Optimize Order Fulfillment with Collaborative Robotics

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PYRAMID | COMPASS

LIGHTNING PICK

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Presenters

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Systems Focus

- Matthews Automation Solutions is an independent provider of material handling systems including software, controls, and MHE
- Systems are built on appropriate technologies combined to provide a comprehensive solution
- It’s not about the pieces – concentrate on the whole result
- The goal should always be to solve a problem or provide quantitative value, not apply a specific technology
- Integrated AMR and robotic solutions

Autonomous Mobile Robots

AMRs are an exciting new tool that can be applied:

- As a standalone system
- As a component of a more complex system

Keep in Mind

End users should not be focused on implementing AMRs

End users should focus on the goals:

Increased throughput

Lower cost

Increased flexibility

Increased accuracy

Decreased order processing time

Consider AMRs as a part of an overall solution

Objectives

- Discuss the benefits of adding robotics to new and existing fulfillment systems
- Introduce potential applications for AMR-assisted material handling
- Discuss methods for successful adoption and best results

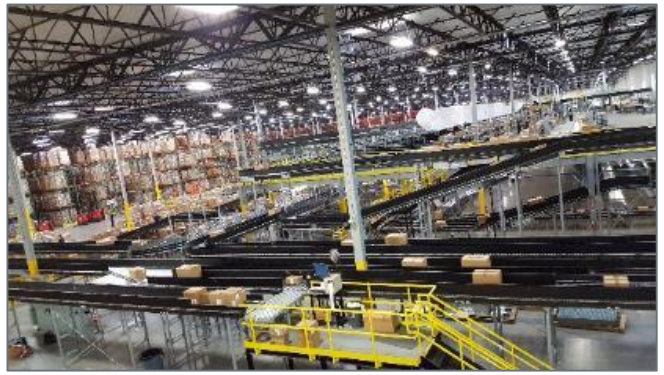
AMR-Assisted Material Handling Systems

- Combine robotic solutions with an operation's existing automated technologies
- Allow DCs to tailor technologies to their unique needs
- Have the flexibility to handle myriad fulfillment channels and requirements
- Scalable for incremental implementation

Why Consider Robots?

- Growing customer service expectations
- Labor pools are shrinking
- Reduce operating expenses
- Scalable, allowing increase in volume (i.e. seasonal peaks)
- Remove conveyors
  - Increase flexibility
  - Compact equipment footprint

Market Segments for Robots



3PL

DTC

Retail

Food & Beverage

Omni Channel

Parcel Post

Where do Robots Really Fit in my DC?

Where will emerging robotic technologies – including Automatic Guided Vehicles (AGVs), Autonomous Mobile Robots (AMRs), Cobots – best fit my order fulfillment operation?

- Interaction with humans
- Low density / e-commerce picking activities
- Multiple feeds and destinations

Where do Robots Not Fit in my DC?

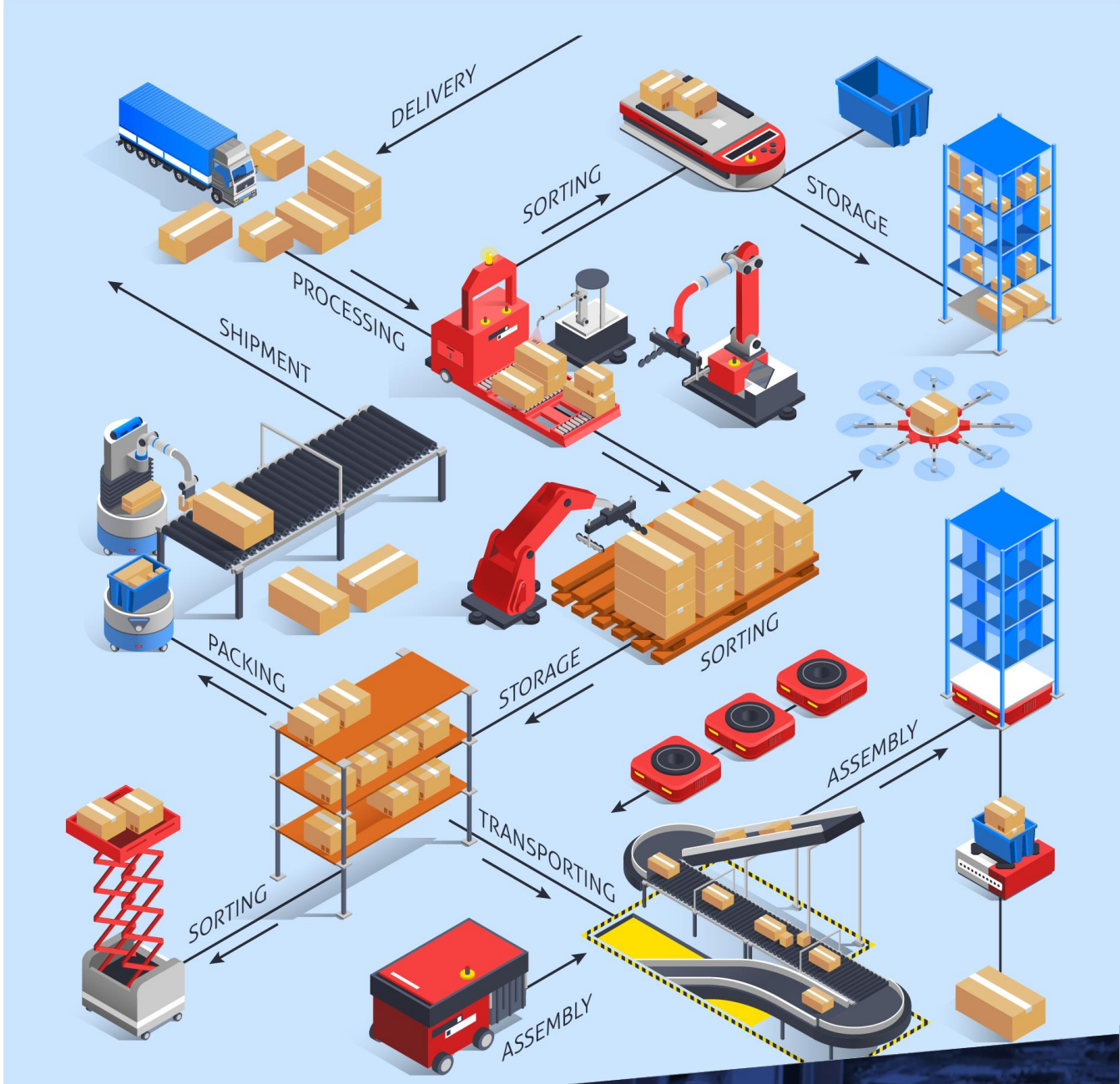
Where do they not fit? Can operations be improved in other ways?

- Dense picking is more suitable to traditional picking methods
- Traditional MHE is more suitable for simple and high-volume material transfer

Improvements from Adding AMRs

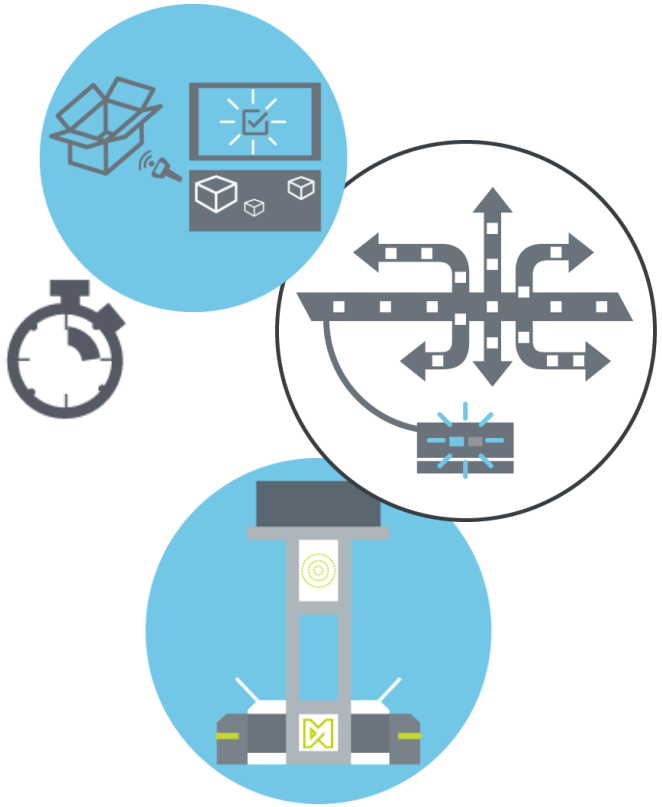
- Reduce labor requirements
  - Keep workers focused, on task
  - Pick cart building process
- Material movement flexibility
- Picking & putting efficiencies
- Ergonomics: repetitive / heavy tasks
- Safety
- DC size constraints:
  - Smaller facility
  - Larger facilities - De-couple far away areas

AMR Applications



Integration with MHE & Systems

- Where can integrating AMRs into your traditional material handling equipment and software provide benefits?
- Depending on the attachment configuration, AMRs can support receiving, putaway, picking, returns, and material movement.



