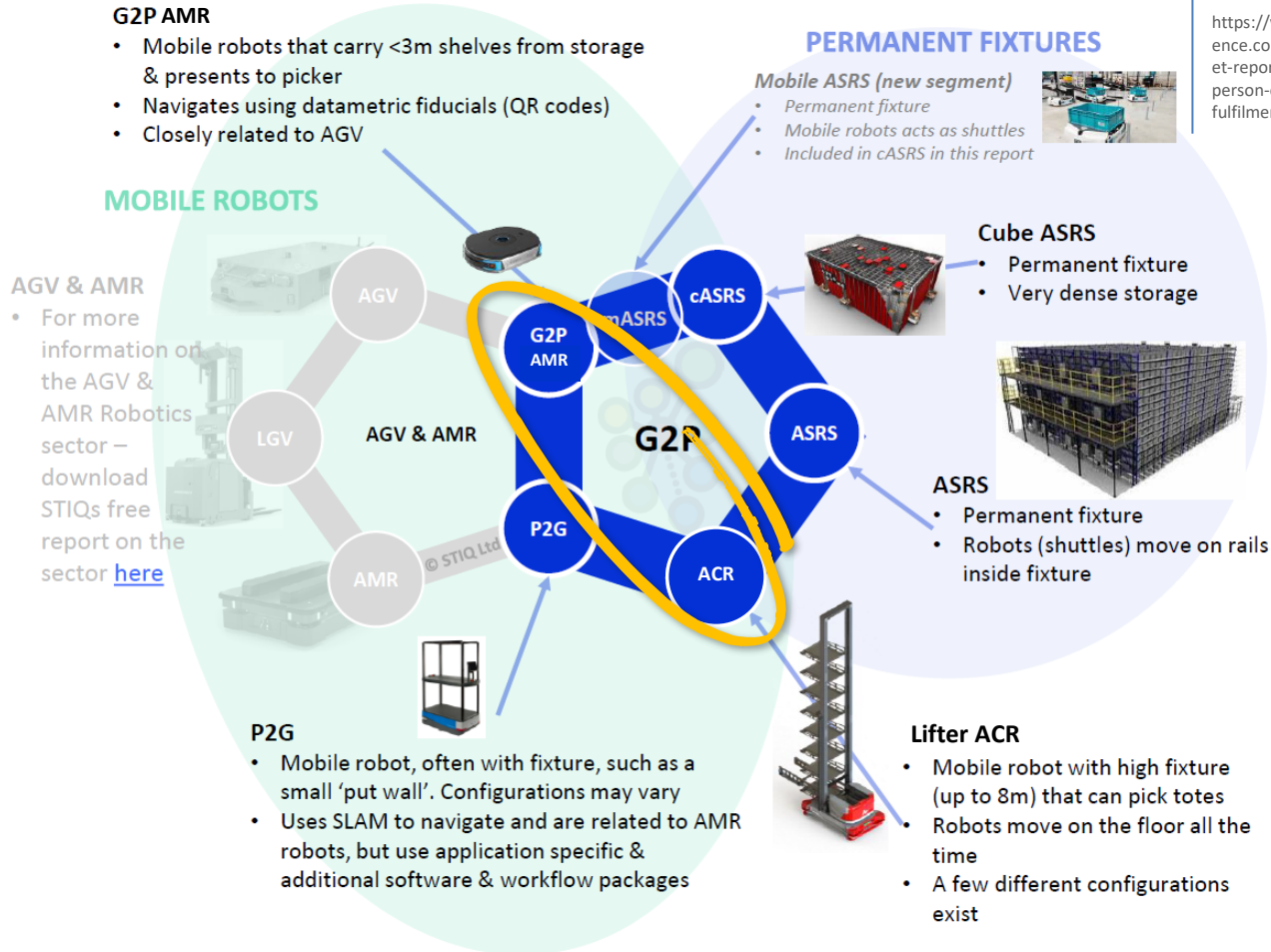# Popularity AMR's to great Heights

Hits and Fits of G2P mobile Robotics

Intro G2P mobile robotics framework

Introduction

- The topic within this presentation is G2P (Goods-to-Persons) mobile robotics
- Scope is mainly storage and retreival within e-commerce applications

