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Innovative 3:1 Merge System for Spiral Freezer to Robotic Case Packer Integration

Executive Summary

A major North American food producer in Vineland, New Jersey required a high-performance 3:1 merge system to solve inconsistent multi-lane product flow exiting a new spiral freezer and feed a consistent single-lane flow into their downstream robotic case packing system.

The system was designed to mount on an existing mezzanine with minimal modifications and integrate directly with an already-installed freezer and largely pre-built infeed system. Only one auxiliary conveyor required rework — avoiding a much larger 8-machine routing overhaul.

Developed in 4 weeks, built in 6 weeks, and delivered in 12 weeks total, the stainless steel 3:1 merge system has delivered exceptional reliability. After more than three years in continuous operation, it has required only planned maintenance with zero unplanned downtime. It integrated flawlessly on the first attempt despite limited direct access to the parallel equipment design teams.

Project Background and Challenges

The customer was in the middle of a major production line upgrade involving a new spiral freezer when variable product flow from the freezer's multi-lane discharge began creating downstream inefficiencies for the robotic case packer.

Key project constraints included:

- Handling inconsistent output from the spiral freezer's multiple lanes
- Creating a smooth, consistent single flow into the robotic case packing system
- Mounting on an existing mezzanine with minimal structural changes
- Integrating with an already-designed and partially installed freezer and infeed system
- Extremely tight timeline to support overall line commissioning
- Full food-grade sanitary requirements

The goal was to avoid a complete redesign of the upstream routing system (originally envisioned as up to 8 machines) by implementing a compact, high-reliability merge solution.

Solution: Custom 3:1 Merge System

The engineered solution utilizes three independent belt staging zones that accumulate, align, and synchronize products from the multi-lane freezer discharge. Once properly staged, the three streams are precisely merged onto a 90-degree transfer outfeed conveyor, delivering consistent single-lane flow to the robotic case packer.

Key Technical Features:

- Multi-Belt Staging Architecture: Three parallel blue modular belts with independent control zones for accumulation, alignment, and release.
- 90-Degree Merge Transfer: Optimized geometry ensures gentle product handling while achieving reliable lane consolidation.
- Mezzanine Compatible Design: Engineered to fit existing infrastructure with only minor modifications.
- Minimal Infeed Rework: Integrated with the largely pre-built infeed system — requiring rework on only one auxiliary conveyor.
- Sanitary Construction: All stainless steel frame and components for washdown compatibility.
- Premium Controls & Motion: Allen-Bradley controls, CSE electrical enclosures, and One Motion Direct Drive rotary technology for precision and long-term reliability.

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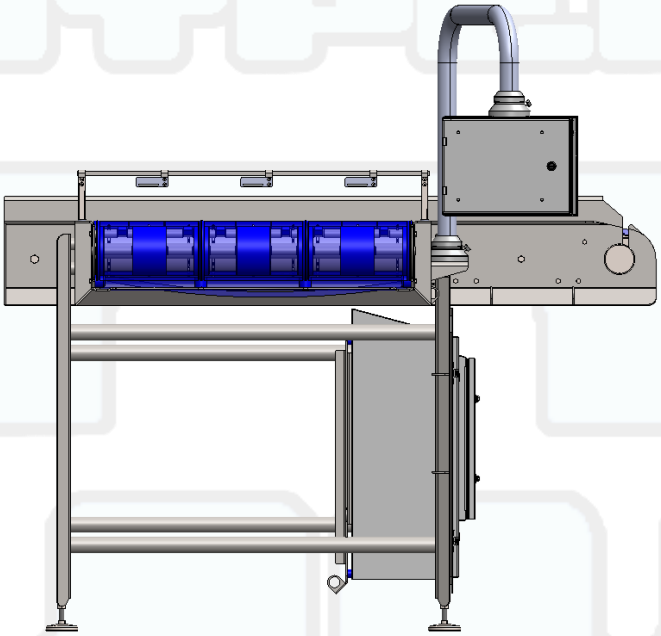
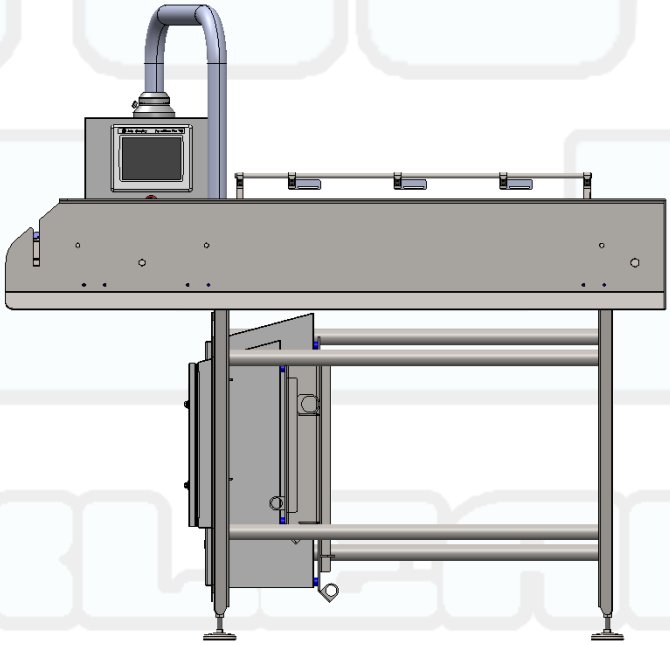
The complete system was modeled in SolidWorks 3D for accurate fit verification and clash detection. Draftsight 2D was used for all layout drawings and cross-company collaboration with the automation integrator and end customer.

