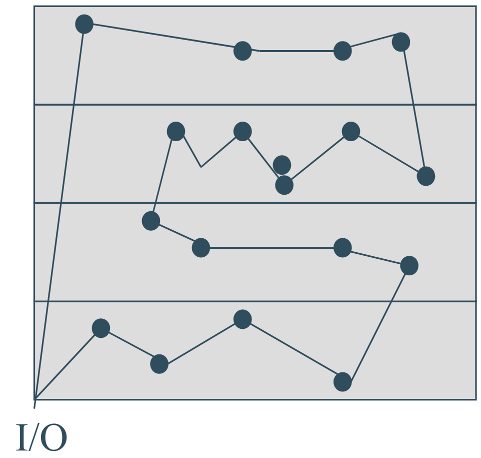
and 60*10/6.1 picks in one hour = **98 picks/h**

Optimum sequencing the pick points

Heavy computational burden, even if **number of picks per trip is relatively small (<20-24)** – reason: Chebyshev metric

Heuristics exist; e.g. *“**band heuristic**”:*

- The rack is divided into *k equal-sized horizontal bands*, where k is an even number.
- Starting with the first band, the S/R machine travels in a serpentine fashion, picking sequentially along the x-axis.
- Note that the S/R machine completes all the picks in the current band before proceeding to the next.
- Variations in the determination of the bands may exist.



Zigzagging effect

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Using the band heuristic, it is shown that the expected time required to perform n picks, that are randomly and uniformly distributed over the rack, can be approximated as follows

$$E[P, n\ picks, D] = E[k, n, T, Q] = T\left[2kA + kB(n-1) + \frac{k-1}{k}Q\right]$$

where k is the number of bands,

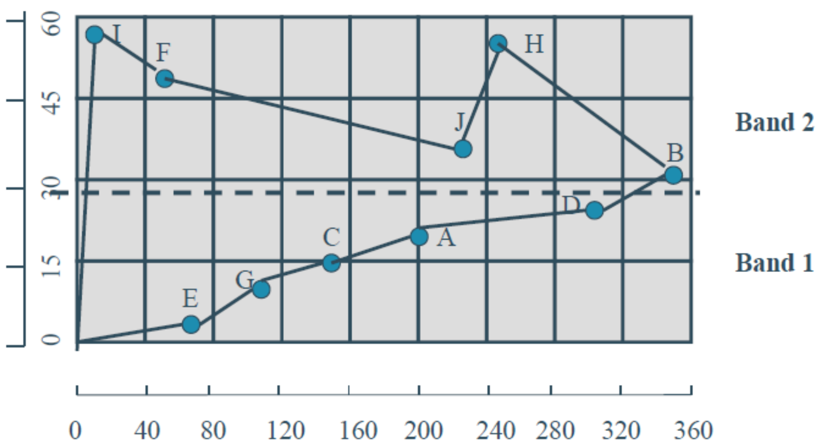
and

$$A = \frac{C}{2} + \frac{1-(1-C)^{n+2}}{C(n+1)(n+2)}$$

$$B = \frac{C}{3} + \frac{2nC + 6C - 2 + 2(1-C)^{n+3}}{C^2(n+1)(n+2)(n+3)}$$

$$C = \frac{Q}{k^2}$$

Example



For k = 2, and recalling that T=0.90 min, Q=0.8333 and n=10 picks/tour, we obtain