AMR-Assisted Order Picking

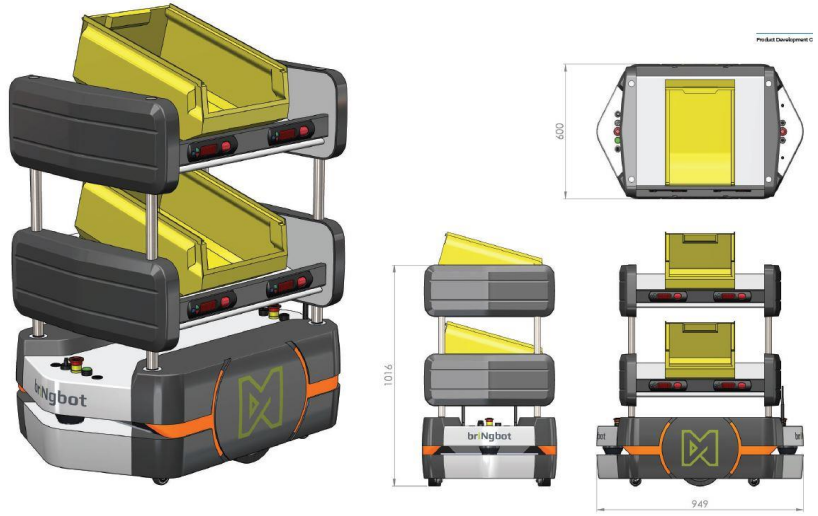
- Equipped with shelves for order containers
- Multiple AMRs bring empty/full containers in and out of picking zones, throughout the picking area
- Ideal for areas that don’t justify conveyors, require space flexibility or have low pick density
- Enables the picker to focus on picking vs. container handling

Picking Systems – Pick/Put AMRs

- Like the picker assistant AMRs, but include light-directed picking modules mounted on the shelves
- Carry multiple order containers
- Act as mobile “put stations”
- Travel with operators from location to location as picks are completed

Picking Attachment – Application Note

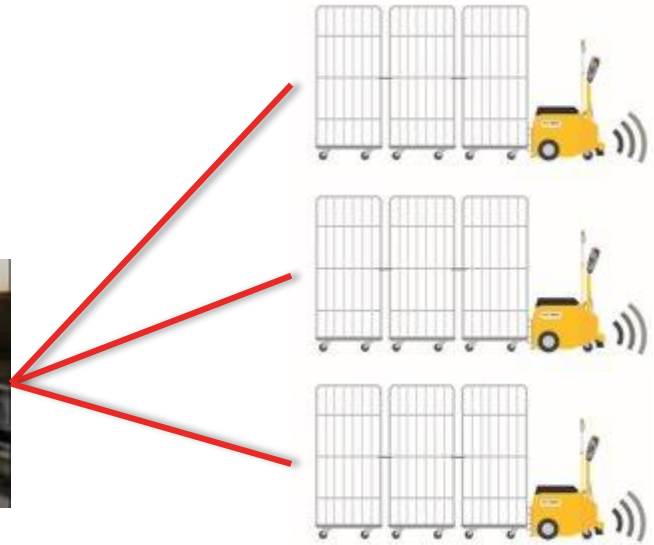
- For batch or cluster picking without the need for conveyors, sleds, or picking carts
- Can replace manual methods for light-directed pick and put systems
- When picks are complete, navigates to pack-out stations for order consolidation, packaging and shipment
- Another AMR navigates to operator for continued picking



Picking Systems Example – Ink Products Warehouse

- Multiple AMRs assist with picking heavy cartons and drums of industrial ink products
- RF Picking system
- AMRs take orders to a packing station

AMR Picking – “Swarm You”



- AMR receives a line order assignment and proceeds to the designated pick location.
- A picker sees the AMR parked displaying the qty of items needing to be picked in correlation to the SKU and pick count displayed on the shelf rack pick light
- Items selected and placed into the corresponding AMR pick light tote
- Once the pick has been confirmed, AMR will automatically travel to the next designated order pick location
- Multiple AMRs can be parked in a single zone which provides continuous high-density picking with short operator travel distances

Picking Systems – Tugger Vehicles

- Tuggers move full or empty carts in and out of the picking area
- Help operators do less walking and less pushing carts from zone to zone, allowing them to spend more time picking

Put Wall with Robots

- Fed by tote carrying AMRs from the pick area
- Sorting arms scan and sort ‘put and pack’ tasks for fast, accurate e-commerce order sortation

Box Transportation AMRs

- Equipped with motor-driven roller (MDR) conveyors on their top decks – available as fixed or adjustable height
- AMRs receive conveyed cartons or totes, then transport them to areas not otherwise connected by conveyor
- Adds flexibility to areas where a permanent conveyor installation doesn’t make sense

