HANDLING APPLICATIONS WITH

Conveyor and Sortation Systems

MHI

CSS
Conveyor & Sortation Systems

Distributed by:

Conveyor & Sortation Industry Group of MHI
8720 Red Oak Blvd. Suite 201
Charlotte, NC 28217

PREFACE

The **Conveyor and Sortation Systems (CSS) Industry Group** members are the Industry's leading providers of conveyors and sortation systems. They design, fabricate and install conveyor and sortation systems worldwide and in virtually every major manufacturing and distribution sector. CSS prepares and distributes educational and promotional materials regarding the proper application and benefits of conveyor and sortation system solutions.

CSS also publishes and promotes materials on the training, inspection, safety and maintenance of conveyors and sortation systems. The Vertical Reciprocating Conveyer (VRC) Subcommittee of CSS is comprised of the industry's leading suppliers of material lifts. They design, manufacture, and install VRCs worldwide for use in a wide variety of industrial, commercial, and institutional operating environments.

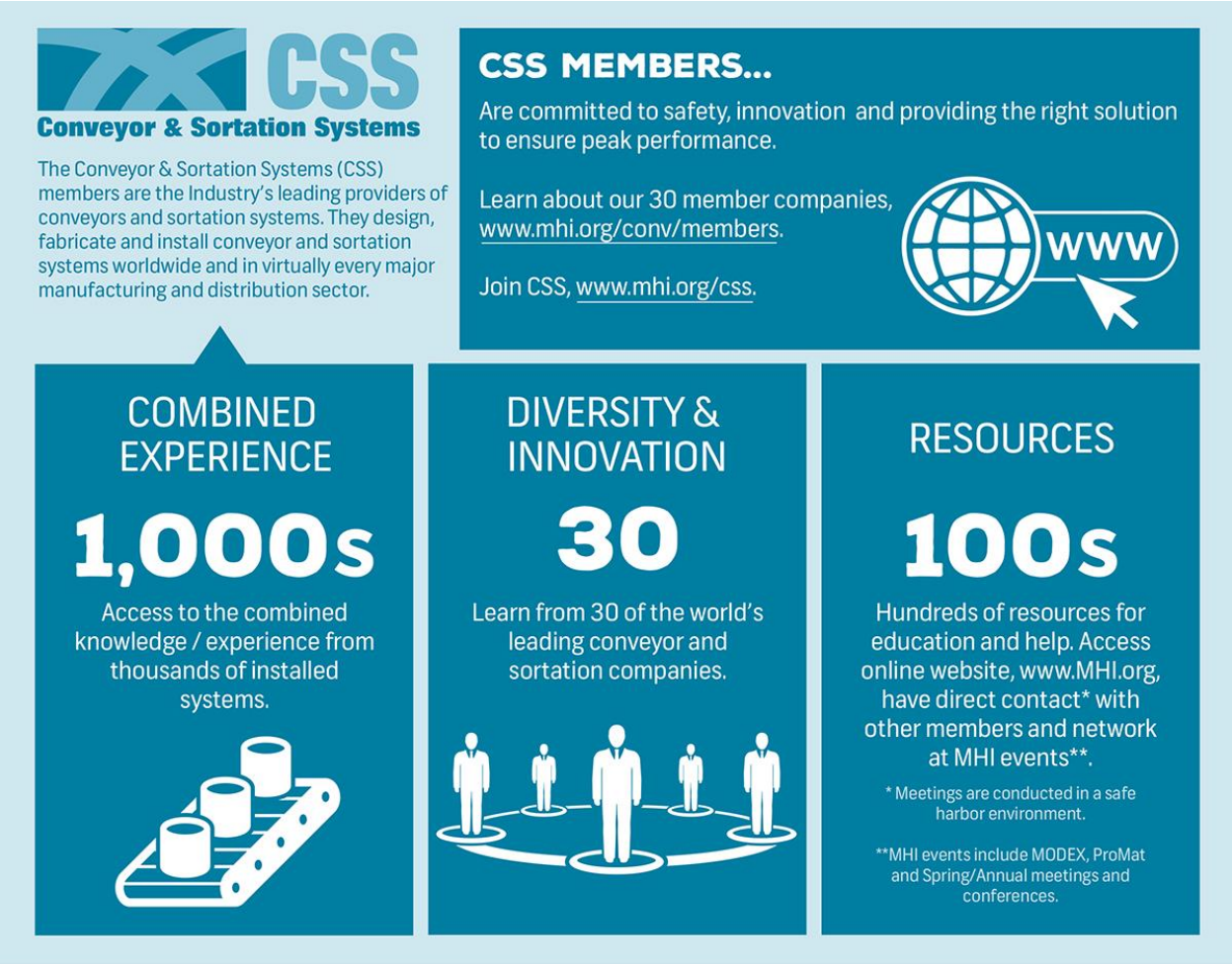
MISSION & VISION

Mission: To promote the market growth and effective use of conveyor and sortation systems in manufacturing, warehousing, distribution and other key markets.