C=0.2083

B=0.1166

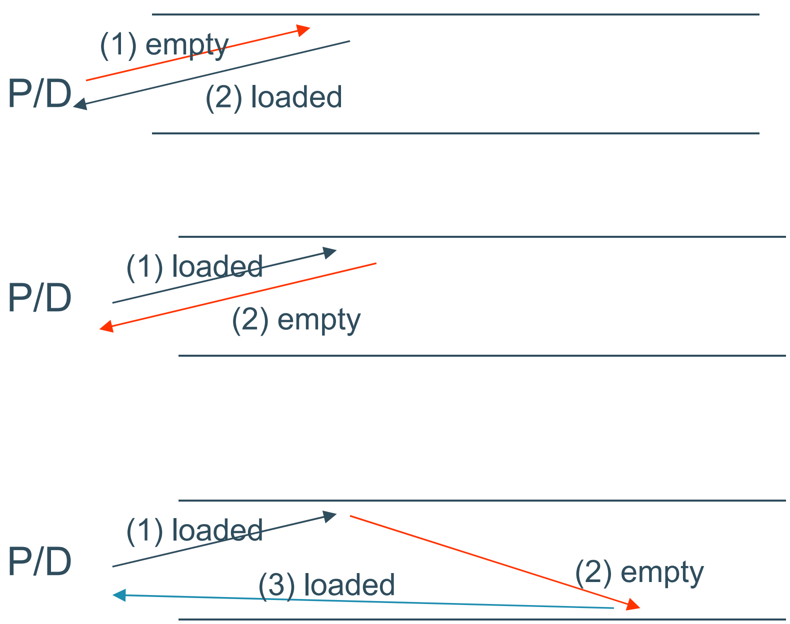
A=0.1383

E[k,n,T,Q]=**2.7617 min**

Comparing the 2.7617 min of the band heuristic with the previously computed 2.4245 min, it seems that using the band heuristic instead of the “optimum” method will reduce throughput capacity with about 14 %. **Discuss.**

Illustration 3: S/R machines

Cycle types



Single command retrieval

Single command storage

Dual command

Notation

E[SC] = expected travel time for single command cycle

E[TB] = expected travel time from storage location to the retrieval location during a dual command cycle

E[DC] = expected travel time for a dual command cycle

L = rack length (ft)

H = rack height (ft)

h_v = horizontal velocity of the S/R machine (ft/min)

v_v = vertical velocity of the S/R machine (ft/min)

t_h = time required to travel horizontally from the P/D station to the *furthest* location in the aisle, $t_h = L/h_v$ (min)

t_v = time required to travel vertically from the P/D station to the *furthest* location in the aisle, $t_v = H/v_v$ (min)

In order to determine the expected travel times in a compact form, we first "normalize" the rack by dividing its *shorter (in time)* side by its *longer (in time)* side.

$T=\max(t_h,t_v)$

scaling factor

i.e. the longer-in-time side of the rack

$Q=\min(t_h/T,t_v/T)$

shape factor

i.e. the ratio of the shorter-in-time to the longer-in- time side of the rack

Note that a normalized rack is Q units long in one direction and 1 unit long in the other direction, where $0<Q\leq 1$.

If Q=1, the rack is said to be "***square-in-time***" (SIT).

Formulas

Assuming *randomized storage*, an *end-of-aisle P/D station* located at the *lower left-hand corner* of the rack, *constant horizontal and vertical S/R machine velocities* (i.e. no acceleration or deceleration taken into account), a *continuous approximation* of the storage rack (which is sufficiently accurate) and *Chebyshev distance measures*, the expected travel time for the S/R machine are given as:

$$E[SC] = T\left[1 + \frac{Q^2}{3}\right]$$

$$E[TB] = \frac{T}{30}\left[10 + 5Q^2 - Q^3\right]$$

$$E[DC] = E[SC] + E[TB] = \frac{T}{30}\left[40 + 15Q^2 - Q^3\right]$$

It can be shown that E[SC] and E[TB] are minimized at Q=1; i.e. given a rack with a fixed area (but variable dimensions), the expected single and dual command travel times are minimized when the rack is SIT.

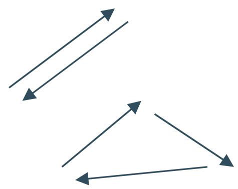
The expected total cycle time for the S/R machine is obtained by adding load handling time to the expected travel time. Let

TSC = expected single command cycle time

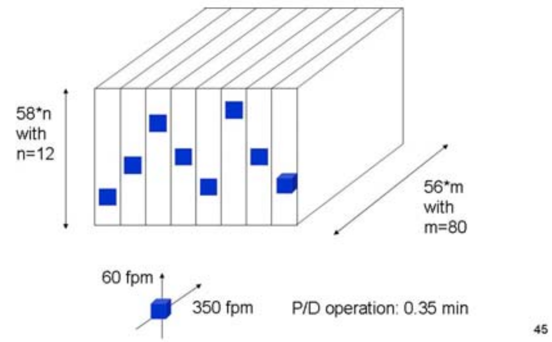
TDC = expected dual command cylce time

TP/D = time required to either pickup or deposit the load

$$T_{SC} = E[SC] + 2T_{P/D}$$
$$T_{DC} = E[DC] + 4T_{P/D}$$



Seen the assumptions taken here and the complexity of real life situations, in practice these estimations are “refined’ using <u>simulation.</u>



Exercise

Consider a warehouse with 8 aisles, a S/R machine for each aisle. Assume the S/R requires 0.35 min to perform a P/D operation, travels horizontally at an average speed of 350 fpm and travels vertically at an average speed of 60 fpm. The dimensions (inches) of the storage racks are 56 m (length) by 58 n (height), where m is the number of horizontal storage positions or addresses (length) and n is the number of vertical storage positions (height).