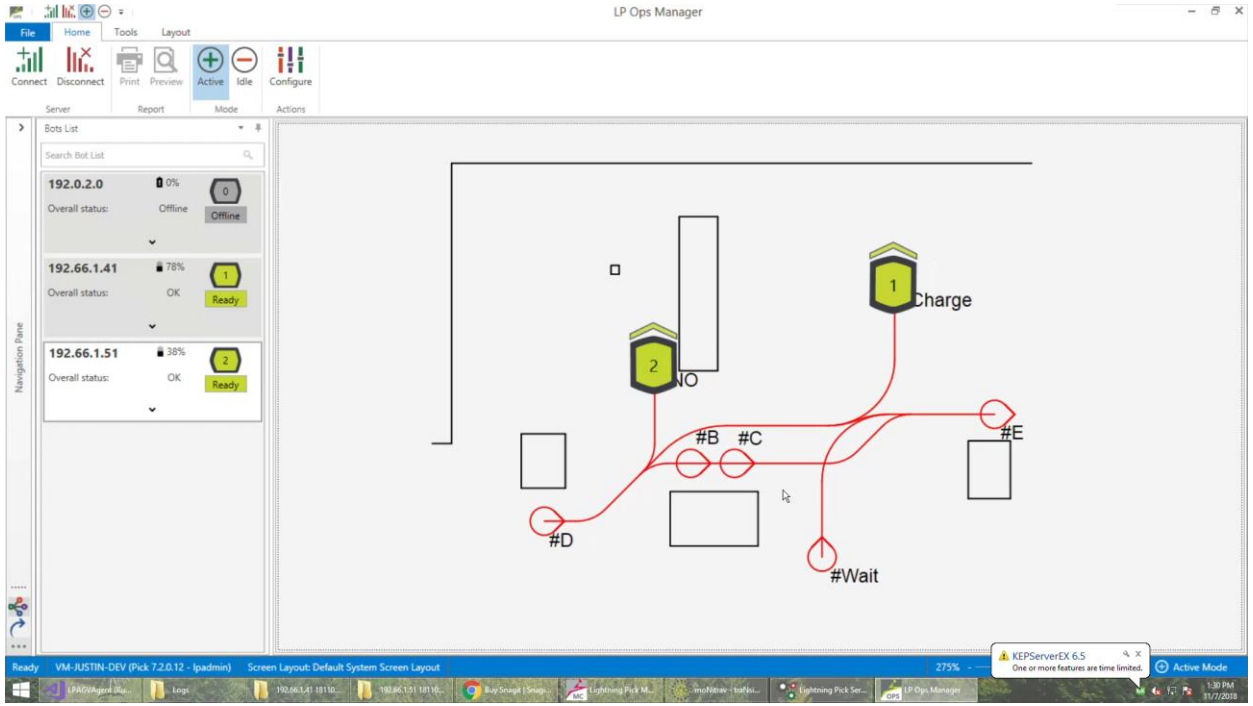
MDR Attachment – Application Note

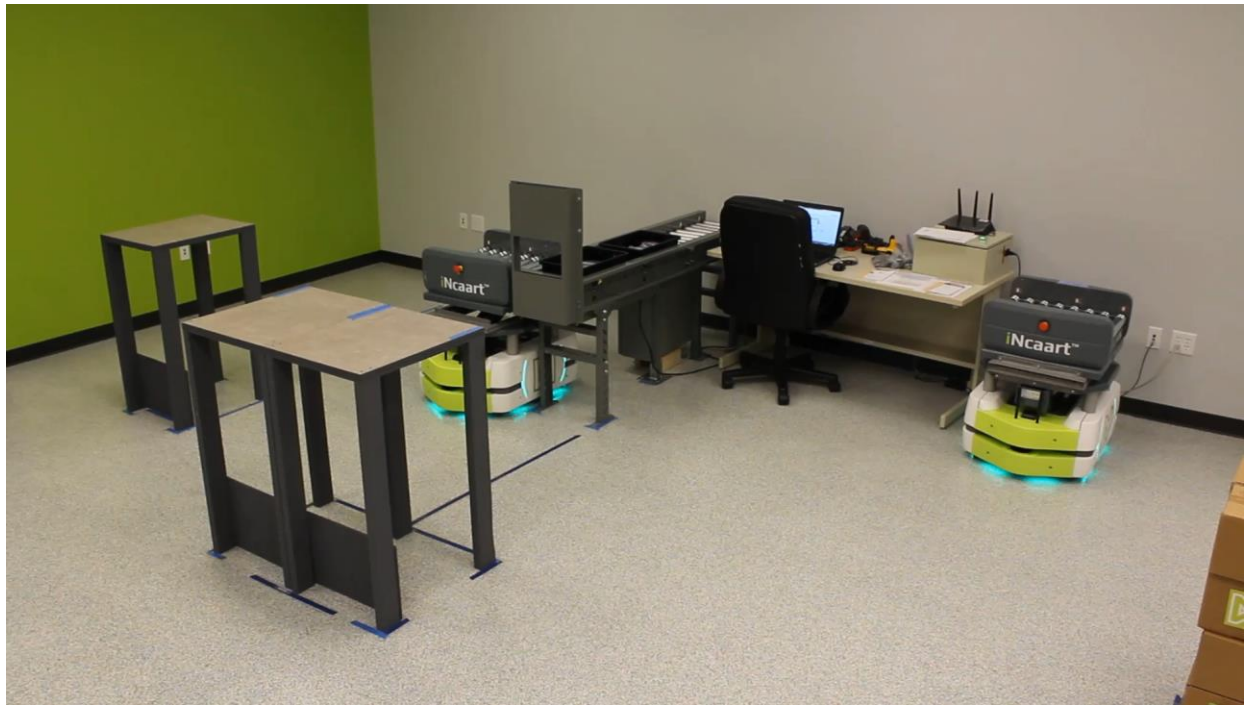
Load transfer to:

- Powered or non-powered conveyors
- Pallets for cross-docking
- Picking and sortation areas (pick-to-light, RF picking, voice picking, put-to-light, automated sorters, and more)
- Order finishing systems

MDR Attachment

Tray Delivery



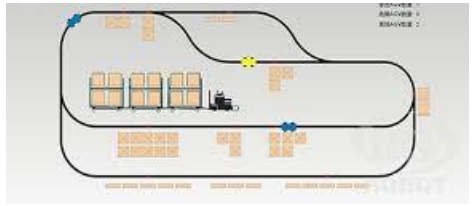


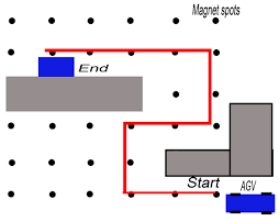
Vending Application

AMR Technology Insights

Navigation – Lines and Symbols

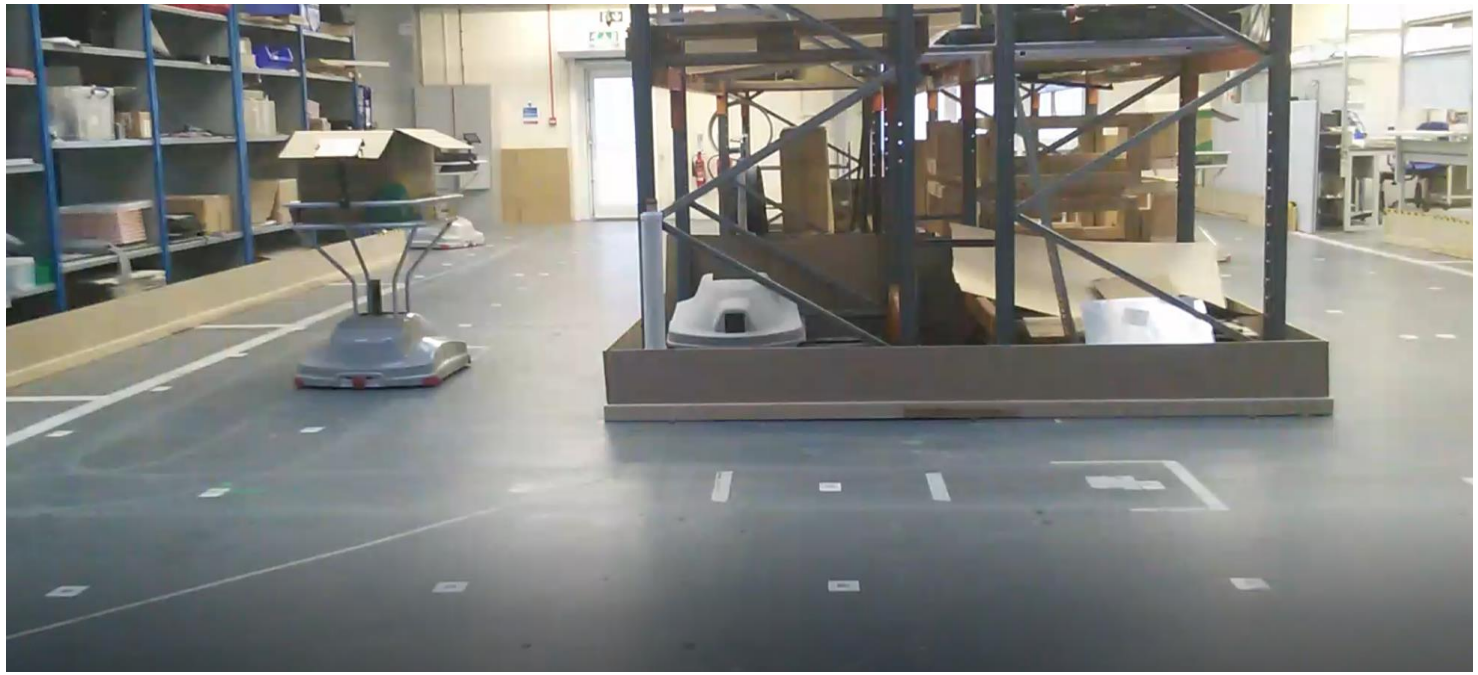
Lines on the floor, wires in the floor, magnets in the floor and symbols stuck to the floor.





We have our own floor symbol solution, which unlike many other symbol-based solutions, the vehicle is not required to drive from code to code, the symbols regulate the AGV's position in the environment and prevent accumulation of error.

This is more flexible than rigid lines, but still requires material to be stuck on the floor which is undesirable in many facilities.