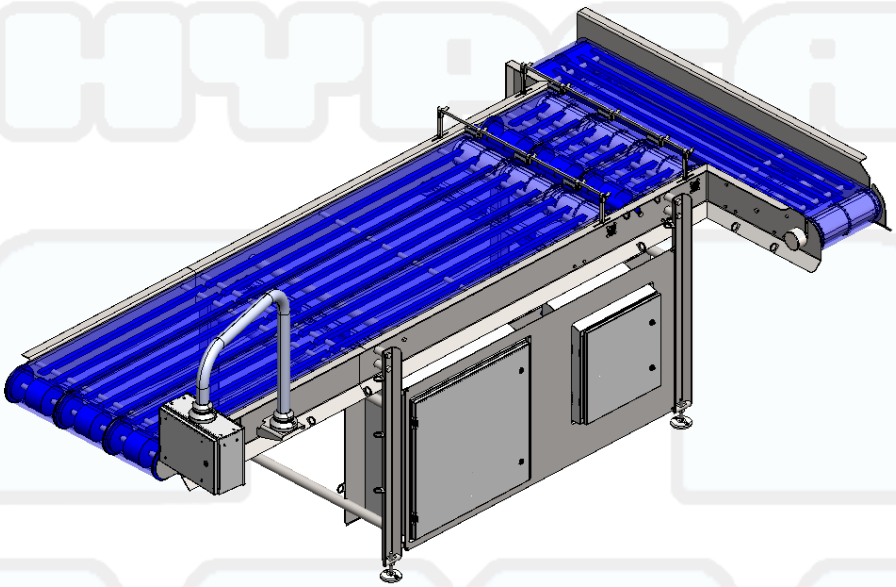
Rear view of the 3:1 merge system showing the three blue staging belt sections.



Front view highlighting the control panel, HMI, and overall integration layout.



Isometric CAD rendering showing the full system layout and 90° outfeed transition.



System in operation at the manufacturing partner's facility during final testing and validation prior to shipment.

Project Timeline

- Weeks 1–4: Rapid concept development, 3D modeling, design reviews, and approval.
- Weeks 5–10: Fabrication, assembly, and comprehensive factory testing.
- Week 12: Shipment to the automation integrator for final line integration.

All design and coordination were completed digitally with high precision, resulting in a smooth installation with no on-site modifications required.

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Performance Results (3+ Years in Operation)

- Outstanding Reliability: Only scheduled maintenance downtime — no mechanical, electrical, or controls failures.
- Perfect Performance Match: Consistently transforms inconsistent multi-lane freezer output into stable single-lane flow for the robotic case packer.
- Seamless Integration: Installed without issues despite concurrent projects and limited direct designer access.
- Significant Cost Avoidance: Eliminated the need for a much larger and more complex 8-machine routing solution.

Technical Specifications

- Controls: Allen-Bradley PLC platform with HMI
- Electrical: CSE industrial enclosures
- Motion Systems: One Motion Direct Drive rotary technology
- Belting: Food-grade blue modular conveyor belts
- Construction: Full 304/316 stainless steel
- Design Software: SolidWorks 3D + Draftsight 2D

Conclusion

This 3:1 merge system successfully solved a critical flow challenge in a complex brownfield automation project. By delivering a compact, highly reliable solution under extreme time pressure, the system enabled the customer to maintain their aggressive production timeline while achieving excellent long-term performance.

The project showcases the value of rapid custom engineering, precise digital modeling, and strategic component selection when integrating with existing food production infrastructure.

Designed and Engineered by: James Grover of Hyper Klean

All images and renderings are from the actual project.