Determine the **average cycle time per operation** for both a single and a dual command cycle for m=80 and n=12.

Answer: 2.06 min (single); 1.615 min (dual)

Suppose 40% of the storages and 40% of the retrievals are performed as single command operations; the remaining are performed as dual command operations. If 120 storages per hour and 120 retrievals per hour are to be handled by the AS/RS, what will be the **percentage utilization of the S/R machines** ?

Answer: 89.65 %

Solution

the rack dimensions are

$L=56*m/12=56*80/12= 373.33$ ft

$H=58*n/12=58*12/12= 58$ ft

the travel times are

$t_h=L/h_v=373.33/350=1.067$ min

$t_v=H/v_v=58/60\ 0.967$ min

thus

$T=\max(t_h,t_v)=\max(1.067;0.967)=1.067$ min

$Q=\min(t_h/T,t_v/T)=\min(1.067/1.067,0.967/1.067)=0.967/1.067=0.906$

the single command cycle time

$T_{SC}=T(1+Q^2/3)+2T_{P/D}=1.067*[1+(0.906)^2/3]+2*0.35$

$\mathbf{T_{SC}=2.06\ min}$

the dual command cycle time

$T_{DC}=(T/30)*(40+15Q^2-Q^3)+4T_{P/D}$

$=((1.067)/30)*[40+15*(0.906)^2-(0.906)^3]+4*0.335$

$\mathbf{T_{DC}=3.23\ min}$

thus, the average cycle time per operation is <u>2.06 min</u> with a single command cycle (1 operation per cycle) and <u>1.615 min</u> with a dual command cycle (2 operations per cycle).

(1 ft = 12 inches)

Case studies

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C1:
CPI-MRO

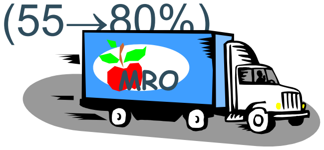
C2:
DC sporting goods

C3
XYZ company

C4: e-conveyors

C1: Batch picking in a MRO store

- setting
  - MRO store in CPI
  - 30000 SKU, 8000 issues/month
  - 8 warehouse employees
  - orders
    - picked up by maintenance worker (45%)
    - delivered on MRO tour (55%)
- project
  - improve warehouse operations (i.e. order picking)
  - э from pick-up ↓ (45 →20%) and delivery ↑ (55→80%)



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analysis

- issues
  - request arrival patterns (peak loads !)
  - “due: ___”: not filled out
- picking
  - 67 % of requests have 1 order line, 18 % 2 order lines, …
- “tour”
  - no priority system
  - fixed tour (45 min)
  - customer waiting time between request (web) and delivery: 10-32-180 min (expected 15 min)

improvements

- warehouse organization & procedures
  - FMI-NMI-SMI zones
  - special equipment (cutting, manipulating, …)
  - priority system
- stimulating “tour” option
  - shorter routes, second truck, …
  - load sequence
- balancing picking time and tour time
  - function(batch size)

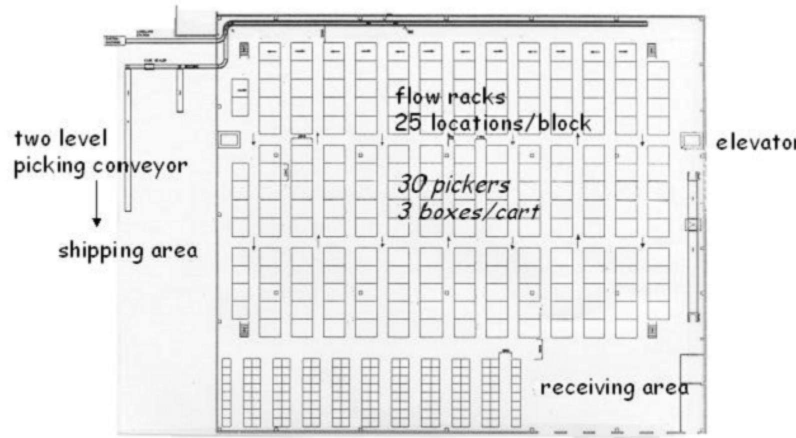
C2: Order picking in a sportswear

situation at hand

- DC for sporting goods
- WMS recently installed

project

- efficiency order picking algorithm



analysis

- cart with "computer" on-board
- fixed walking direction in aisles
- waiting times at elevator: stochastic
- new picking routes starts at conveyor, where boxes from current picking route are dropped off
- routing heuristic: snake (S-shaped)

