CAN MOBILE ROBOTS HELP YOUR BOTTOM LINE?

October 2018
AGENDA

• What is a Mobile Robot?
• Mobile Robots vs. Traditional AGVs
• Deploying Multiple Mobile Robots
• Case Studies and Examples
• So are they right for you?
What is a MoBot?

(Not necessarily an industry-wide term)
What is a MoBot?

Called several things by the industry
- **A I V** – Autonomous Intelligent Vehicle
- **A M R** – Autonomous Mobile Robot
- **I G V** – Intelligent Guided Vehicle

Central feature of a Mobile Robot:

The ability to **detect obstacles and find alternate routes** when needed and **without intervention**
Anatomy of a Mobile Robot

- **Vehicle Intelligence**
- **Navigation & Path Planning**
- **On-board Safety**
- **Battery & sensor management**

**Robot**
- **Active or passive**
- **Cargo carried here**

**Payload**
- **Application**
- **Cargo**
  - EX: Totes, boxes or product
Application Payload Examples

• Carts
• Conveyors
• Secure storage
• [Almost unlimited options]
Mobile Robots vs AGVs

SIMILAR, BUT DIFFERENT
MoBots and AGVs are Similar...

- Move “stuff” from point A to B
- Can safely operate alongside people
- Can be deployed as part of a fleet
## But Different

<table>
<thead>
<tr>
<th></th>
<th>Mobile Robots</th>
<th>Automated Guided Vehicles</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td>WiFi</td>
<td>Wire guidance, magnetic tape, reflective markers, RFID, etc.</td>
</tr>
<tr>
<td></td>
<td>Overhead lights (optional)</td>
<td></td>
</tr>
<tr>
<td><strong>Navigation</strong></td>
<td>Internal map for autonomous navigation</td>
<td>Follows fixed routes with physical markers</td>
</tr>
<tr>
<td></td>
<td>Simultaneous Localization and Mapping</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Overhead “lights”</td>
<td></td>
</tr>
<tr>
<td><strong>Obstacle Handling</strong></td>
<td>Finds alternate routes around obstacles</td>
<td>Stops until obstacle is removed</td>
</tr>
<tr>
<td><strong>Scalability / Optimization</strong></td>
<td>Remap facility by scanning Reprogram on PC and deploy via WiFi</td>
<td>Possible to add or change tracks, but extensive overhaul may be required</td>
</tr>
<tr>
<td><strong>Charging</strong></td>
<td>Autonomously determines best charging schedule</td>
<td>Scheduled or trickle charging at stations</td>
</tr>
<tr>
<td><strong>Human/Robot Collaboration</strong></td>
<td>Accomplishes tasks even with dynamic and unpredictable human traffic</td>
<td>Accommodates occasional human traffic through travel path</td>
</tr>
</tbody>
</table>
Moving Material in a Nutshell

Manual Logistics

Push Carts
Forklifts

Traditional Automation

AGVs
Conveyors

Decentralized Navigation

Mobile Robots
FLEETING THOUGHTS

Managing Multiple Robots
Multiple Mobile Robots

• Allows simultaneous tasks to be carried out
• Must be coordinated in carrying out multiple tasks
• Individual robots *can* be tied to specific jobs, but what happens when
  • Facility layout changes?
  • Job queues are not balanced?
  • One robot needs repairs?

The true power of multiple mobile robots can be unlocked with fleet management software
Strength in Numbers

• Mobile robot fleet management provides autonomous, dynamic transport of goods and **on-demand flexibility**

• Fleet manager software centralizes:
  • Job dispatch and management
  • Configuration management
  • Traffic flow optimization
  • Control of up to 100 MoBots

• Similar to a foreman
Key System Features

• Ability to interface with operators
• Integration with WMS and related IT systems
• Queue Management
• Fleet Management
How Big of a Fleet?

