Conquering palletizing challenges in manufacturing and warehouse environments

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Your presenters

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Frank has nearly 40 years of experience in the automated material handling industry in a variety of positions, from estimating and design engineering to product management and AutoCAD implementation. He currently oversees the Intelligrated machinery product line and is available for comment on packaging industry trends, robotic systems, palletizers and depalletizers. Frank holds a bachelor’s degree from Oklahoma State University in industrial engineering and management.

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Matt has more than 18 years of experience in the material handling industry with expertise in the areas of controls and software integration for high-volume facilities as well as unique build-to-order fulfillment solutions. He holds a bachelor’s degree in electrical engineering from the University of Missouri – Rolla (Missouri S&T) and currently sits on the university’s corporate development council. Matt is also a registered Professional Engineer in the state of Missouri.
How important is palletizing?

Pallet loads of product moving out your shipping door = sales $$$

When the palletizing process is inadequate, customer commitments are in jeopardy, sales can suffer, and the entire facility feels the pain.
The challenge

Knowing when to incorporate or upgrade an automated palletizing solution is a difficult decision for many manufacturing or distribution facility managers.

If you’re struggling to keep up with increasing order volumes, unable to adapt to evolving packaging methods or outgrowing your manual pallet building processes, it may be time to reevaluate palletizing methods.

From conventional systems and state-of-the-art robotics to hybrid options with varying degrees of sophistication, today’s palletizing solutions can be difficult to sort through.
Polling question #1

Which type of palletizing do you currently use in your operation?

- Manual
- Conventional
- Robotic
- None
Conditions driving the need to invest in palletizing

1. Desire to improve operating efficiencies
2. Trends in package/case design (including totes for order fulfillment)
3. SKU explosion, creating the needs for flexibility and auto changeover
4. The requirement for more complex load configurations
5. Increasingly stringent safety requirements
6. Labor market challenges
1. Palletizing and line efficiency

The impact of palletizer downtime on operating performance is usually obvious; however, even “normal operation” can be hurting efficiency.

**Palletizing must be treated as a system,** not just a machine.

- The ability to feed product “back-to-back” (no air)
- This is particularly challenging when curves exist close to the palletizer infeed
- Line pressure must be avoided, i.e., upstream conveyor pushing product into machine. It causes loss of gap, miss-counts and ultimately, jams.
1. Palletizing and line efficiency

Additional system challenges:

• Even short, “normal” stoppages at the palletizer can ripple up through the case delivery system and have a significant impact.

• If the palletizer stops for five seconds each time a load is discharged, with an improperly designed or controlled infeed system, this can translate into downtime of upstream processes many times greater.

• This is because of “singulation” that is occurring on the conveyor system.

• Think of automobiles accumulated at a stop-light.

• The concept of “negative accumulation”
1. Palletizing and line efficiency

The best protection against a poorly designed case delivery system is a palletizer that is fast enough to “pull away” and the infeed never stops during normal cycle.

However, as rates goes up, these challenges increase exponentially.

For optimum performance - palletizing must be treated as a system.
2. Packaging trends create new challenges

**Trend**

Less (or in some cases, No) Secondary Packaging
Consumer package often the product that must be palletized
Printed Graphics with slick, low friction surfaces
Shrink film only packs (“unsupported film”)
“Stagger” or “Offset” packs in beverage
Film bundle, (lose wrap, no shrink)
Display packs with “knock-out” panels or open sides
Lighter weight, (less rigid), primary packaging and containers

**Impact**

Easily damaged, more difficult to handle
Smaller Packs = Higher Rates
Case control, pattern forming is challenging
Uneven bottom, may not convey well
Uneven sides & corners, and packs interlock
Lose, 'squishy' package, film can snag
Weak case, product can fall out
Susceptible to damage
Palletizing totes

- Growing in popularity for shipping small and loose items
- Common in distribution applications and order fulfillment
- Totes present unique palletizing challenges
  - Nesting can be difficult
  - Load stability issues
  - Over-filling is common (lids won’t close)
  - There is often a mixture of tote designs within a load
3. An explosion in the number of SKU’s

- The variety of case and pack sizes continues to increase
- Large packs for club stores, small packs for convenience

This puts pressure on the need for rapid, tool-less changeover.
4. Changing load configurations

• Frequent pattern revisions (due to changes in packaging type and size)
• Display loads (end-of-aisle and club stores)
• Labels or graphics out (visible from exterior of load, four sides)
• Less pack strength requires revisions to how loads are constructed
  - Shorter loads
  - Stretch film
  - Tier sheets
  - Trays and cap sheets
  - Corner-boards
• Labeling and tracking of loads
5. Increasingly stringent safety requirements

- CAT 3, dual channel safety rated components, including PLC
- Distance from hazard considerations
- Physical barriers, interlocked access gates, etc.
- Zero-energy state (i.e., automatic air dump)
- Arc flash considerations
- High-voltage isolation
- Lockable e-stops and disconnects
- Audible alarms
6. Labor market challenges

- Dwindling labor pool
- Unskilled labor cost to increase faster than inflation? $15 minimum wage?
- Jobs such as manual palletizing typically see high turnover rate
- Risk of injury to workers (back injuries, etc.)