- In a sequential presentation we will focus on ''pallet''handling and internal transport applications within the mobile robotics domain

G2P AMR
- Mobile robots that carry <3m shelves from storage & presents to picker
- Navigates using datametric fiducials (QR codes)
- Closely related to AGV

MOBILE ROBOTS

AGV & AMR
- For more information on the AGV & AMR Robotics sector – download STIQs free report on the sector here

PERMANENT FIXTURES

Mobile ASRS (new segment)
- *Permanent fixture*
- *Mobile robots acts as shuttles*
- *Included in cASRS in this report*

Cube ASRS
- Permanent fixture
- Very dense storage

ASRS
- Permanent fixture
- Robots (shuttles) move on rails inside fixture

P2G
- Mobile robot, often with fixture, such as a small 'put wall'. Configurations may vary
- Uses SLAM to navigate and are related to AMR robots, but use application specific & additional software & workflow packages

Lifter ACR
- Mobile robot with high fixture (up to 8m) that can pick totes
- Robots move on the floor all the time
- A few different configurations exist

Intro G2P mobile robotics framework

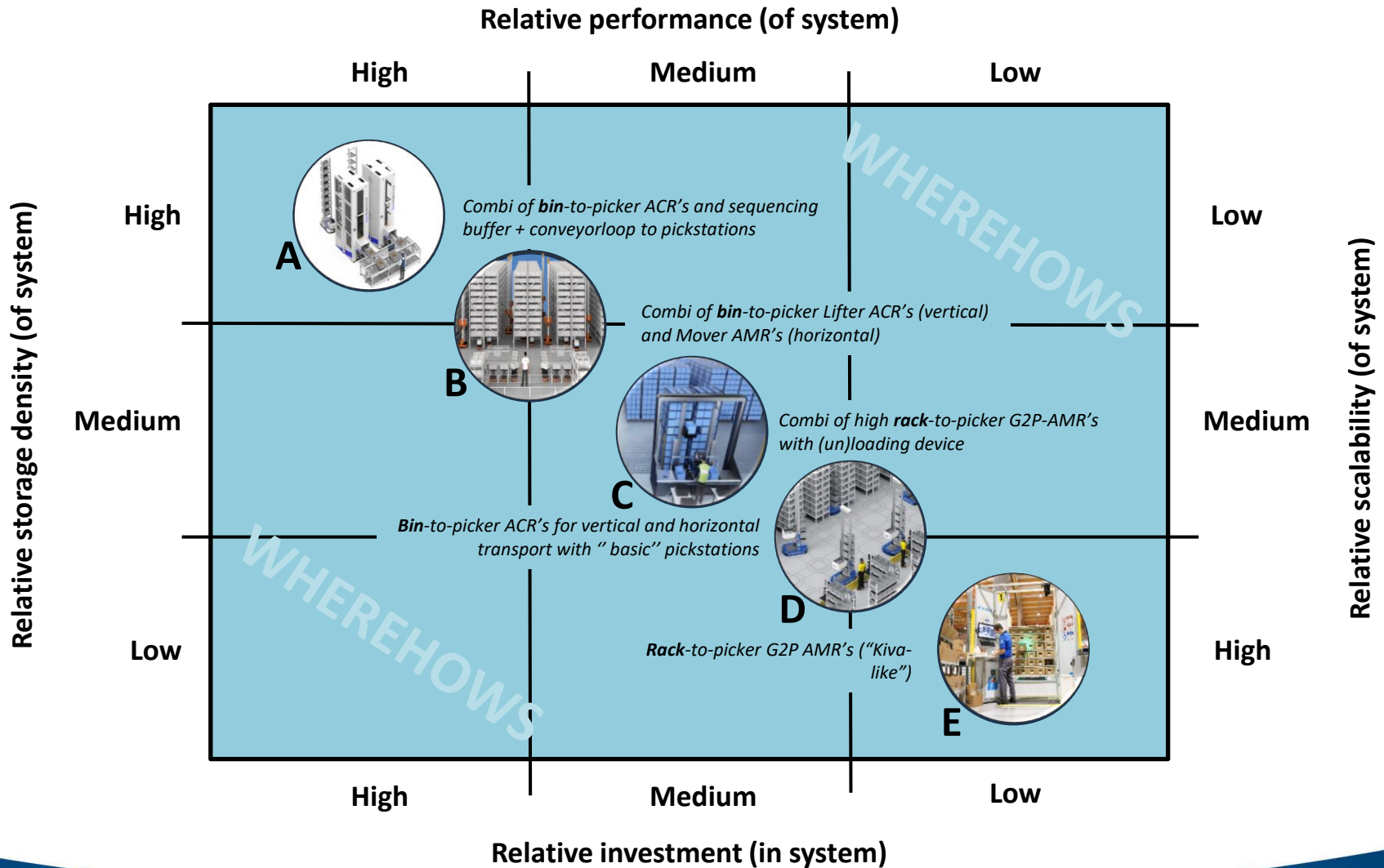HIGHLY SIMPLIFIED E-COMMERCE G2P SOLUTIONS THROUGHPUT VS COST

- Pick from top
- Pick from side
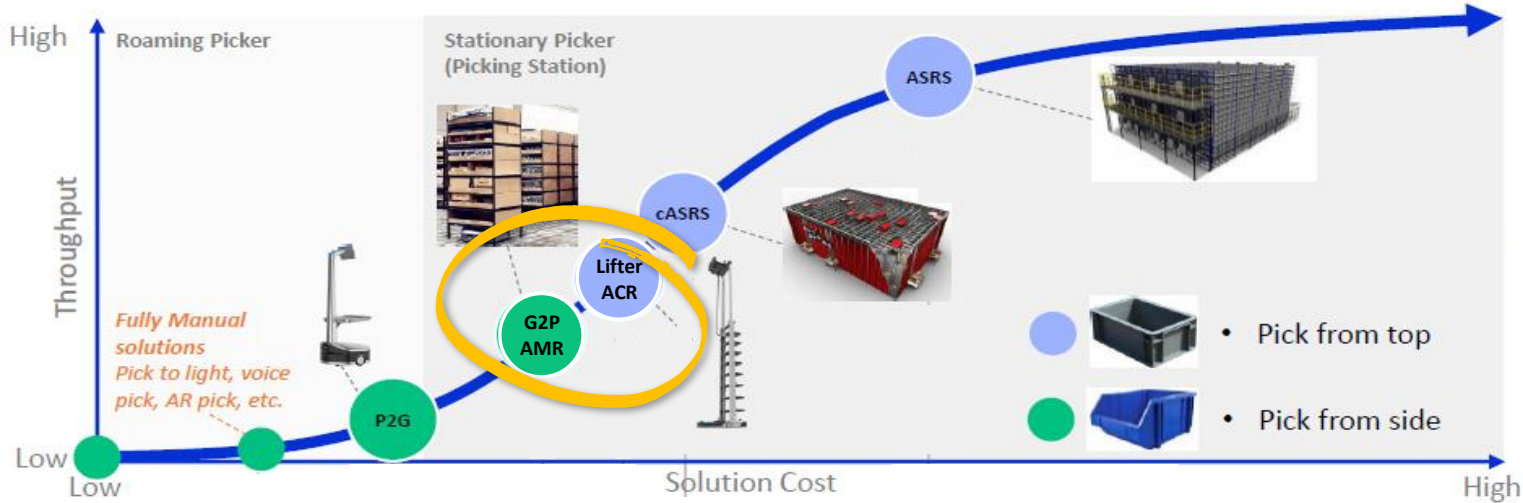
Abbreviations and terminology

- In this presentation we talk about Lifter ACR, Mover AMR and G2P-AMR
- During the last couple of years there have been quite some new solutions on the market, both on individual basis aswell as part of integrated combined applications
- Terminology and/or abbreviations change or are being used in different ways over the years and currently aswell
- As mentioned the terminology we use is comparable with:
  - Lifter ACR = AMR-Shuttle = Bin-to-Picker solution
  - Mover AMR = AMR = Bin-to-Picker (as part of a total solution in combination with Lifter ACR)
  - G2P-AMR = Rack-to-Picker solution

Mover AMR

Lifter ACR

G2P- AMR

Primairy system indicators 5 solutions

Relative performance (of system)

High — Medium — Low

Relative storage density (of system)

High — Medium — Low

Relative scalability (of system)

Low — Medium — High

Relative investment (in system)