approach

- consider only first floor
- heuristic vs unidirectional TSP and vs TSP without direction constraint
- test sets of representative orders

question asked *our suggestion*

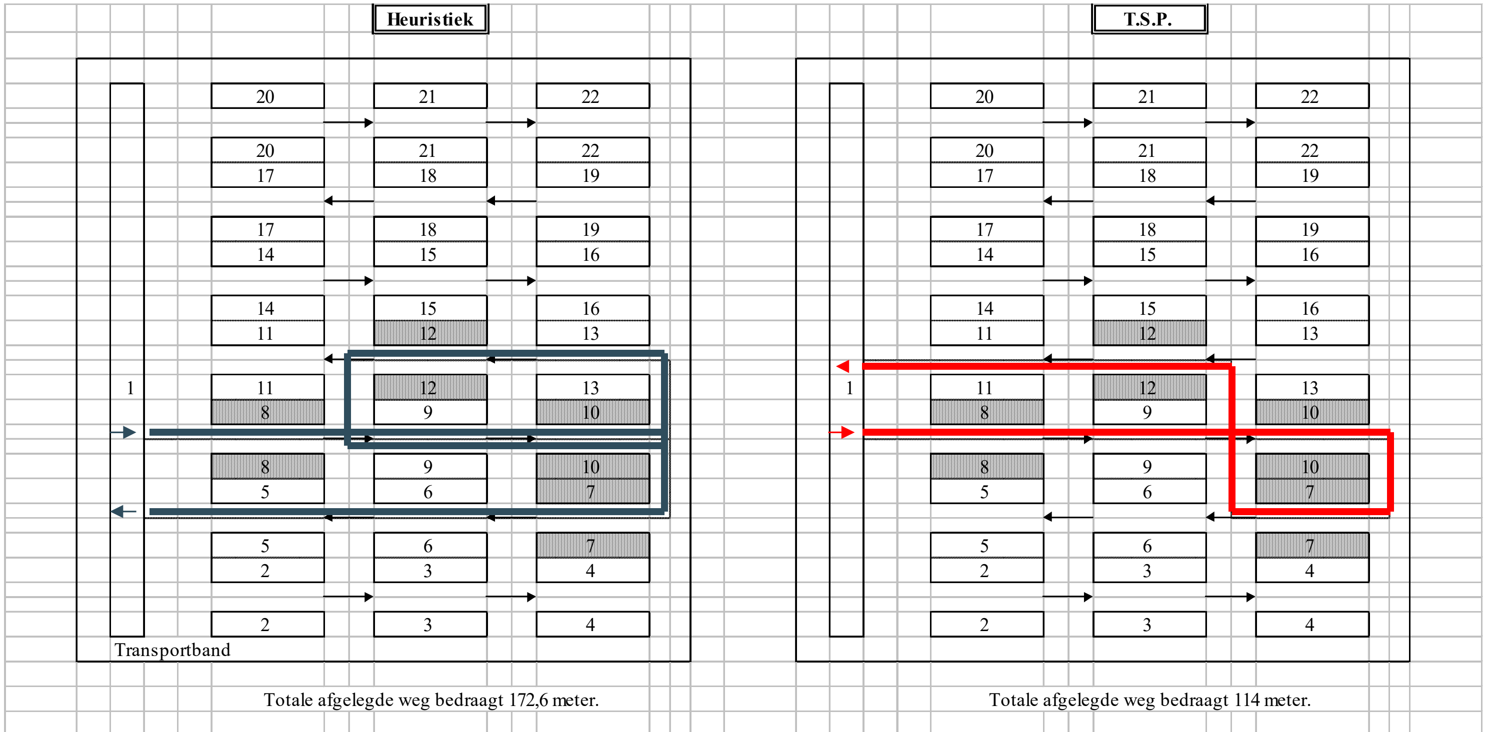
performance results

Ratio of distances traveled for snake heuristic (**S**,) TSP with (**TSP1)**, TSP without (**TSP2)**

Results (averages)

	S/TSP2	S/TSP1	TSP1/TSP2
global average	140%	109%	129 %

The S heuristic generates the optimal solution in 67 % of the cases;
the average overall deviation from the optimum (with direction constraint) is 9%.
For the non-optimal solutions the average deviation is 19 %, and a few cases with a deviation between 30% and 51% have been found.