Vision: To be the recognized independent authority for end users and suppliers on market trends, technology developments, and applications through:

- Education the market on key features, advantages, and benefits of conveyor and sortation systems
- Identifying key issues affecting our marketplace through user outreach
- Development and distribution of educational materials
- Collaboration of manufacturers and technology providers on trends affecting the industry
- Promotion of career opportunities within the CSS industry

The **Conveyor and Sortation Systems (CSS) Industry Group** of MHI combines the knowledge and experience of thousands of installations. For more information, visit **mhi.org/css.**



CSS MEMBERS

Aegis Sortation
AGiLE Business Media LLC
Alfacon Solutions
Autoquip Corp.
BEUMER Corp.
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Carter Control Systems Inc.
Datalogic
Dematic
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This handbook provides an overview of the different possible functional applications of conveyors and sortation systems within warehouses and distribution centers. Its purpose is to give an overview into some of the ways in which conveyors and sortation systems can be potentially deployed throughout a variety of inventory handling processes. Examples range from manual operations to highly automated facilities; technical specifications are not included. However, the conveyor and sortation systems industry group of MHI can support an individual analysis on a project basis. Therefore, details on how to contact material handling experts are included at the end of this handbook.

INTRODUCTION: CONVEYORS & SORTATION SYSTEMS IN THE WAREHOUSE / DISTRIBUTION CENTER

The essential function of a warehouse or distribution center is to store inventory until needed. Whether that inventory is stored as individual items, in cases or totes, or by the pallet load, it will be transported throughout a facility by one or more types of equipment as it passes through each functional area:

- **Inbound Receiving:** Unloading of received inventory and transporting those items to storage
- **Order Picking:** Moving products from storage to picking areas, or within picking zones as orders are filled
- **Order Staging & Sortation:** Accumulating and holding items for further processing or packaging, then organizing products to deliver them to their final destination
- **Outbound Shipping:** Transporting completed orders to trailer-loading area for distribution

Although every facility is different, those that implement conveyors and sortation systems do so within a functional area because they enable more efficient movement of materials. Because they are engineered to transport and organize large volumes of materials rapidly through a process, conveyors and sortation equipment save labor expense while increasing handling productivity.

INBOUND RECEIVING

At the point of inbound receiving, trailer loads of product arrive at a dock. The trailers are backed into the dock doors, and items are unloaded. The methodology for how this process occurs is determined based on a number of factors, one of which being the format in which the items arrive.

Trailer Unloading

Palletized loads are nearly always unloaded manually with a pallet jack or forklift (unless the items on the pallets are being removed individually by hand). However, loads received unpalletized—that is, in floor-stacked reusable plastic totes or cardboard cartons—unloading is typically handled manually.

This manual unloading process can be facilitated by an **accordion conveyor** *(pictured left)*. This type of conveyor is flexibly extendable, allowing it to stretch further into a trailer as the associate moves further into the vehicle to remove product. Accordion conveyors are frequently **gravity wheel**, relying on the force of gravity (and a push from the associate) to send the carton or tote down the incline to another associate waiting to receive it at the dock floor level. These systems are often installed when unloading activities are not under significant time, throughput or labor pressures.

Alternately, for manual unloading of trailers, **powered extendable belt conveyors** may be specified. The powered belt ensures that an item placed upon it will travel out of the trailer, regardless of the angle of incline. Because the belts run continuously, only a single operator is needed to unload the trailer; adding a second operator can increase unloading throughput.

