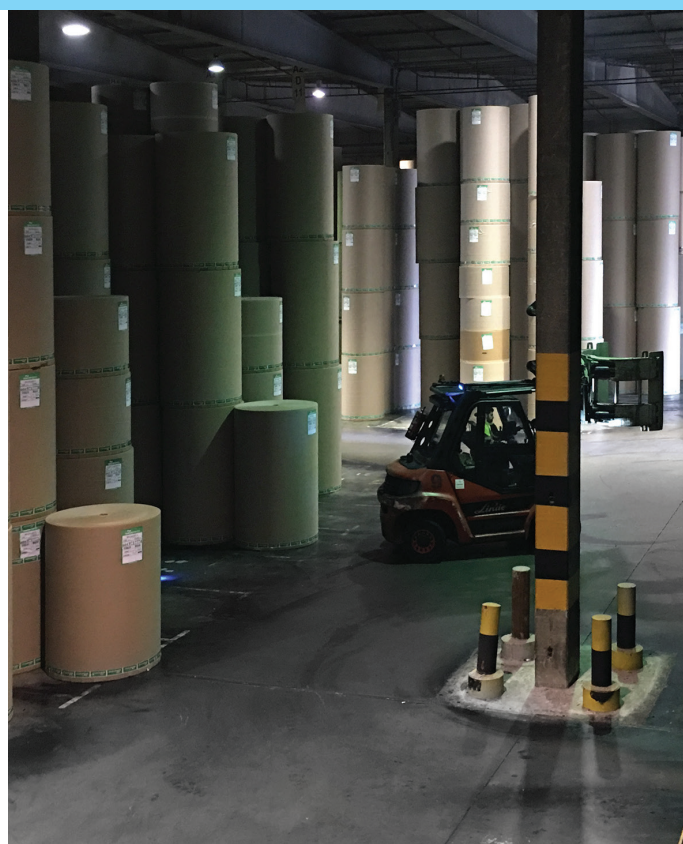


Automated warehouse for an integrated, proactive and safe supply chain

Kaj Fahllund. Vice President, Pulp & Paper, Pesmel

INTRODUCTION:

When comparing different alternatives for automated warehouses, it's vital to examine the financial impact with a wider perspective to see and understand the real benefits and limitations different alternatives can offer, and how these affect the connecting processes. A properly done cost (TCO) analysis provides a broader view, not only to clarify the investment goals, but also to compare different alternatives.



Why an automated warehouse?

In the past, the need for warehouse automation in paper mills was mainly related to operational volumes. When stacking rolls on the warehouse floor using forklifts got too hectic, overhead cranes were taken in use. This improved the warehouse's density and safety. By eliminating forklift traffic in the warehouse, the driving aisles are also eliminated, and the available space for actual product storing could be fully utilized. Forklift aisles, needed to manage the inventory, easily take up 50% of the floor space in practice. Also, the roll stacks' heights could be doubled with cranes from 5x to 10x of the roll diameter, which also increases the storing density per m² by raising the warehouse roof from 12 meters up to 23 meters.

New era - new requirements

Today, the reasons for warehouse automation have shifted from the need to cope with bigger volumes to better control of the inventory as part of the supply chain. Reasons for this development is the well-known industry's structural changes due to the digitalization combined with raised sustainability demands.

Figure 1 (Before) & 2 (After): Automating warehouse operations lays the foundation for streamlining the entire supply chain.

These megatrends have changed the direction and mindset in the paper industry, as it has done almost in every other business too. There is more information available for all, and there are more alternatives to choose from.

To compete as a producer in this environment, automation is a must to be able to respond to customers' preferences efficiently. Suppliers need to be able to manage the whole supply chain from raw materials to order fulfillment better than their competitors to survive and serve with required accuracy, speed, and quality. Warehouse automation is cutting what used to be two weeks' lead times down to two days, with 100% accuracy and 0% broke. In distributed manual warehousing, rolls could be handled as many as 12 times before dispatching them to the customer. In centralized automated warehouses roll handling is reduced to only one movement in and one out to dispatch.

Main characteristics of different warehouse types used in paper mills and converting plants

Warehouse types		Handling capabilities	Max. storing densities
ASRS	HBW Deep Channel	+++++	7 metric tons/m ²
	HBW Single Pocket	+++	4 metric tons/m ²
	Overhead Cranes	+++	5 metric tons/m ²
	AGV	+	1,5 metric tons/m ²
Manual PIT		++	1,5 metric tons/m ²

ASRS = Automated Storage and Retrieval System = Automated warehouse

HBW deep = High-Bay Warehouse, rack type ASRS to store rolls on deep storing channels

HBW single = High-Bay Warehouse, rack type ASRS to store rolls on single roll channel pocket

OHC = Over-Head Crane ASRS to stack rolls on floor

AGV = Automated Guided Vehicle, rolls stacked on floor

Manual PIT = Manually operated Powered Industrial Trucks equipped with clamps to stack rolls on floor

Figure 3: See the summary of main characteristics of different warehouse types used in paper mills and converting plants:

The reasons for automation are now changing due the megatrends explained above, which are accelerating the change towards automation. It's not about volume management anymore, it's about how to deliver products faster, with more flexibility, and ultimately cutting costs across the whole supply chain. In other words: how to change the reactive supply chain to be proactive, how to be able to react faster to changes in the market and customer demands.