Figuur 4 : Voorbeeld van het verschil tussen de heuristiek en TSP

This case study is based on real life data (MMH). The situation is simplified in order to allow some quick, rough computations. The objective is to illustrate the problem complexity of order picking optimization and its interrelationships with aspects as layout, storage, replenishment, material handling, etc.

C3: XYZ company

Situation

XYZ is a major **distributor** and retailer of active and casual apparel, sporting goods, and wares for home and camp use.

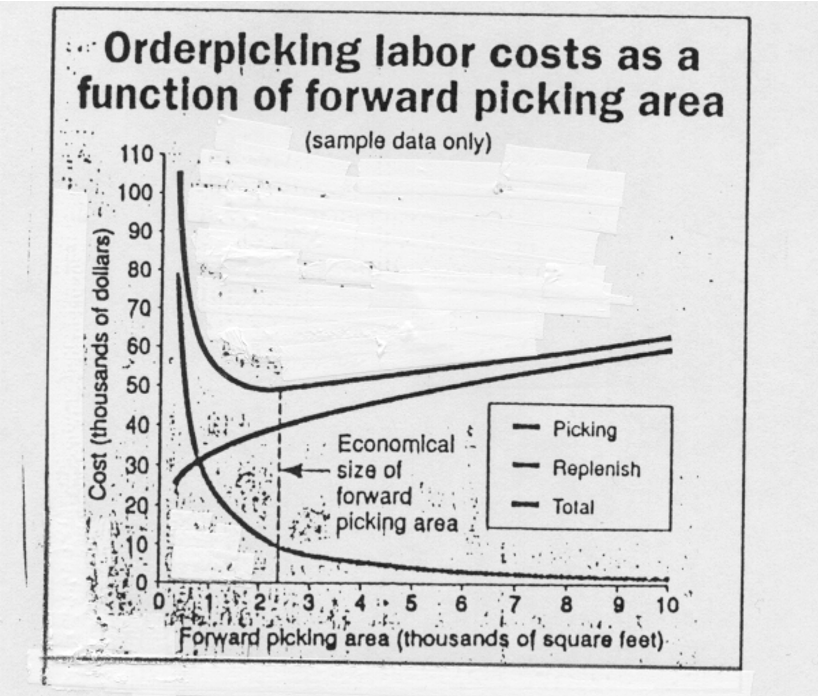
At XYZ, 1.25 million **orders** for 2.5 million **items** generated approximately $50 million in annual sales last year. The company is experiencing 5% annual **growth** in sales and 2% annual growth in the number of stock keeping units (SKUs) handled.

The company currently handles 5000 unique **SKUs**, which are housed in a 45000 sq.-ft **distribution center**. Two thirds of the total area is available for **forward picking** and **reserve storage**. To conserve space in the reserve area and to minimize congestion in the forward picking area, a **random storage policy** is employed throughout the facility.

Currently, the reserve storage and forward picking areas are of equal **size**. The reserve storage **consists** of automated storage and retrieval in several narrow aisles. The forward picking area consists of bin shelving and flow racks. Each of the 5000 SKUs is allocated enough **space** in the forward picking area to house 20 units. All 2.5 million **picks** (per year) currently take place in the forward picking area.

A **Pareto <u>analysis</u>** determined that 85% of all picks can be completed with 15% of the SKUs. During each picking **tour**, an order picker completes between 20 and 30 orders, consisting of an average of 2 line items each. Based on the current size of the forward picking area, each **line item pick** requires approximately 1 minute. A line item pick from the reserve area requires approximately 2 minutes. A line item **replenishment** from the forward area to the reserve area requires approximately 4 minutes. Labor **costs** are approximately $15/hour per employee.

After reviewing its current operations, XYZ believed it could cut labor costs and improve efficiently significantly by **<u>reorganizing</u>** its warehouse and reallocating the amount of stock housed in the forward and reserve areas. However, it was not sure what stock should go into the forward area or how much space should be allocated for it. Results of a **preliminary study** are shown in the graph below. XYZ discovered also that in a walk and pick system such as its forward picking system, the travel distance of the pickers is proportional to the square root of the warehouse area.



QUESTIONS

What **size** for the forward picking area will minimize labor costs? What will be the annual expected **savings** ?