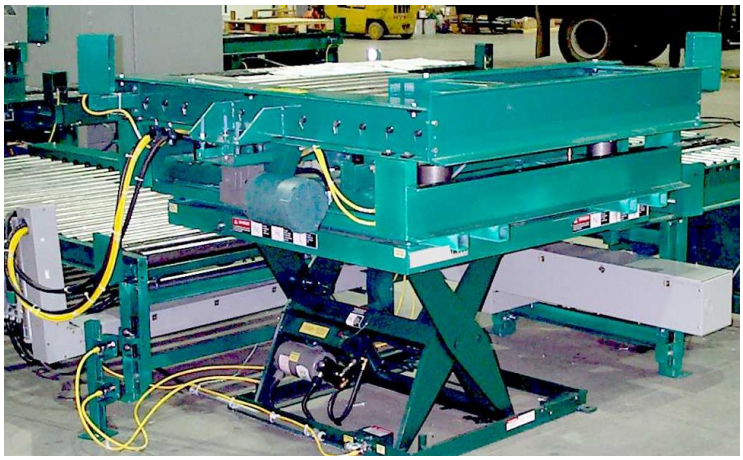
Regardless of the type of trailer unloading conveyor specified, they are frequently installed so that a single conveyor line can serve more than one (usually up to three) adjacent dock openings. This maximizes return on investment, as a single line can be used while subsequent dock positions turnover from one vehicle to the next.

Transport to Storage

Once inventory has been received and documented in the facility's inventory management system, the items are assigned to their unique storage location.

Full pallet loads are moved to a variety of locations within an operation—including reserve storage or multi-level pick modules—usually by **powered roller accumulation conveyor**. Upon arrival at the destination, a forklift typically removes the load from the conveyor and places it within its storage location or pick module position.

In a more manual operation, after being unloaded, individual cases or totes could be sorted and stacked by hand onto pallets. **Lift tables** *(pictured right)* or **pallet positioners** and **turntables** can be used to reduce the lifting, bending and carrying loads for this manual loading process. Loaded pallets can be transported to storage by forklift or **powered roller accumulation conveyor**.

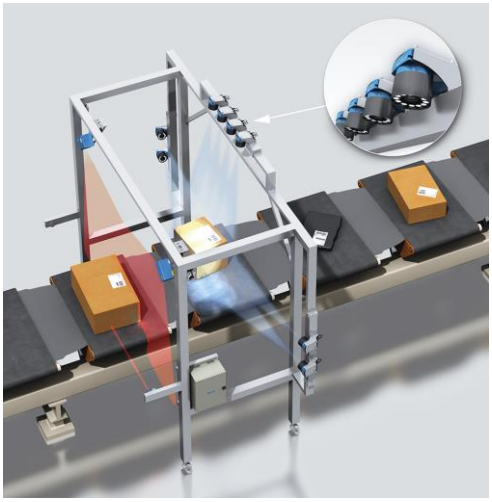


In a more automated process, the totes and cases could be transferred from an unloading conveyor to an **incline belt conveyor** *(pictured left)* that merges all the received items onto a single transport conveyor, either a **powered roller conveyor** or a **belt conveyor**. Depending on the size of the facility, this transport conveyor could be several hundred feet long. At the endpoint—usually a storage area—**zero-pressure zoned accumulation conveyor** might be used for staging the cases prior to putaway.

At that point, in manual operations, a person would handle the cases. Processes could involve manually separating a carton of items and placing them into totes for induction into an automated storage system. Cases and totes stored in static locations might travel by **incline conveyor** or **spiral conveyor** to another elevation, such as within a pick module or mezzanine.

Alternately, in more automated operations, a **shoe sorter** *(pictured left)* could be deployed to route each item to a different destination based on identification scans. The next pre-storage handling process might include manual or **in-line automatic dimensioning and weighing** *(pictured below)* of the received items; decanting a large box into separate items stored in totes for handling in an automated storage and retrieval system (AS/RS); or manual placement in a storage location.

In highly automated applications handling variably sized cases of received product, **inbound shoe sorters** might be used. These complex systems utilize scanners or imagers to trigger the shoes to slide across the conveyor's surface slats and divert the item to a takeaway conveyor. The items are then transported to their storage destination, typically an automated storage and retrieval system (ASRS).



ORDER PICKING

Zone-Based Picking

In a zone-based picking approach, associates are assigned to one (or more) separate aisles of rack or shelves storing products within a facility. Items to be picked are either in individual or case quantities. Positioned perpendicularly to the aisles—and often running between two flanking sides—is a **powered roller accumulation conveyor** or a **powered belt conveyor** that moves shipping cartons or reusable plastic totes along its surface from zone-to-zone.

Additionally, depending on the design of the system, multiple spurs of other conveyors might branch off the main powered **accumulation conveyor** *(pictured left)* to accept cartons or totes as they are transferred or diverted to a specific zone. These **diverts** are usually **bi-directional**, allowing the totes or cartons to be transferred to a zone on either the right or the left side of the main conveyor line. Based on an identification scan, the conveyor's control system knows which zones each tote or carton needs to visit in order to receive an item picked from those specific aisles.