1. Gather preliminary info
2. Spreadsheet it
3. Simulate it

Omron can help with this!
MoBots, Mo’ Productivity
Use Cases and Examples
“Milk Run”

• Manufacturing:
  • Line-side replenishment
  • Kitting for assembly

• Order Fulfillment:
  • Running
  • Put-away

• Eliminates:
  • Low value-add task
  • Error in selecting carts
  • Error in selecting destinations
  • Late deliveries
  • Employee delays/distractions

• Allows traceability in movement of goods
Kitting Delivery

- Kitting for food trays w/ delivery to final assembly
- Two-shift operation (replaced two people)
- Eliminates:
  - Low-value add human task
  - Human error in cart selection
  - Large number of staged carts in assembly and lineside
  - Batch processing (converts to JIT fulfillment)
- Allows traceability in movement of goods
Bus Route Pickup

• Small Manufacturer assembling Jewelry
• 2-shift operation
• Eliminates:
  • Human Error in selecting carts
  • Human Error in selecting destinations
  • Late deliveries
  • Employee delays/distractions
• Allows traceability and control during movement of valuable WIP components
• Suitable for use in tight corridors near humans
Final Goods Inventory Pickup

• Example of complex Application Payload
• Transport totes from an ASRS to manual sorting stations.
• Pick up the completed package and deliver to the exit (fixed) conveyor
• Eliminates:
  • Human Error in selecting carts
  • Human Error in selecting destinations
  • Late deliveries
  • Employee delays/distractions
Flexible Production Line

• Not constrained by floor plan
• Augment existing cells with “mobile conveyors”
• Allows much greater flexibility in planning a production line
Are Mobile Robots Right for You?

Mobile Robots and Your Bottom Line
The 8 Deadly Wastes in Material Transport

1. Defects: Efforts caused by rework, scrap, and incorrect information.
2. Overproduction: Production that is more than needed or before it is needed.
3. Waiting: Wasted time waiting for the next step in a process.
5. Inventory: Excess products and materials not being processed.
6. Motion: Unnecessary movements by people (e.g., walking).
7. Extra-Processing: More work or higher quality than is required by the customer.
8. Non-Utilized Talent: Underutilizing people’s talents, skills, & knowledge.

Mobile Robots Can Address or Eliminate 5 of them:

1. Computer-driven task list with traceable actions
2. Automated material flow optimizes movement of WIP from cell to cell
3. Labor Redeployment to higher value tasks
4. Reduces non-value-add touches – movement performed by robot
5. Reduces walking and manual material handling
...and Combine that with High Turnover

- Today’s job market is booming for seekers
- For employers, this has led to **high turnover**, especially in less skilled positions
- In skilled and semi-skilled jobs – cost of replacing a **worker** typically 1.5 - 2.5x their annual salary
- This *really* hurts when the worker’s job involves a lot of **non-value-add material handling**

Automating your material handling can be a **buffer against high turnover** in semi-skilled material handling positions
## What Are Your Needs?

<table>
<thead>
<tr>
<th>If this is you:</th>
<th>Mobile Robots:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cannot alter floor, high possibility that work areas will change</td>
<td>Uses environment to navigate – no need for magnets, buried wires, or tape for pathfinding</td>
</tr>
<tr>
<td>Unpredictable and/or continuous human traffic</td>
<td>Avoids people, can maneuver thorough a crowd of people walking down a corridor</td>
</tr>
<tr>
<td>Pathways routinely subject to complete or partial blockage by people, material, pallets, or equipment</td>
<td>The vehicle is able to find an alternative route to reach its goal if one route is blocked.</td>
</tr>
<tr>
<td>The scale of operation does not permit waiting on one automated material mover</td>
<td>Multiple vehicles can operate together to find the most efficient method of executing multiple tasks</td>
</tr>
</tbody>
</table>
Return on Investment

For “push cart” jobs, a single Mobile Robot doing half of the human job can break even in less than one year.