High — Medium — Low

A

Combi of **bin**-to-picker ACR's and sequencing buffer + conveyorloop to pickstations

B

Combi of **bin**-to-picker Lifter ACR's (vertical) and Mover AMR's (horizontal)

C

Combi of high **rack**-to-picker G2P-AMR's with (un)loading device

Bin-to-picker ACR's for vertical and horizontal transport with '' basic'' pickstations

D

Rack-to-picker G2P AMR's ("Kiva-like")

E

ACR/AMR solutions compared

	A	B	C	D	E*
Solution type ACR and/or AMR	ACR's combined with sequencing buffer and conveyor	Combi of Lifter ACR's & Mover AMR's	High Rack G2P-AMR's combined with (un)loading device	Standard ACR's (=AMR-Shuttle)	Standard G2P-AMR's (Kiva-like)
Suppliers E*) Many suppliers, only few mentioned	HAI ROBOTICS	Mushiny, Geek+, Quicktron, HAI ROBOTICS, HIKROBOT	Geek+, Mushiny	HAI ROBOTICS, Quicktron, Mushiny, Geek+, HIKROBOT	Scallog, Quicktron, Geek+, GreyOrange
Pickface (top/side)	Top	Top	Top	Top	Side
Loadtype (bins/loose)	Bins	Bins	Bins	Bins	Loose
Technical maturity	🟡	🟢	🟡	🟢	🟢(dark)
Weight balance (within bin / rack)	🟢	🟢	🟡	🟢	🔴
ABC-sensitivity	🟢	🟢(dark)	🟡	🟢	🔴
Workload balancing	🟡	🟢(dark)	🔴	🟢	🟡
Pickstation sequencing	🟢	🟢(dark)	🔴	🟡	🟡
Required free height (m)	6-10	6-10	<4	4-6	<4
Use of additional height (mezza's)	N.A.	N.A.	Possible	Possible	Possible
Putaway efficiency	🟢(dark)	🟢	🔴	🟢	🟡
Inbound preparation	🟢	🟡	🟡	🔴	🟡
Picking ergonomics	🟢(dark)	🟢	🟡	🔴	🔴
Process control	🟢	🟡	🟡	🟢(dark)	🟡

WHEREHOWS
WHERE TO STORE, HOW TO HANDLE

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Solution A

Combi of bin-to-picker Lifter ACR's and sequencing buffer + conveyorloop to pickstations

Process
- Lifter ACR picks multiple bins from multiple racklocations (picture 1)
- Lifter ACR moves to sequencing buffer and stores all bins (max 9) simultaneously in the buffer (picture 2)
- Bins are retreived from the buffer in sequence towards (multiple) pickstations by a conveyorloop (picture 3)
- After picking bins are transported to sequencing buffer
- Lifter ACR retreives all bins in buffer (max 9) simultaneously
- Lifter ACR stores bins one by one in storage locations

System benefits
- Inbound preparation relatively easy to integate by use of conveyorloop (no loss of capacity at pickports)
- By using sequencing buffer for multiple pickstations Lifter ACR's can be used more efficiently (zone-picking)

Question marks
- High investment in sequencing buffers and conveyorloop required for productivity improvement
- Non-logical concept as free-moving ACR's are combined with static conveyors

Solution B

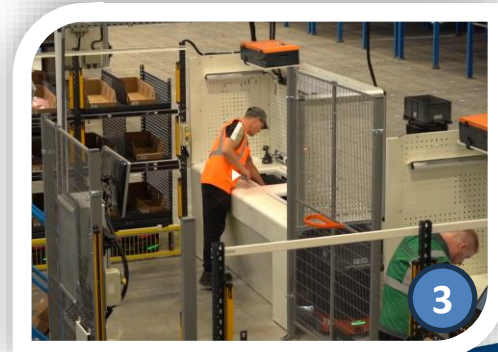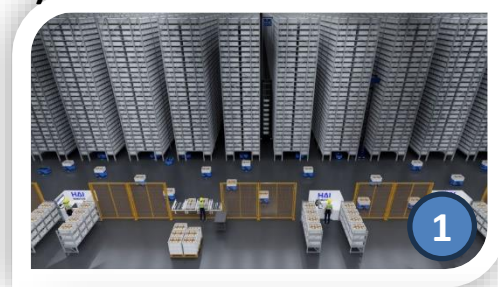## Combi of bin-to-picker Lifter ACR's (vertical) and Mover AMR's (horizontal)