Polling question #2

Which factor do you feel is the most crucial to consider when investing in palletizing?

• Desire to improve operating efficiencies
• Trends in package/case design (including totes for order fulfillment)
• SKU explosion, creating the need for flexibility and auto changeover
• The requirement for more complex load configurations
• Increasingly stringent safety requirements
• Labor market challenges
• Other
All of the previous considerations can be satisfied.

The trick is to pick the right solution.
Palletizing options

- Manual/semi-auto
- Conventional machine
- Robotic: pick-and-place
- Hybrid
Determining the best solution

**Manual/semi-auto**

**Positive**
- Low capital cost
- Flexible
- Scalable

**Negative**
- High operating cost
- Slow and inefficient
- Can be unreliable
- Risk of injury
- Labor shortages

**Automatic**

**Positive**
- Fast and efficient
- Reliable
- Repeatable/predictable
- Cost-effective over time

**Negative**
- Requires capital investment
- Requires more floor space
- Requires maintenance
- **Wrong solution = failure**
Robot or conventional?

More often than not, the first question asked today is:

What is the better palletizing solution... robots or “conventional” palletizing machines?
Conventional palletizing machines

Row-forming pattern formation

In-line, continuous flow pattern formation

High-level, row forming

High-level, in-line, continuous flow

Floor-level, row forming
Robotic palletizing

- Single-case pick
- Row pick with “fork-and-clamp” tool
- Multi-case pick, two load-build positions, vac tool
Robot or conventional: first consider the application

- Products to be handled: type, construction, dimensions, weight, etc.
- Required palletizing rate
- Number of products/lines to be palletized simultaneously
- Load requirements:
  - Stacking patterns
  - Pallet, slip sheets, tier sheets, top sheets
  - Display loads (graphics-out), mixed SKU/rainbow loads
- Facility considerations: available space, distance from production ...
- Personal preference

One or more of these parameters may make the choice clear.
Robot or conventional: first consider the application

And don’t forget: it’s a system!

- System considerations
  - Conveyance methods for the product to be handled
  - Multi-line vs. dedicated machines/cells
  - Full-load handling
  - Ancillary equipment: sheet dispensers, wrappers, labelers, etc.
  - Order fulfillment needs? Mixed SKU system?
Robots or conventional: rate is a key parameter

- **Robots:** Rough rule of thumb — a typical palletizing robot with more than one load-build position on average will achieve **6 to 8 cycles/minute.**

  The number of cases handled per pick cycle is key in determining rate. Example: (4 cases/pick) x (6 cycles/min) = 24 cpm

  Patterns, case types, cell layout and other factors also impact rate.

- **“Conventional” palletizers:** Palletizers are typically designed to handle product in a continuous flow. Rate is based on case-feet/min at the infeed, minus any stoppages.

  Capacity ranges from less than 20 cpm to more than 200 cpm, depending on the palletizer design and product characteristics.
Factors favoring conventional palletizing

- Rates above 30 cpm (not a hard rule; varies greatly)
- The need for slip sheets and/or tier sheets combined with a high rate
- While robots are known for flexibility, in many instances, conventional solutions offer great package handling versatility (tooling considerations)
- Certain package types: like open-top, shrink-trays or display packs
- Conventional load quality can actually be better in some circumstances
Factors favoring robotic palletizing

- Multiple, slow speed production lines
- One robot often handles four lines without long runs of accumulation conveyor
- If rates are low enough, robot can also handle pallets and sheets, saving the cost of dedicated pallet and sheet handling equipment
- Unique requirements, such as labels or graphics to outside of load
- Certain product types, such as bags or pails
- Mixed SKU loads
- The need to interface with a vision system
- Highly unstable loads: pallet remains stationary during build process, option to simultaneous stack and stretch-wrap (stack-and-wrap)
Selecting a robotic integrator

- Should have extensive knowledge of automation in this industry
- Deep understanding of robotics across the organization
- Has a plan and can execute to it
  - Good pre-order service is an indicator of post-order service
  - Complete proposal with attention to detail
  - Installation and commissioning are two different skills; do they have both?
  - Professional project management

- Reputation
  - What kind of references do they have? Are they offering to take you to installations?
  - Are they RIA certified?

- Size matters
  - Can the company successfully execute more than one project at a time?
  - Financial security

Remember, you are buying a system, not just a robot.
What is a “hybrid” solution?