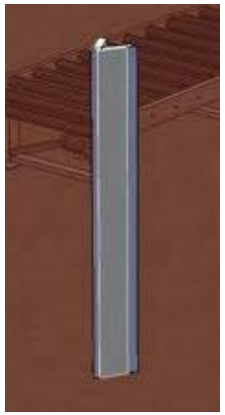


Navigation – Triangulation of Reflectors

By mounting an array of reflective targets around a wide-open area, a rotating laser scanner uses triangulation to calculate its position.

Our own in-house laser scanner design relies mainly on its very high accuracy bearing measurement to achieve 4 mm positional accuracy.

This exceptional processing capability produces the X and Y coordinates and heading that directs the AGV with maximum flexibility, unconstrained by the targets.



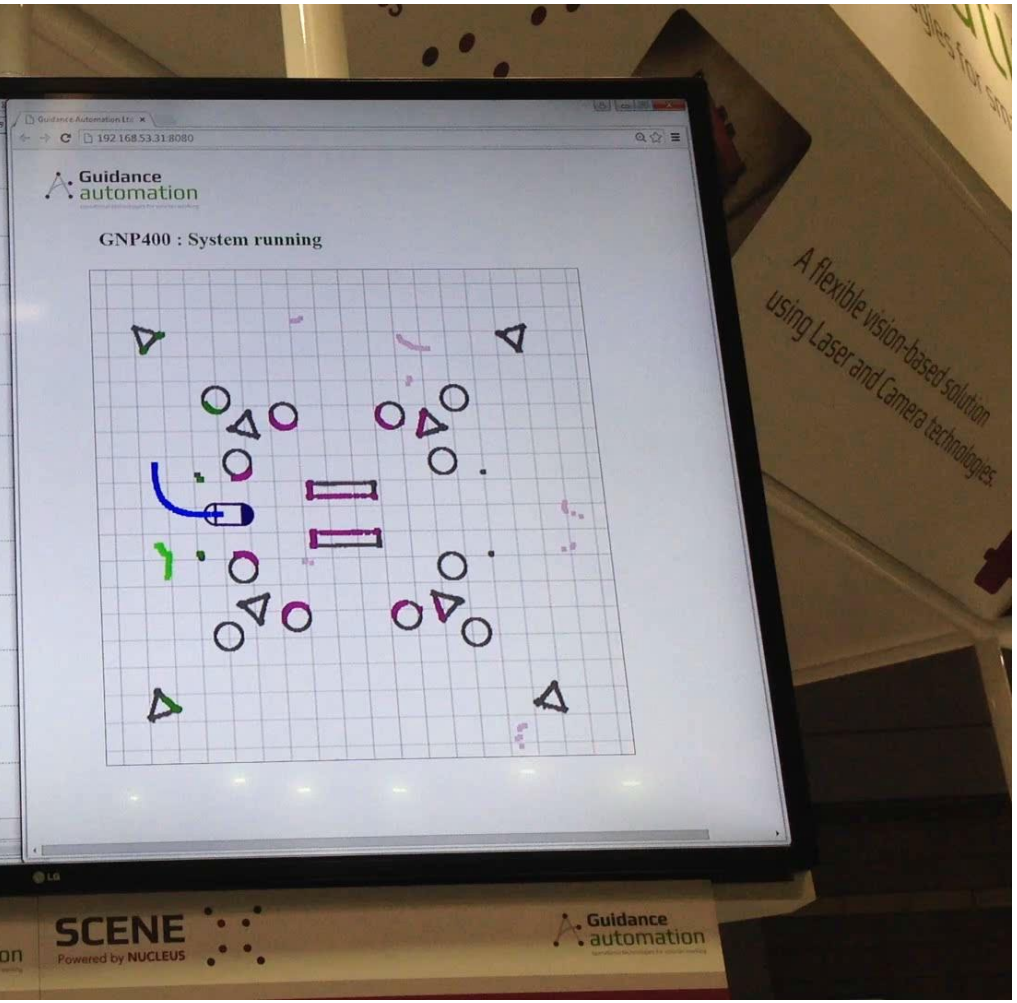
Navigation – Contour

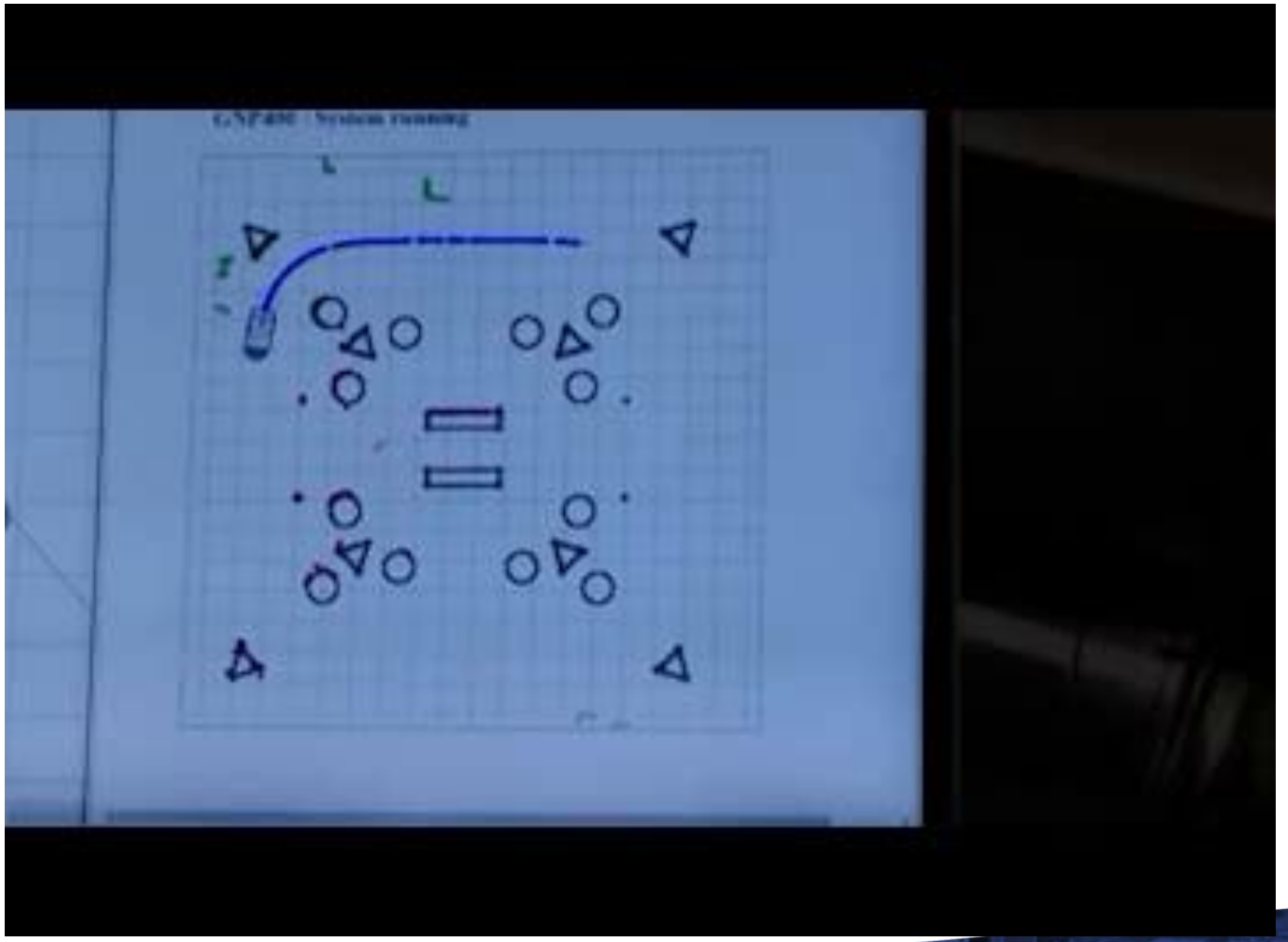
Natural feature navigation or contour navigation is becoming very popular due to its flexibility. Using data from the laser safety scanners already mounted on the vehicle, there is a reduced cost of hardware.

We created our own 2D laser navigation solution using any laser scanner which outputs range and bearing (safety scanner or other, indoor or outdoor).