Process
- Lifter ACR picks bin from rack (up to appr. 9 meters high) (picture 1)
- Bins are buffered at lowest level in rack (cantilever-like position) (picture 2)
- This can either be done immediately after picking the bin from the rack or the Lifter ACR picks multiple bins before putting these in different buffer positions at lowest level
- Mover AMR picks up bin, transports bin to pickstation and pushes bin to desirable (ergonomic) height (picture 3)
- After picking the Mover AMR transports the bin back towards a buffer position in the rack
- Lifter ACR will move the bin into a storage position at an efficient moment

System benefits
- Received goods direct into system (avoid replenishment)
- Efficient; relatively time consuming vertical process decoupled from fast horizontal transport process
- Easy in sequence delivery of bins to pickstations and continous flow
- Short waiting-time at pickstation (just one bin)

Question marks
- More complex flow control as Lifter ACR's and Mover ACR's work together

Solution B (add-on)

Combi of bin-to-picker Lifter ACR's (vertical) and Mover AMR's (horizontal)

Update per October 1st 2023

- HAI ROBOTICS presented yesterday their latest innovation, the HaiPick System3..........and at first sight it's mainly focused on higher storage density, as bins are stacked up to 10 meters and multi-deep up to 5 bins deep.
  By using the innovative chainpick technology, put/pick productivity has increased substantially aswell!!!
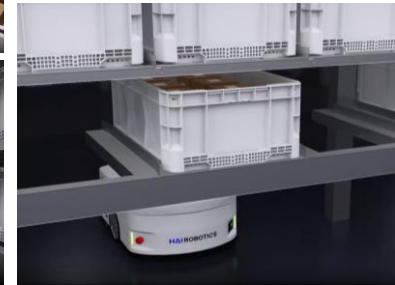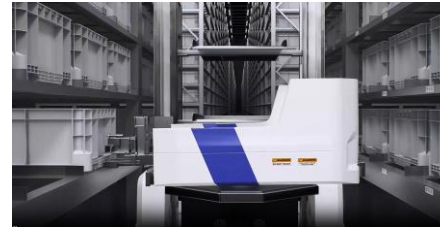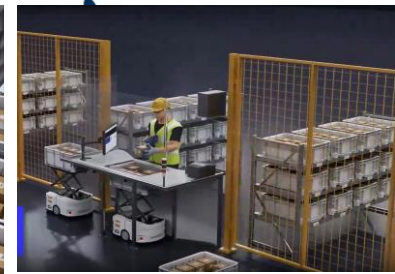
  So, is it a gamechanger?
  Hard to say at this point, but from a functionality point of view it's definitely best-in-class within the field of G2P ACR/AMR!!

  Other players for this type of solution (combination of ACR/AMR) are Geek+, Quicktron, Mushiny (All Chinese). Which of these will introduce their next innovation, when and for which warehouse type?

  Last week I presented in a short presentation 5 types of G2P ACR/AMR solutions. The most efficient solution is in my opinion the combination of ACR's and AMR's. From a pickingprocess point of view, decoupling of vertical (done by ACR's) and horizontal (done by AMR's) tasks is prefered in order to optimize productivity and leadtime. The new HaiPick System3 fits perfectly within this solution aswell.

https://www.hairobotics.com/project-nexus

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Solution C

## Combi of high Rack-to-picker G2P-AMR's with (un)loading device

Process
- G2P-AMR has 60 rackpositions for bins (60x40x30) (picture 1)
- Racks are stored in blocks of 20 racks, optimizing trade-offs between storage density and travel aisle between the blocks (picture 1)
- During idle time racks will be optimized at pickstations in order to cluster fastmovers on racks
- Racks are transported to pickstations by G2P-AMR's (picture 2)
- Bins are retrieved from the rack in sequence or put into a buffer above the pick-station by (un)loading device (picture 3)
- After picking bins are stored on the rack again by (un)loading device