- Hybrid solutions are the combination of conventional and robotic technologies to capitalize on the strengths of each
- Can provide greater overall performance and/or versatility
- Typically more expensive, so there must be a tangible benefit
Why consider a hybrid solution?

- Potential for more reliable pattern formation ("repeatable")
- Flexibility: good for frequent and fast changeover
- Accuracy allows tighter patterns (reduces ancillary hardware)
- Labels-out (graphics-out) capability comes “free”
- Well-suited for multi-line systems
- New stacking patterns can be added by end user, minimal mods
- Ability to “tweak” on the fly
Hybrid palletizers

Infeed can be low or high level

Robots: industrial arm or gantry

Robot places cases on the apron of a row-forming palletizer.

Robots perform layer forming on an in-line palletizer.
# Palletizing rate overview

<table>
<thead>
<tr>
<th>Type</th>
<th>Infeed Elevation</th>
<th>Pattern Forming</th>
<th>Typical Rates up to...</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional Low Row Forming</td>
<td>Low</td>
<td>Row Forming</td>
<td>4 LPM</td>
</tr>
<tr>
<td>Conventional High Row Forming</td>
<td>High</td>
<td>Row Forming</td>
<td>8 LPM</td>
</tr>
<tr>
<td>Conventional High In-Line, Continuous Flow</td>
<td>High</td>
<td>In-Line, Continuous Flow</td>
<td>15 LPM</td>
</tr>
<tr>
<td>Robotic Low or High Pick and Place</td>
<td>Low or High</td>
<td>Pick and Place</td>
<td>10 CyPM</td>
</tr>
<tr>
<td>Robotic Low or High Pick and Place Rows</td>
<td>Low or High</td>
<td>Pick and Place Rows</td>
<td>8 CyPM</td>
</tr>
<tr>
<td>Robotic Low or High Pick and Place Layers</td>
<td>Low or High</td>
<td>Pick and Place Layers</td>
<td>5 LPM</td>
</tr>
<tr>
<td>Hybrid Low In-Line, Continuous Flow</td>
<td>High</td>
<td>Pick and Place Rows</td>
<td>10 CyPM</td>
</tr>
<tr>
<td>Hybrid Low In-Line, Continuous Flow</td>
<td>Low</td>
<td>In-Line, Continuous Flow</td>
<td>5 LPM</td>
</tr>
<tr>
<td>Hybrid High In-Line, Continuous Flow</td>
<td>High</td>
<td>In-Line, Continuous Flow</td>
<td>12 LPM</td>
</tr>
</tbody>
</table>

Note: Rates given are “normal” maximums. However, rates well above these figures are possible, depending upon product, pattern, and machine or cell design characteristics.
Additional factors in selecting a palletizing solution

• Cost. No simple rule here. Depends upon application and solution.
• Best long-term reliability, given the application and environment
• Building constraints
• Existing equipment
• Which technology can be supported by operations and maintenance staff?
  - Example: proprietary controller vs. PLC
• Flexibility and ability to adapt to future needs
• Availability of service, support and spare parts
• **Preference and comfort level** (often an emotional preference)
Palletizing in a DC or order fulfillment center

• Tote palletizing, by order:
  - Sort and accumulate totes into buffer lanes, by order
  - Release completed orders to palletizer
  - Conventional palletizing has advantages over robots
Palletizing in a DC or order fulfillment center

• Mixed SKU loads
  - Uniform case size, but mixed SKU
  - Rainbow loads: homogenous layers, but each layer is different
  - Begin with “starter load”, and stack mixed products on top
  - Loads built in columns rather than layers
  - Total mixed SKU
    • Pre-planned, sequenced load build (for stackability — best puzzle fit)
    • Partial pre-planned — present options at time of palletizing
    • Total random — stack whatever arrives in whatever sequence
Palletizing in a DC or order fulfillment center

- Due to upstream system cost, semi-auto is often a viable solution.
- This is particularly true for totally mixed SKU palletizing.
De-palletizing from donor loads

Semi-auto

Multi-layer pick

Layer pick

Tigard “claw”

Single-case pick
Software: consider the whole system, now and future

- **Architecture considerations**
  - Common user interface vs. dedicated interfaces
  - How does this fit in with my system now?
  - How flexible will my system be in the future, based on trends?
  - Flexibility, scalability and ease of use
Software: consider the whole system, now and future

- Integrated system considerations
  - WMS/WES

- Simulation should be performed on robotic systems
Software: win now with future flexibility

- Tools and utilities should be easy to use and accessible
  - Load-forming tools: pattern, layers or mixed loads
  - Data and reporting (IoT, “Internet of Things”)
  - Documentation/drawings
Software: win now with future flexibility

- Key considerations
  - Will maintenance and operations be able to support the system?
  - If products/patterns change in the future, what is involved?
  - Vision, labeling and scanner integration
Questions, answers and discussion