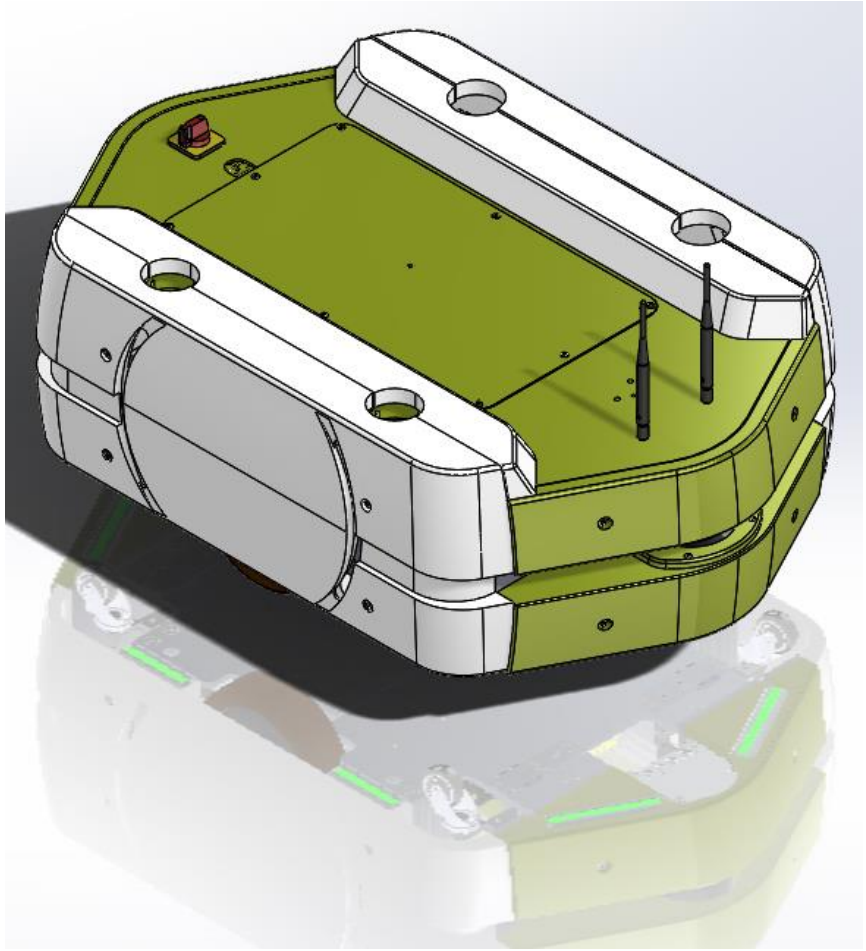
All of these navigation solutions have pros and cons and we were in a lucky position to have tried and tested them all to see which work best. Often this depends on the environment that we plan to work in. (Not all solutions will work in all facilities.)

Navigation – Contour





Vehicles



Application of Vehicles

The function of the vehicle needs to defined by adding the extra hardware and sensors to achieve this.

The vehicle controller operates this hardware as needed to perform the function of the vehicle.