Zone-based picking can also occur at different heights or levels of a mezzanine or pick module. Frequently used in case picking applications, pallet loads are placed from the outside of the racking structure into each level at openings with short runs of **gravity roller conveyor**. The pallets then flow down to an aisle with a **powered roller or belt conveyor** running between the two sides of the racking, upon which individual picked cases are placed.

The picks exit the higher levels of the structure via a **spiral conveyor** or a **vertical reciprocating conveyor (VRC)** *(pictured right)* to reach floor level, where they merge onto a **powered belt** or **roller conveyor** for transport to the packing or shipping area.

Replenishment of Forward Pick Zones

Often, facilities will designate a specific area for bulk storage of palletized inventory. In operations that are more manual, this stock is typically stored in pallet racking. When specific items are needed to replenish forward pick zones, a forklift will retrieve the required pallet and either deliver it directly to the picking area, or place it onto a **powered roller** or **belt conveyor** that routes the pallet to a different area of the facility.

Alternately, in a highly automated facility utilizing automated storage and retrieval systems (ASRS) to store pallets, the system automatically retrieves the pallet and then feeds it via **powered belt** or **roller conveyor** to the area requiring replenishment.

Goods-to-Person Picking Systems

In manual operations, carton flow rack—with short segments of **gravity wheel conveyor**—are often deployed to feed cases or containers of individual product to operators picking within that area. Whether the items are in reusable totes or cardboard cartons, an overhead **belt conveyor** may be deployed in that area for takeaway of the containers when they are emptied. Replenishment of these flow racks is from the rear of the racking system and nearly always completed by hand.

In semi-automated or automated systems, such as shuttle- or crane-based ASRS handling totes of individual products for item picking, the system delivers the required tote to an operator (or a robot) positioned in one location—a picking station. **Powered roller** or **belt conveyor** with diverts is a commonly used approach in this type of automated goods-to-person picking *(pictured right).*

ORDER STAGING AND SORTATION

Transport of Picks to Packing

Completed orders (that don't require additional items) are typically routed to a quality control and packing area prior to shipment. A variety of conveyors might be implemented to transport these cartons or totes, including **powered accumulation roller** or **powered belt**. The container itself is usually diverted into a series of **gravity roller conveyors** to travel down to one of many pack stations and a waiting operator for manifesting processes *(pictured below)*.

Upon arrival at this station, an associate would remove items from a reusable tote and place them into a shipping container, envelope or pouch (or would receive the shipping container with the required items already inside). After verification of the contents, an associate in a more manual operation might add a packing list, invoice, void fill or other information into the parcel, prior to sealing it and applying a label.

In a more automated operation, the shipping carton may travel on a **powered roller** or **belt conveyor** with a gapping function to separate each parcel prior to routing it through a dimensioner or scan tunnel to verify the correct items are inside based on weight (operations also packing to envelopes and pouches are more likely to use a **belt conveyor** to accommodate the different parcel formats.) Triggered by in-line scanners or imagers, automatic document

insertion, label printing and application, and box sealing systems can also be integrated with this conveyor system to finish each parcel prior to shipping.

Transport of Picks to Consolidation Area

A similar process is used when multiple items required to fulfill a single order are routed to a consolidation area. **Belt or roller accumulation conveyors** are often used to facilitate this process as the order carton awaits the arrival of items picked in different areas of a distribution center.

Alternately, **circular sorters** may be deployed to keep open orders moving throughout an operation as they wait to be completed. Cartons or totes travel atop individual modules of **tilt-tray** or **bi-directional cross belt** *(pictured right)* style sorters, awaiting divert to a consolidation area when the needed items arrive.

Sorting of Packed Orders

Upon completion of order packout, the outbound parcels are transferred either manually or via a **divert** to a **powered belt** or **roller conveyor.** Operations utilizing reusable plastic totes frequently use a similar conveyor system to move the empty totes back to the start of the picking line. In either case, scanning technology *(pictured left)* identifies the container then routes it to its next destination.

Individual cases might be palletized—either manually or automatically. Those items are most commonly routed to an operator with stretch wrap or an automatic palletizing machine via a **belt** or **roller accumulation conveyor** to maintain control of the items and feed them at a metered rate.

