Agenda

• Trends

• Enabling technology

• Market applications
TRENDS
State of the industry: retailers omnichannel challenge

- Earnings pressure, reduction in same store sales driving need to rationalize existing logistics network - Opportunities to reduce cost to serve
- Urbanization changing store footprints, distribution model and direct to consumer fulfillment
- Omnichannel buying behavior and competition driving exploration of new approaches to serve
Population densities

• In 2008, civilization crossed a landmark: half the global population now living in urban areas. Fifty years ago it was 30%. A century ago it was 10%.

• In 2012, 82% percent of the total population in the United States lived in cities.

• Retail strategies evolving to serve population concentrations
  – Small format urban
  – Suburban mixed formats
  – Rural big box
  – All with direct to consumer delivery
E-commerce trends

• Web retail growth (~9.5%) continues to outpace non-web growth (~2%)
• Omni-channel brand experience driving evolution of order fulfillment
  – What I want
  – For the price I want
  – Where I want it
  – When I want it
• M-commerce adds fuel to the fire
  – Art Technology Group: 40% of consumers 18 - 34 use mobile phones to research or browse for product information
  – comSource: Of mobile Americans (~235M), 36% access mobile web and 34% applications
  – $57B project for 2014, 9% of all ecommerce sales
Omni-channel defined

Single Channel
Customers and retailer have a single touch point
Retailer’s channels operate in independent silos

Multi-Channel
Customers see multiple independent touch points

Cross-Channel
Customers see multiple touch points as the same brand
Retailer has a unified view of customer but operates in functional silos

Omni-Channel
Customers have a holistic brand experience
Retailer strategically leverages a unified view of the customer
And the MHI survey says…

More store fulfillment? More small format FCs near city centers? Dark Store redeployment?
ENABLING TECHNOLOGY
Background

• Many of the applications we are working on today are not new ideas, but are just now possible based on advances in technology

• Improvements like:
  – Improved robot speeds and configurations
  – Vision systems
  – Sensor technology
  – Mobility
  – Control software
Robotics and motion control

• Advances
  – Controller capabilities and platforms
  – Motion control capabilities
  – Live load v. unit size ratio improvements
Environment detection technology

• Vision & Sensors
  – Laser ranging
  – Camera cost
  – LiDAR
  – Infrared sensor bar
Mobility

- Battery technology
- Sensor integration
- Autonomy
- Simultaneous Localization and Mapping (SLAM)
Enabling technology

• There are four basic technologies at the core of all the DC applications.
  – Palletizing
  – Depalletizing
  – Bin picking
  – Mobile platforms
MARKET APPLICATIONS
State of the industry: automation

• Increasing capacity, speed and efficiency
  – Labor-only operations peaks at 2,000–3,000 orders per day
  – Requires decisions at the speed of automation with operational information
  – Drive throughput to outbound in best trailer load sequence for store and direct-to-consumer deliveries
# North American Warehouse Metrics

<table>
<thead>
<tr>
<th>Performance Metric**</th>
<th>Rank</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-time shipments</td>
<td>1</td>
<td>&gt;99.8%</td>
</tr>
<tr>
<td>Internal cycle time</td>
<td>2</td>
<td>&lt;3.8 Hours</td>
</tr>
<tr>
<td>Dock-to-stock time</td>
<td>3</td>
<td>&lt;2 Hours</td>
</tr>
<tr>
<td>Total order cycle time</td>
<td>4</td>
<td>&lt;7 Hours</td>
</tr>
<tr>
<td>Order accuracy</td>
<td>5</td>
<td>&gt;99.8%</td>
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</tbody>
</table>

Same top 5 metrics as 2015
Dock-to-stock moved from #4 to #3.
No significant change in fulfillment mix.

Operation metrics focus on managing opposing forces:
- Available Inventory vs. Inventory Cost
- Speed of Fulfillment vs. Order Accuracy
- Cycle Time vs. Fulfillment Costs

[Image showing the distribution of order sizes]
Robotics in the warehouse

- Fluid Truck Unloading
- Pallet Stripping:
  - Layer
  - Random Case
- De-case for AS/RS
- Mixed Load Palletizing
- Mobile Full Case Pick
- Full Case Slapper Line w/ Print and Apply
- AGV Pallet To Robotic Case Depal / Pick
- Each Picking

Warehouse Costs:
- Shipping: 15%
- Receiving: 15%
- Storage: 20%
- Order Fulfillment: 50%
Robotics in the warehouse

- **Receiving**
  - Robotic fluid truck unloading
  - Robotic layer pallet stripping
  - Robotic random case pallet stripping
  - Robotic de-case for AS/RS
  - Robotic pallet building for put away

- **Order Fulfillment**
  - Robotic full case slapper line
  - Robotic mobile full case pick
  - AGV pallet to robotic case depal / pick
  - Robotic each-picking

- **Shipping**
  - Robotic mixed load palletizing
  - Robotic fluid truck loading

Warehouse Costs

- Storage: 20%
- Order Fulfillment: 50%
- Shipping: 15%
- Receiving: 15%
Receiving — single SKU depalletizing by layer

- Replacement for manual hand line operations
- Utilize integrated machine control and vision guided robotic technology
- Combine with an Print solution for cross docking and order fulfillment
Receiving / order fulfillment — case depalletizing

- Replacement manual operations
  - “Slapper Line” case pick
  - Ergo depal replacement
  - Combine with a print solution for cross docking and order fulfillment

- Utilize integrated machine control and vision guided robotic technology

- Solution still in development
Put away and replenishment

- Mobile robotics for full load handling
- Replacement for long pallet conveyor runs
- Multi-function platform
- Goods-to-Man retrieval
- Robot-to-Robot handling
Order fulfillment robotic each picking

- Repack/Bin Picking Operations
- Highly dynamic environment
- Multiple technology advancements required
- Mobile manipulation in unstructured environments
- Mobile Robotic Platform w/ autonomous navigation
- Low cost highly functional arm(s)
- Robust vision algorithms for reliable/consistent object detection
- Current technology very costly
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