Hydraulic lifter

Short conveyor

Scrubber mechanism

Linear sensors

Hydraulic controller

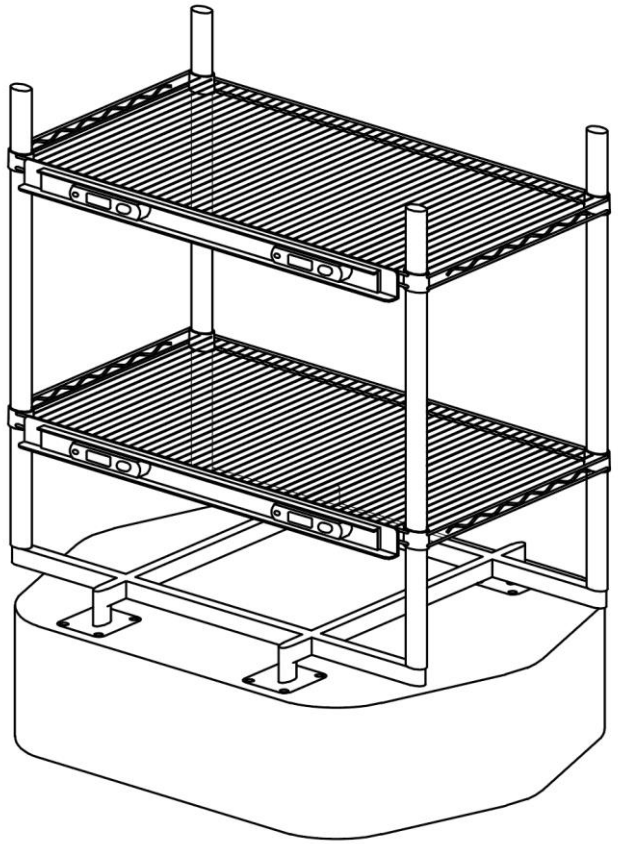
CANbus interface

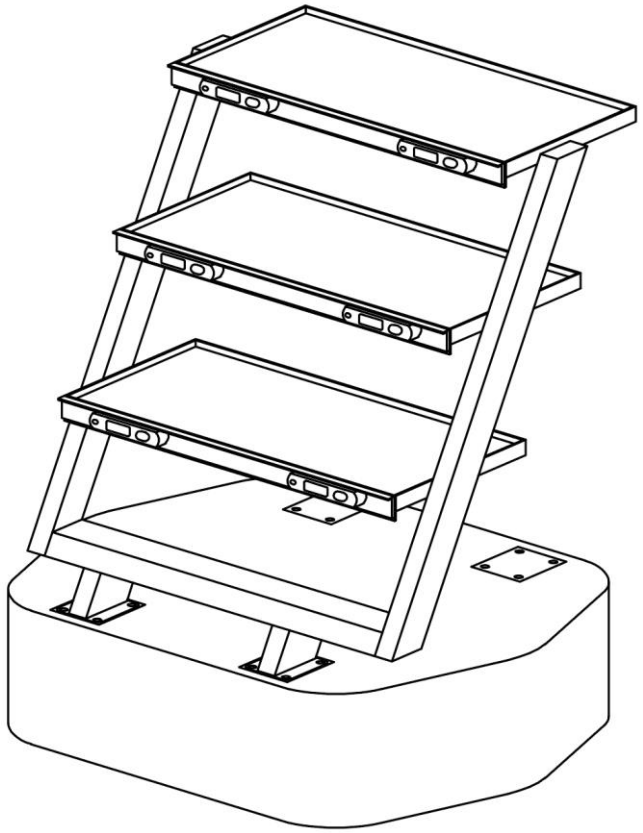
Draw string sensor

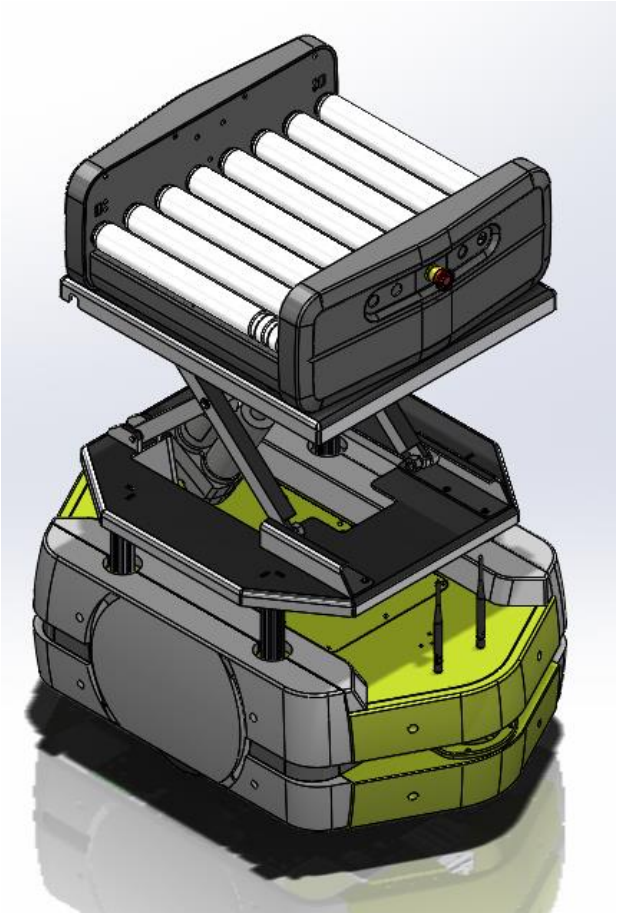
Tilt sensors

Limit switches

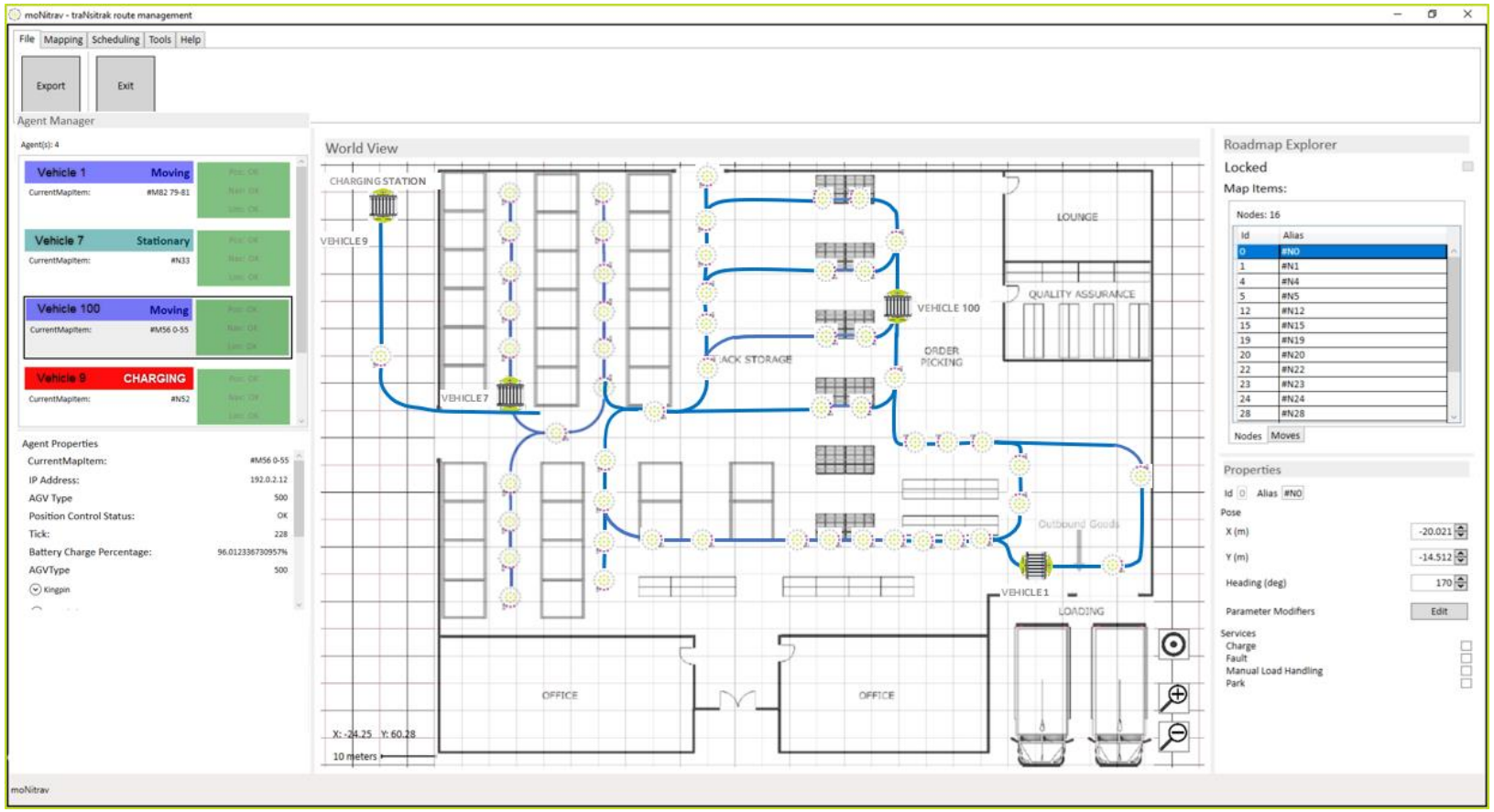
Application-Specific Accessories







Fleet Management



A fleet of vehicles need a suitable software package that can control them in the most optimal way.

This is the most important component of the vehicle system. So again we developed our own solution.

‘Jobs’ are passed to the fleet manager. The FM decides which vehicle to use for the task. This is a complicated and streamlined process which sets the efficiency of the vehicle flow and job completion.

Diagnostics

- Reporting
- Camera Integration

ANSI Safety Compliance

Table 2 – Risk level decision matrix

Severity of Injury	Exposure to the Hazard	Avoidance of the Hazard	Risk Level
S1 - Minor	E0 - Prevented		NEGLIGIBLE
	E1 - Low	A1 - Likely	NEGLIGIBLE
		A2/A3 - Not likely/ Not possible	LOW
	E2 - High		LOW
S2 - Moderate	E0 - Prevented		LOW
	E1 - Low		MEDIUM
	E2 - High	A1 - Likely	MEDIUM
		A2/A3 - Not likely/ Not possible	HIGH
S3 - Serious	E0 - Prevented		LOW
	E1 - Low		HIGH
	E2 - High	A1/A2 - Likely/Not likely	HIGH
		A3 - Not possible	VERY HIGH