OUTBOUND SHIPPING

Transport to Shipping

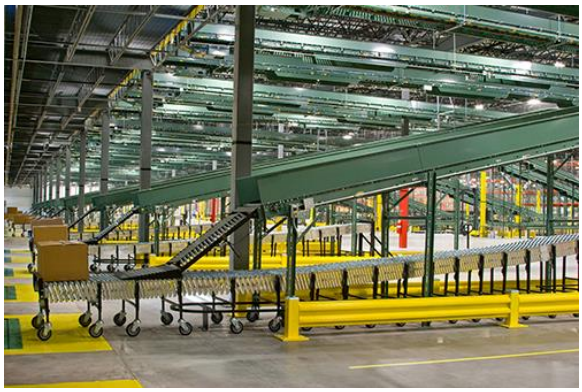
Once packed and ready for shipment, individual parcels are routed typically via **powered belt** or **roller conveyor** to their next destination: the shipping dock.

Depending on the throughput requirements of the operation, different types of shipping sorters may be applied within this area of the facility. A low- or medium-throughput operation might implement multiple **right-angle transfer sorters** or **divert sorters** running alongside the dock to direct parcels to different trailers; a high-throughput operation—or one with a broad range of product dimensions and weights—is more likely to utilize either a **narrow belt sorter** or a **sliding shoe sorter**.

Each trailer usually represents a different destination, geographic region or carrier service; integrated scanners or imagers read the barcode or shipping label to route each parcel accordingly. As the parcels or cartons are diverted, they travel down a **decline—either powered or gravity—roller conveyor** *(pictured left)*, then usually onto an **accumulation conveyor (powered belt or roller)** as they await loading onto the correct trailer.

Trailer Loading

As with trailer unloading on the inbound receiving side, the same types of conveyor technologies are used for trailer loading on the outbound shipping end of an operation. Manual loading of floor-stacked cartons process can be facilitated by an **accordion conveyor** *(pictured right)* or by **powered extendable belt conveyors.** Palletized loads are frequently placed into trailers with forked vehicles.



THINGS TO CONSIDER WHEN SPECIFYING CONVEYORS AND SORTERS IN AN APPLICATION

Load Type

The type of load—or loads—to be transported and transferred will often dictate the type of conveyor or sorter chosen. It is important to know item dimensions, weights, packaging formats, degree of fragility or robustness, and so on when determining the optimal handling solution. Additionally, consider how often the type of inventory handled may or may not change, as different solutions are more adaptable to variable item types.

Load Origin and Destination

The distance between Point A and Point B is important, as are any obstacles (building columns, fixed structures, ceiling heights, floor conditions, etc.) that might be between the two. These factors—along with the availability of space in general—could impact the complexity of the system layout and design.

Desired Throughput Rate

Current and desired throughput rate during normal and peak operations are important factors to consider when specifying a system. Lower rate handling speeds are generally considered under 100 cartons per minute. Medium rate handling speeds fall between 100 and 150 cartons per minute. High rate handling speeds are usually those above 200 cartons per minute. Different speed requirements equate to different conveyor and sortation system design decisions.

Existing or Other Equipment

What types of equipment—either material handling or processing—will the conveyor system interface with, and how will that interface be achieved? Additionally, the types of controls already in place in an operation, either PC-based or programmable logic controller (PLC)-based may influence the choice of conveyor or sorter.

Associated Costs

Beyond design, capital equipment, installation and commissioning expenses, it is important to address potential costs associated with routine maintenance and spare parts availability, system energy efficiency, noise levels, ergonomics and safety.

ADDITIONAL RESOURCES

General Information

Conveyor and Sortation Systems (CSS) Industry Group
mhi.org/conv

CSS Conveyor Procurement Specification Standards
mhi.org/downloads/industrygroups/conv/specdoc.pdf

CSS Case Studies Exploring Conveyors and Sortation Equipment in Use
mhi.org/conv/casestudies

Conveyor Equipment Manufacturers Association (CEMA)
cemanet.org

College-Industry Council on Material Handling Education (CICMHE) Taxonomy: Transport Equipment
mhi.org/learning/cicmhe/resources/taxonomy/TransEq/Conv/index.htm

Vertical Reciprocating Conveyor (VRC) Subcommittee of the CSS Industry Group
mhi.org/conv/vrclift

VRC Application Guidelines
mhi.org/free/4572

VRC Installer Guidelines
mhi.org/downloads/industrygroups/conv/vrc_installer_guidelines.pdf

Wikipedia: Conveyor System
en.wikipedia.org/wiki/Conveyor_system

Safety Information

ASME Safety Standard for Conveyors and Related Equipment, B20.1 – 2015
asme.org/products/codes-standards/b201-2015-safety-standard-conveyors-related-(1)

CEMA Safety Labels
cemanet.org/safety-labels-2

CEMA Safety Posters
cemanet.org/safety-label-posters