System benefits
- Racks contain a high number of bins, multiple hits per rack (fast-movers)
- If the system operates under a mezzanine, the storage density is relatively high
- Probably the best solution for cold storage (compact and dense)
- Highly flexible by use of mixed racks (including non-binnables) (picture 4)

Question marks
- Risk for inbalances at the pickstation as result of batchtype flow, mainly when slow-mover items are required to be picked
- In order to maximize hitrates of multiple bins per rack, the number of SKU's should be limited, where SKUs will be stotred on multiple racks

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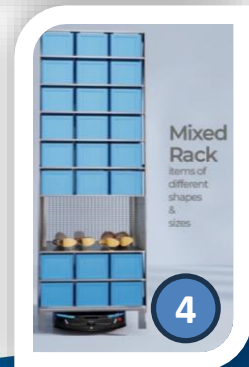
Solution D

**Bin-to-picker ACR's for vertical and horizontal transport with '' basic'' pickstations**
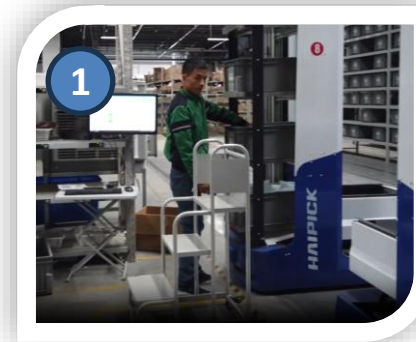
Process
- Lifter ACR picks bin from rack (up to appr. 9 meters high) (picture 1)
- Bins are buffered at lowest level in rack (cantilever-like position) (picture 2)
- Lifter ACR picks multiple bins and moves to pickstation
- At pickstation an operator takes goods directly out of the bins on the Lifter ACR (max pickheight 4 bins) (picture 1+2)
- After goods have been picked, Lifter ACR returns to racking area to put bins back into position

System benefits
- Simple system, no high-end features
- Mainly for operations not pushing the limits
- High Lifter ACR's with telescopic masts (up to 10 meters) make high storage densiity possible (picture 3)

Question marks
- ACR Lifters need to travel through the warehouse in order to pick bins for one specific pickstation
- Less ergonomic pickstations (''basic" ones)
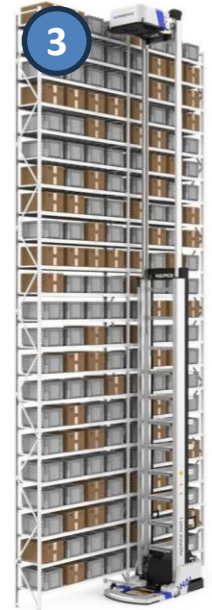
Solution E

Rack-to-picker G2P-AMR's ("Kiva-like")

Process
- Loose items are put into shelves/racks/pods, preferably directly after receiving (avoiding replenishments
- Ideally no replenishment of goods take place as replenishment is time-consuming process (due to the required manual interface)
- Racks are stored in blocks, where G2P-AMR's to all the transport towards and from the pickingstations (picture 1)
- During idle time racks are reshuffled within the storage area to maintain ABC-allocation logics

System benefits
- Best would be having incoming goods directly put away in the rackpositions, without need for replenishment
- "Fashion" related operations are in favor (apparel) and/or bulky goods (shoes/toys) (picture 3)

Question marks
- System's sweet spot is quite tight, due to process restrictions (loose manual handling) and rack restrictions (weight balance, pickface sizing, goods allocation)
- Less ergonomic pickstations (picking goods >1,5 m) (picture 3)
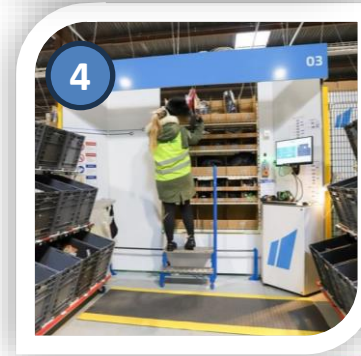
G2P-AMR

Amazon Robotics
Arculus
Aresbots
Caja Systems
Eiratech Robotics
Geek+
Grenzebach
GreyOrange
HAI Robotics
HIK Robotics
Idealworks
JD Warehouse Logistics
Makhina
Malu Innovation
Mushiny
Prime Robotics
Quicktron
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Scallog
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