What **other changes** should XYZ consider to increase the efficiency and effectiveness of its order picking operation?

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C4: e-conveyors

"Eaches at web speed"

Dot.coms orders: items are small in size, "**eaches**" (relatively small number of items per order, 1-6 items per carton, 1 carton per customer) - cfr old catalog companies

Large volume of orders

Speed is a must

Three basic choices

build new facility - retrofit old facility - contract with 3PL

e-considerations

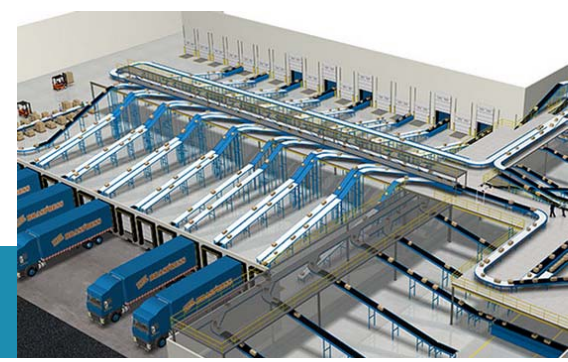
Systems must be **flexible** to ship a wide range of products

Right-sizing systems to reflect actual volume is crucial , but often little or no hard information available

Rate shopping can save on shipping

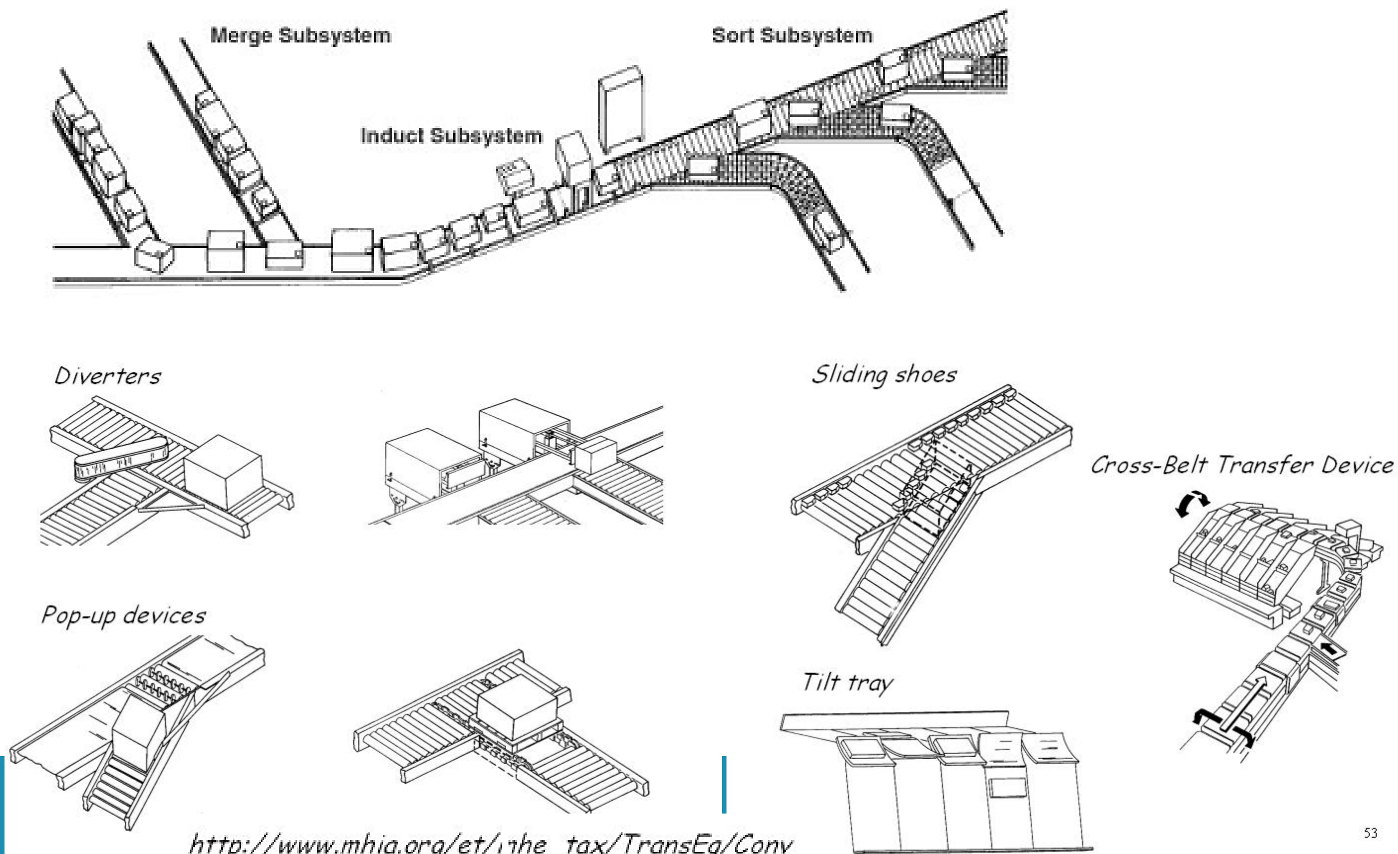
Hybrid materials handling systems often work best