<table>
<thead>
<tr>
<th></th>
<th>Push Cart FTE</th>
<th>Push Cart TEMP</th>
<th>Tugger</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labor cost per hour</td>
<td>$16</td>
<td>$10</td>
<td>$12.00</td>
</tr>
<tr>
<td>Labor Cost per hour with Fringe</td>
<td>$21.39</td>
<td>$10.00</td>
<td>$14.76</td>
</tr>
<tr>
<td>Annual wage</td>
<td>$44,491</td>
<td>$20,800</td>
<td>$30,701</td>
</tr>
<tr>
<td>Labor Churn factor</td>
<td>$4,449</td>
<td>$2,080</td>
<td>$6,140</td>
</tr>
<tr>
<td>Cost of Cart</td>
<td>$500.00</td>
<td>$500.00</td>
<td>$15,000</td>
</tr>
<tr>
<td>Total Annual Cost per shift</td>
<td>$48,940</td>
<td>$22,880</td>
<td>$36,841</td>
</tr>
<tr>
<td>Assume Lynx does 50% of person’s job (transport time)</td>
<td>$24,470</td>
<td>$11,440</td>
<td>$18,420</td>
</tr>
<tr>
<td>Increase in Person’s non-transport task capacity/efficiency</td>
<td>15% $6,674</td>
<td>$3,120</td>
<td>$4,605</td>
</tr>
<tr>
<td>Damage to infrastructure</td>
<td>$-</td>
<td>$-</td>
<td>$1,000</td>
</tr>
<tr>
<td>Damage to goods transported</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Errors in goods transported (time)</td>
<td>5% $2,447.02</td>
<td>$1,144.00</td>
<td>$1,842.05</td>
</tr>
<tr>
<td>Personal (unscheduled) down-time during work shift (minutes) - annual impact</td>
<td>30% $2,781</td>
<td>$1,300</td>
<td>$1,919</td>
</tr>
<tr>
<td>Personal Sick leave</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Work injuries (manuf. &amp; WH) one person (typ.8 days per incident)</td>
<td>4% $60</td>
<td>$28</td>
<td>$45</td>
</tr>
<tr>
<td>Insurance premium</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Time spent “searching” in a WH (up to 8% )</td>
<td>3% $1,468</td>
<td>$686</td>
<td>$1,105</td>
</tr>
<tr>
<td>Traceability (material loss)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adept Vehicle Selling Price</td>
<td>$60,000</td>
<td>$60,000</td>
<td>$60,000</td>
</tr>
<tr>
<td>Breakeven Months @ 60k ASP 1 shift</td>
<td>19</td>
<td>41</td>
<td>25</td>
</tr>
<tr>
<td>Breakeven Months @ 60k ASP 2 shifts</td>
<td>9</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>Breakeven Months @ 60k ASP 3 shifts</td>
<td>6</td>
<td>14</td>
<td>8</td>
</tr>
</tbody>
</table>
# Mobile Robots Comparison

<table>
<thead>
<tr>
<th></th>
<th>&lt;250kg</th>
<th>1500kg</th>
<th>Safety Compliant</th>
<th>LIDAR Navigation</th>
<th>Fleet Mgmt.</th>
<th>Industrial Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>ClearPath</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>&lt;2 years</td>
</tr>
<tr>
<td>MIR</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>&lt;2 years</td>
</tr>
<tr>
<td>Aethon</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✗</td>
<td>☁</td>
<td>&gt;12 years</td>
</tr>
<tr>
<td>MT Robot</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>&lt;2 years</td>
</tr>
<tr>
<td>IncubedIT</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>&lt;2 years</td>
</tr>
<tr>
<td>Seegrid</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>&gt;10 years</td>
</tr>
<tr>
<td>Savant</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>&gt;10 years</td>
</tr>
<tr>
<td>Fetch</td>
<td>✓</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>☁</td>
<td>&lt;2 years</td>
</tr>
<tr>
<td>Omron</td>
<td>✓</td>
<td>✗</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>&gt;17 years</td>
</tr>
<tr>
<td>Adept</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>&gt;17 years</td>
</tr>
</tbody>
</table>
THANK YOU
WWW.CROSSROBOTICS.COM

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