Table 1 – Injury severity, exposure, and avoidance factors

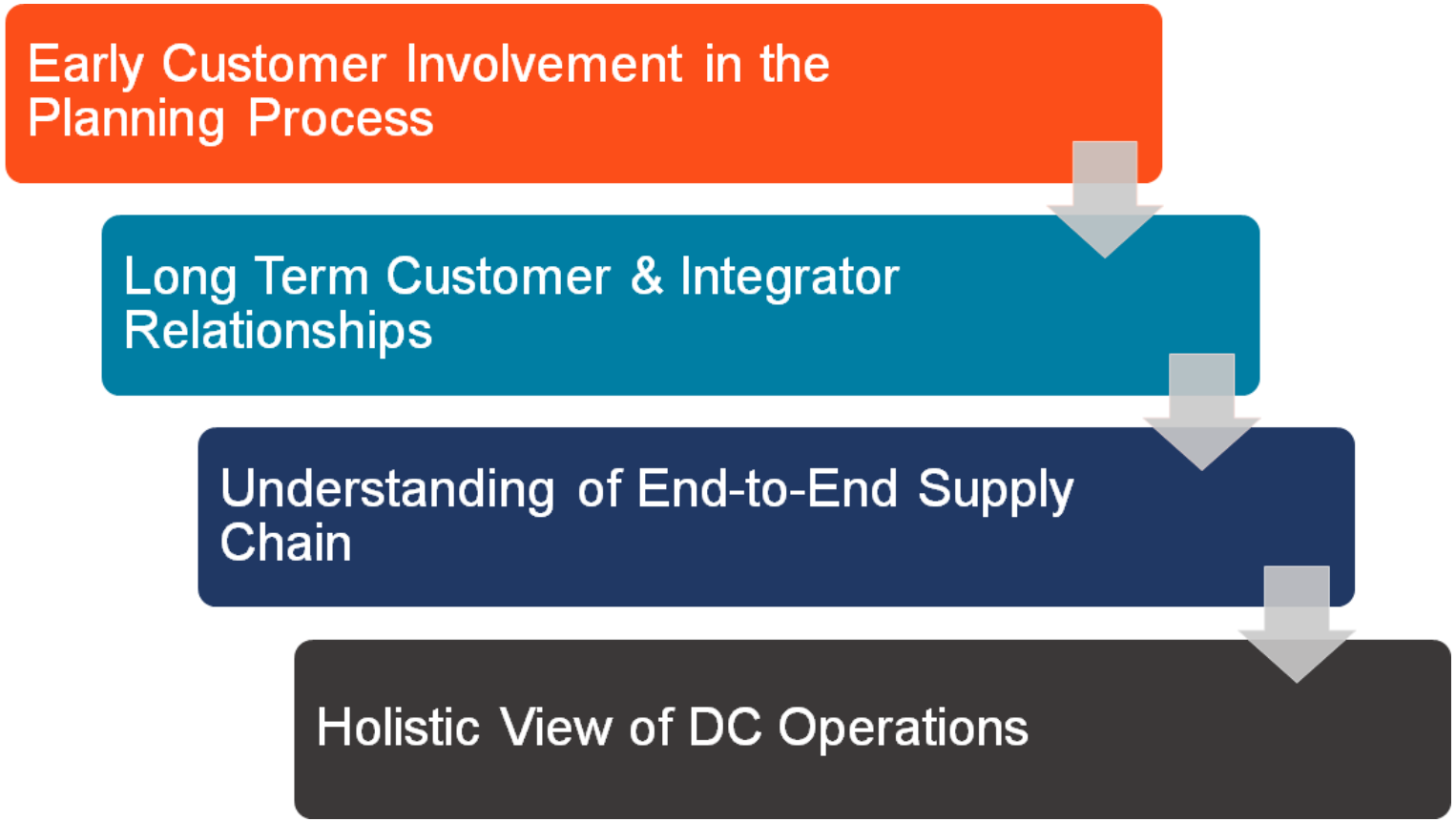
Factor	Rating	Criteria (Examples) – choose most likely *Read criteria from the top for each factor*
Injury Severity	Serious S3	Normally non-reversible; likely will not return to the same job after recovery from incident: – fatality – limb amputation – long term disability – chronic illness **If any of the above are applicable, the rating is SERIOUS**
	Moderate S2	Normally reversible; likely will return to the same job after recovery from incident: – broken bones – severe laceration – short hospitalization – short term disability – lost time (multi-day) – fingertip amputation (not thumb) **If any of the above are applicable, the rating is MODERATE**
	Minor S1	First aid; no recovery required before returning to job: – bruising – small cuts – no loss time (multi-day) – does not require attention by a medical doctor **If any of the above are applicable, the rating is MINOR**
Exposure[1]	Prevented E0	– Exposure to hazard(s) is eliminated/ controlled/ limited by inherently safe design measures. – Use of guards prevents exposure or access to the hazard(s) (see Part 2, 5.10). If an interlocked guard is selected, the following bullet must also be met. – If functional safety is used as a risk reduction measure, the implemented functional safety performance (PL) meets or exceeds the required functional safety performance (PL$_r$). See Part 2, 5.2. **If any of the above are applicable, the rating is PREVENTED**
	High E2	– Typically more than once per day or shift – Frequent or multiple short duration – Situations which could lead to increases in the duration of a task, not to include teaching tasks **If any of the above are applicable, the rating is HIGH**
	Low E1	– Typically less than or once per day or shift – Occasional short durations **If either of the above are applicable, the rating is LOW**
Avoidance	Not possible A3	– Insufficient clearance to move out of the way and safety-rated reduced speed control is not used – The robot system or cell layout causes the operator to be trapped, with the escape route toward the hazard – Safeguarding is not expected to offer protection from the process hazard (e.g. explosion or eruption hazard) **If any of the above are applicable, the rating is NOT POSSIBLE**
	Not likely A2	– insufficient clearance to move out of the way and safety-rated reduced speed control is used – obstructed path to move to safe area – hazard is moving faster than reduced speed (250 mm/sec) – inadequate warning/reaction time – the hazard is imperceptible **If any of the above are applicable, the rating is NOT LIKELY**
	Likely A1	– sufficient clearance to move out of the way – hazard is incapable of moving greater than reduced speed (250 mm/sec). – adequate warning/reaction time – positioned in a safe location away from the hazard **If any of the above are applicable, the rating is LIKELY**

Summary

- Vehicle designed for 100 kg, easy to change if needed
- Base design flexible for various tops and functions
- Flexible fleet management controller – independent of application – mixed fleet
- Issue jobs to FMC and it selects the vehicle based on priority, time, type and location
- Vehicle completes task and reports when job complete
- Charges as needed or opportunity charging can be employed
- Functions performed by vehicle are stored in vehicle controller