Customer acquisition costs are higher than with traditional retailers



conveyors
- roller, belt, slider bed, accumulating, modular
- high-speed conveying of light-to medium weight products

sorter choices
- speed & volume - automation - dock flexibility
- small-to-medium size companies: pop-up wheel, pop-up belt, push diverters, right angle
- larger facilities: sliding shoe, tilt tray, cross belt



Trends

Linked with trends in material handling & warehousing

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Discussion example

Pros – cons ?

Supporting technology

"traditional"	RF Scanning	Visual Logistics	Pick to Light	Voice Technology
Productivity Speed	★★	★★★	★★★★★	★★★★
Accuracy	★★★	★★★★★	★★★★	★★★★★
Data Capture Capability	★★★★★	★★★★★	★	★
Flexible Multi-Functional Capability	★★★★★	★★★★★	★★	★★
Hands Free	★	★	★★★★	★★★★★
System Cost	★★★★★	★★★★★	★★	★★★

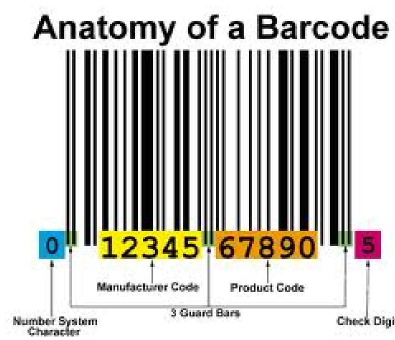

RFID


Pick-to-light


Visual logistics

Voice (directed) picking


LibBest Library RFID Management System
Shelf Management
Check in/out Service
Self Check in/out
Book Drop
Tagging
Anti-Theft Detection


Anatomy of a Barcode
0
12345
67890
5
Manufacturer Code
Product Code
3 Guard Bars
Number System Character
Check Digit

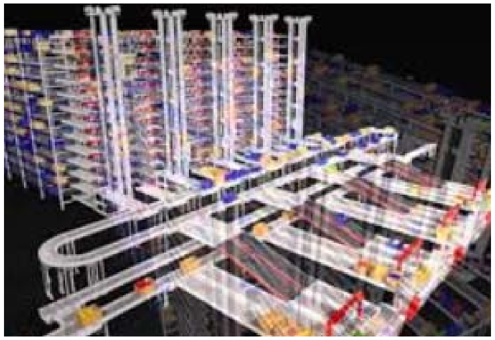
“newer”

