Optimize Order Fulfillment with Collaborative Robotics

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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
Tray Delivery
Vending Application
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 be 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.
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 1 - Injury severity, exposure, and avoidance factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Rating</th>
<th>Criteria (Examples) – choose most likely need criteria from the top for each factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serious</td>
<td>S3</td>
<td>Normally non-reversible; likely will not return to the same job after recovery from incident</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- fatality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- limb amputation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- long term disability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- chronic illness</td>
</tr>
<tr>
<td>Moderate</td>
<td>S2</td>
<td>Normally reversible; will return to the same job after recovery from incident</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- broken bones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- severe laceration</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- short hospitalization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- short-term disability</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- lost time (multi-day)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- finger amputation (not limb)</td>
</tr>
<tr>
<td>Minor</td>
<td>S1</td>
<td>First aid, no recovery required before returning to job</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- hazing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- small cuts</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- no loss time (multi-day)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- does not require attention from a medical doctor</td>
</tr>
</tbody>
</table>

If any of the above are applicable, the rating is SERIOUS

If any of the above are applicable, the rating is MODERATE

If any of the above are applicable, the rating is MINOR

Table 2 - Risk level decision matrix

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

Prevented

E2 - Typically less 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
- Occupational short duration
- Neither the above are applicable, the rating is LOW

Avoidance

A3 - Insufficient clearance to move out of the way and safely avoid reduced speed control
- The robot system or cell layout causes the operator to be trapped, with the machine rotated toward the hazard
- Safeguarding is not expected to offer protection from the process hazard (e.g. explosion or ignition hazard)
- Neither the above are applicable, the rating is NOT POSSIBLE

A2 - Insufficient clearance to move out of the way and safely avoid reduced speed control
- 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
- Neither the above are applicable, the rating is NOT LIKELY

A1 - Insufficient 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
- Neither 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

- Early Customer Involvement in the Planning Process
- Long Term Customer & Integrator Relationships
- Understanding of End-to-End Supply Chain
- Holistic View of DC Operations
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

- Consultation and Site/AMR Strategy
- Software Updates
- Site Survey
- Warehouse Layout – Map Facility
- User Training/Go-Live Support
- Integration Testing
- Site-Specific Simulation
- Integrated Hardware/Software Plan
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
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