AMR Implementation

Successful Implementation Depends on a Proven System Development Strategy

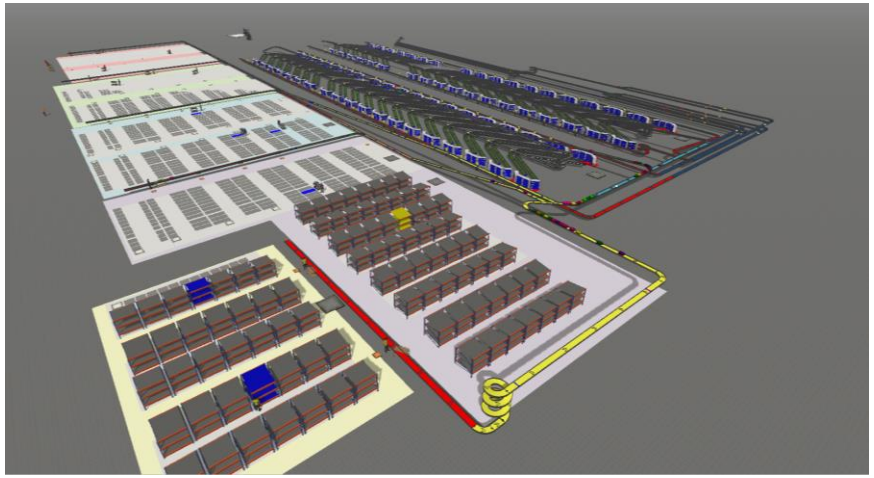


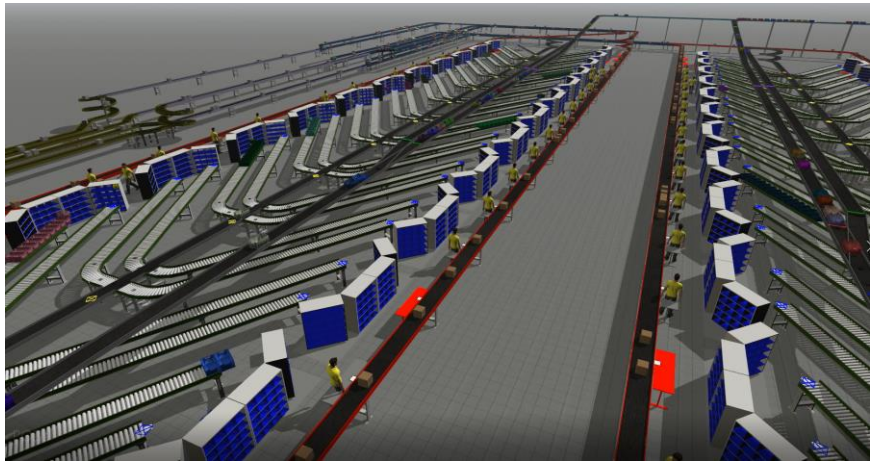
Planning & Design

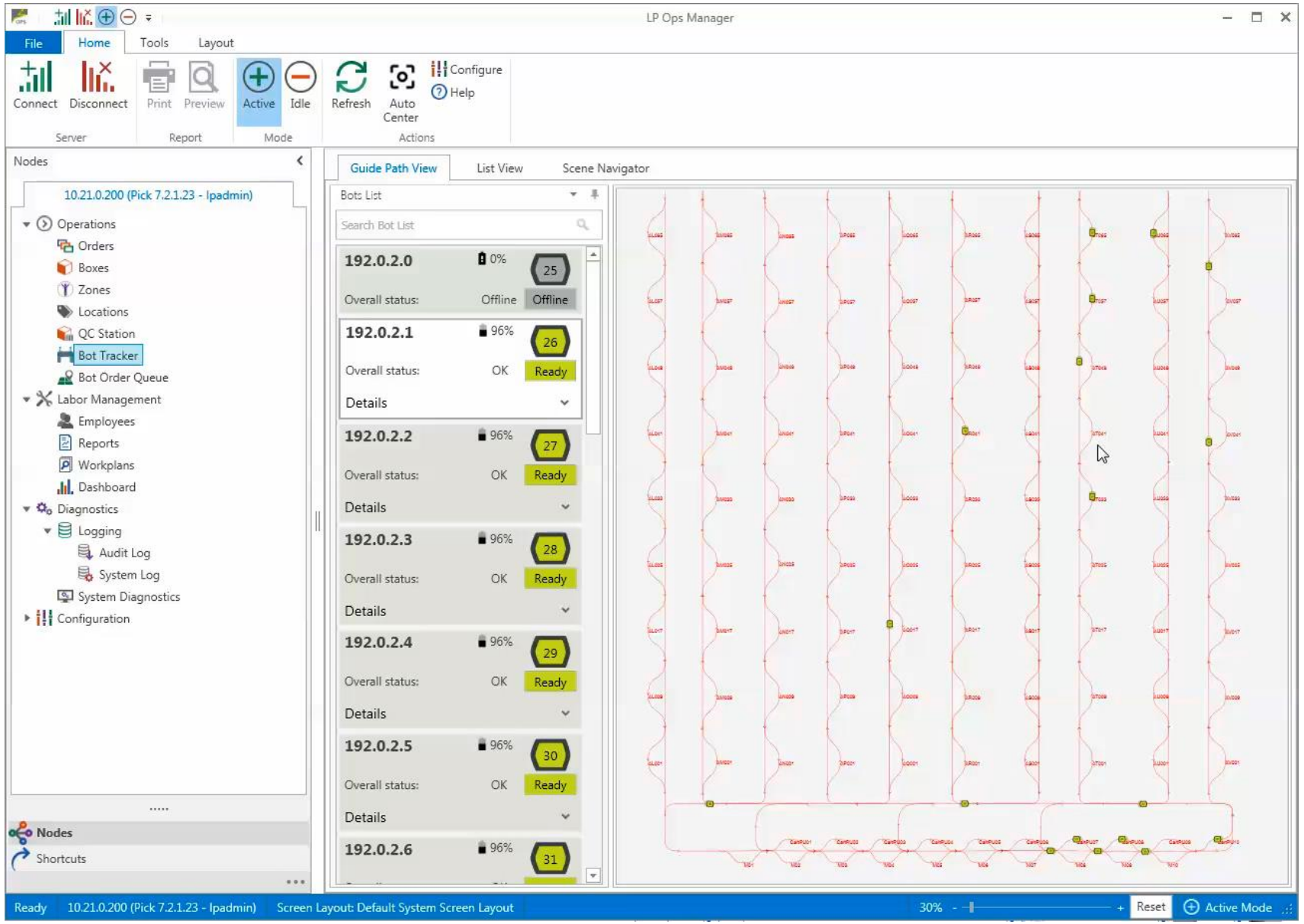
- Determine and document customer requirements and system design in a manner that is easy for both parties to understand
- Identify technologies for meeting the requirements
  - Part of this process involves identifying where AMRs can provide unique benefits
- Configure solution to best fit the system
  - Start small by identifying good areas to test and acclimating employees, maintenance, and management; then measure the initial results

Simulations

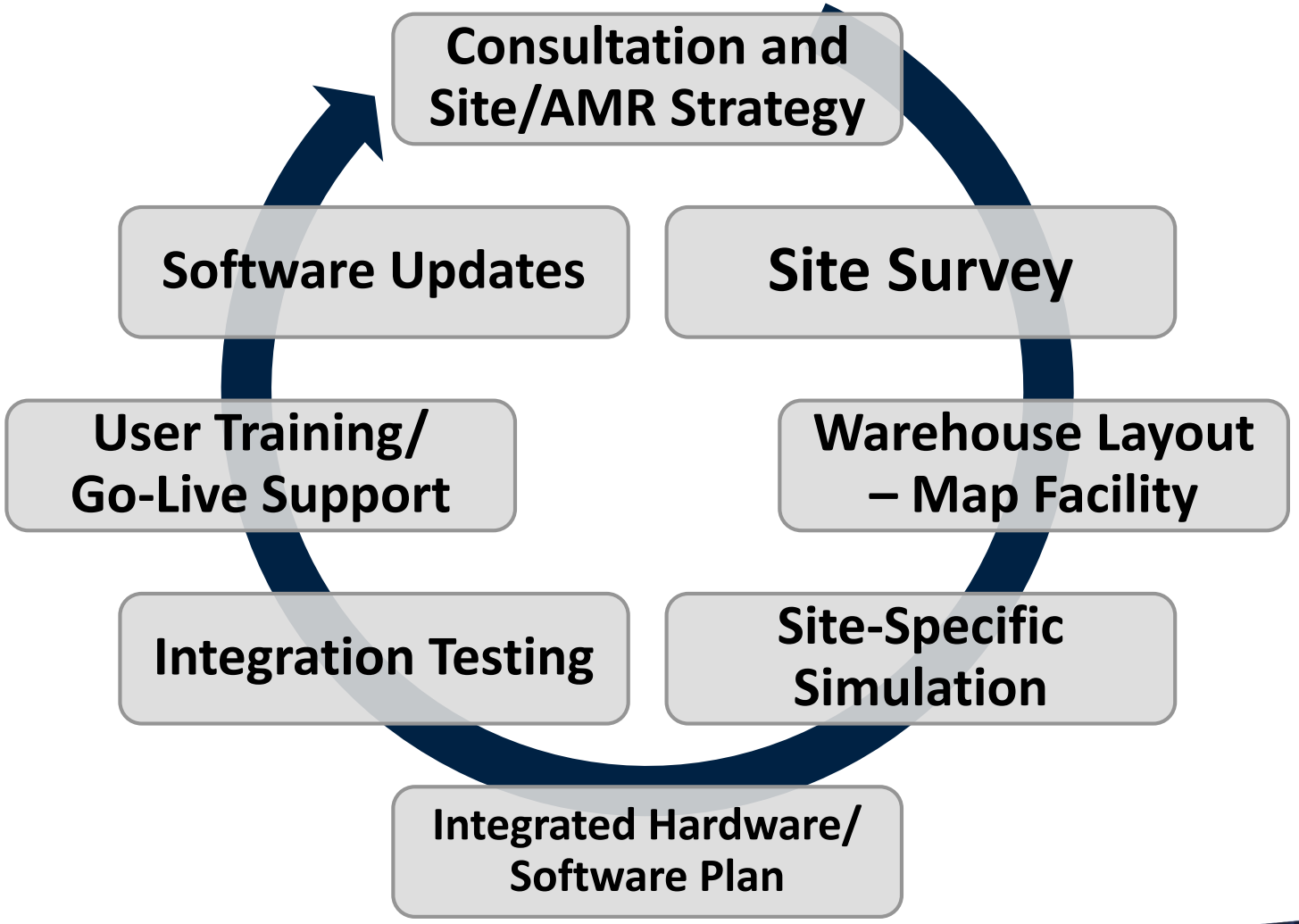
- Determine how the addition of robotics will effect end-to-end operations
- Exact facility size and MHE placement, real software and robotics logic, order volume, and SKU count ensure an accurate representation of a proposed system
- Low risk
- Cost-effective





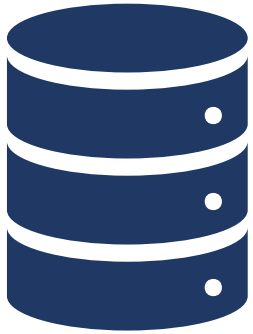


Implementation Process



Software Integration is Key

- Fully integrated fleet management software aligns AMR activity with other automation, unifying communications
- Fleet Management Integrated with WES, WCS, Pick Software, etc.
- One host interface (WMS, ERP) and one centralized User Interface
- Balance operations
- Enables scalable AMR adoption



Strategic Advantages

- Provide flexibility by replacing permanent conveyor for material movement
- Allow humans to do the challenging, value-added jobs that can’t be easily automated, while robots take up the heavy lifting and reduce repetitive task errors
- Increase sortation accuracy
- Enhance warehouse safety and ergonomics

Key Takeaways

- New robots can expand the agility and performance of existing material handling automation equipment and systems
- The name of the game is “evolution” not “revolution” – incrementally adding emerging robotic products to proven material handling technologies delivers process flexibility with less risk and a higher probability of a solid ROI
- Demonstrated software and controls interfaces (such as WES) and end-to-end system experience are crucial in effective automation adoption

For more information

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