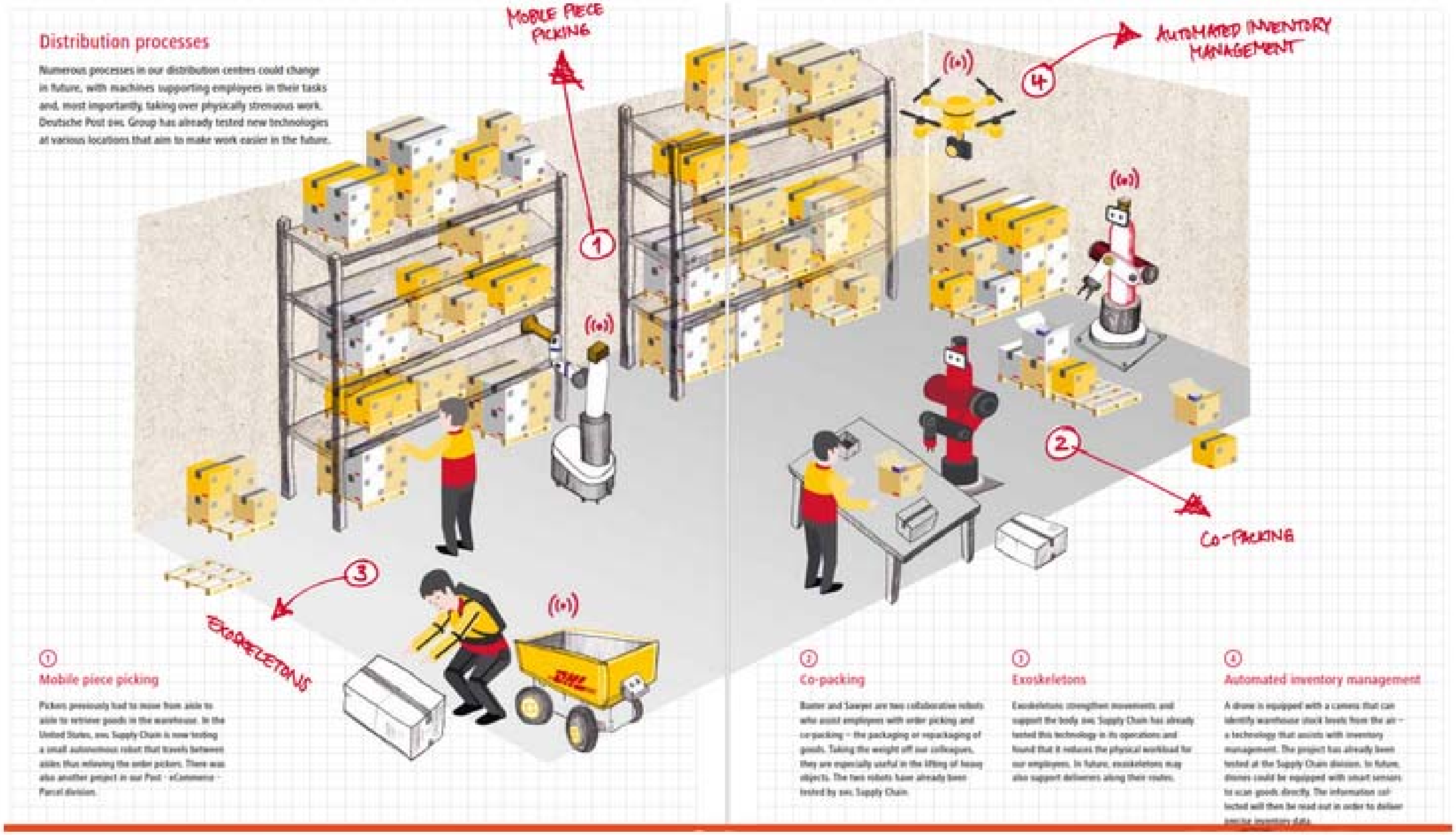
With the assistance of smart glasses

In 2015, DHL tested the use of smart glasses and augmented reality for the first time at a distribution centre in the Netherlands. Wearing the glasses, pickers see information that tells them what to do next. This can accelerate the picking process and reduce errors.

Vision-assisted picking

Automation areas





Distribution processes

Numerous processes in our distribution centres could change in future, with machines supporting employees in their tasks and, most importantly, taking over physically strenuous work. Deutsche Post DHL Group has already tested new technologies at various locations that aim to make work easier in the future.

1
Mobile piece picking

Pickers previously had to move from aisle to aisle to retrieve goods in the warehouse. In the United States, DHL Supply Chain is now testing a small autonomous robot that travels between aisles thus relieving the order pickers. There was also another project in our Post - eCommerce - Parcel division.

2
Co-packing

Baxter and Sawyer are two collaborative robots who assist employees with order picking and co-packing – the packaging or repackaging of goods. Taking the weight off our colleagues, they are especially useful in the lifting of heavy objects. The two robots have already been tested by DHL Supply Chain.

3
Exoskeletons

Exoskeletons strengthen movements and support the body. DHL Supply Chain has already tested this technology in its operations and found that it reduces the physical workload for our employees. In future, exoskeletons may also support deliverers along their routes.

4
Automated inventory management

A drone is equipped with a camera that can identify warehouse stock levels from the air – a technology that assists with inventory management. The project has already been tested at the Supply Chain division. In future, drones could be equipped with smart sensors to scan goods directly. The information collected will then be read out in order to deliver precise inventory data.

Wrap-up

Important issues

What is order picking about? What types are there around? What is the terminology used?

What do order picking algorithms try to accomplish?

Challenges? Supporting technology?

"It was someone from corporate's idea to improve our inventory turns."