Key features to be compared

A supply chain model means how mills are producing and distributing specific products to their customers. Common practice used to rely solely on reactive "Make to Order" (MTO) model, where manufacturing is driven by orders. But if you want to excel with speedy deliveries, beat your competitors by weeks with reduced lead times from order to delivery, you also need to be able to manage the "Made-to-Stock" (MTS) model from a single warehouse, not from a distributed network of warehouses. This defines the key features that automated warehouse needs today, and why manual work in warehouses is disappearing. It's about the density to be able to store needed volumes (tons) in one warehouse within available space at the mill, as well as handling capabilities to be able to manage the mixed content to ensure short turnaround times for transportation logistics.

The differences between handling and sorting capabilities are explained by how rolls are handled through the warehouse. Deep channel high-bay warehouses are handling the rolls in sets, compared to other alternatives which handle single roll or pair of rolls at once. When you handle 2-6 roll sets per cycle, instead of one roll, you have 2-6 times bigger handling capacities per equipment. This also lowers the overall need of equipment in the system accordingly.

And the big difference in storing density is explained partly with the maximum roof heights different concepts allow. Flexible high-bay rack storages can be anything between 10 and 40 meters, when overhead crane storage heights are limited to 25 meters and AGV and manual PIT warehouse to 10 meters. The above-mentioned handling capacity affects to the storing density too. When you have enough handling capacity to reorganize your inventory, you can store also mixed sets. This reflects directly to the practical fill rates different solutions can manage. The fill rate in HBW deep channels is 85%, with overhead cranes it is 70% and with AGV and manual PITs 50% due to the driving aisles.

Total cost of ownership defines the most cost-efficient alternative for both, big and small volumes

Selection of the right warehouse type depends on many issues which vary case by case. These are preferred supply chain model, produced grades, location, surrounding infra and so on. There is no "one-size-fits-all" solution available. But what is clear, is that the most important fact in the selection is the total cost of ownership, comprising both the capital and operational expenses. Also costs, which are difficult to measure, such as improved safety with zero-accident-zones and competitiveness achieved against the competitors with more resilient and agile warehouse operations make a difference. In the text below, two reference cases are introduced, along with how their unique needs and challenges were solved through automated warehousing.

Case Mondi Štětí: Shipments organized by automated warehousing

A customized automated sorting buffer has been installed at Mondi's new 210,000 metric ton per annum kraft paper production line in Štětí, Czech Republic. "Every warehouse has its own purpose. In the case of Mondi Štětí, it is not to store but to organize," says says Jani Matikainen, Sales Manager at solution provider Pesmel.

The new production line is intended to meet growing demand for paper-based, flexible packaging and has started up production in December 2024. The system supplied by Pesmel includes an automated roll warehouse (ARW) with a 3,000 metric-ton capacity for buffering sack kraft paper rolls. The incoming roll flow is first pre-sorted on sorting channels, from where stacker cranes pick-up and store rolls on storing channels. This two-step flow ensures high flexibility, along with full redundancy and re-routing capabilities.

"Daily production is about 600 tons per day, so with five days' worth of storage this has a shorter turnover rate compared to some facilities we have worked on," continues Matikainen, "and it fills a need that would be almost impossible to meet manually or with other alternatives within such a limited space."

A 32-meter-high deep-lane rack warehouse serves as shipment storage, operated by two stacker cranes enable a high storage density crucial in an area with limited space but with very high roll flow.



Figure 4 & 5: The deep-channel high-bay warehouse, with its high storage density, enabled Mondi Štětí to locate an automated storing and sorting buffer directly after the production line, despite the confined mill layout.

Rolls with different characteristics are constantly produced, so the ARW must organize inventory SKUs (Stock Keeping Unit) according to product type, receiving them in random order and send them out as required.

Dispatch loads are automatically retrieved from the warehouse and transported to the loading area via two outfeed lines. The dispatch area is designed for both efficiency and flexibility, allowing simultaneous loading of trucks and trains. "Traditional clamping can damage the products," Matikainen explains. "In this system, rolls only need clamping once as they are loaded onto transport. This essentially eliminates 'broke' from the equation."

Adaption and customization are key

Pesmel's proprietary Warehouse Management System (WMS) ensures fluid and optimized operation by controlling the warehouse, pre-sorting and dispatching functions, enabling inventory management, product identification and product traceability.

"This kind of rack storage solution was a new idea to us, and we were bit skeptical at first," admits Helmut Riesengerger, Mondi's senior project manager, "but the benefits it offered compared to alternatives were overwhelming. We got interested – it would be perfect fit for our needs. The reference visit to see the Saica mill in El Burgo de Ebro, Spain finally convinced us. I have long relationship with Saica and when they gave us a strong recommendation, we were convinced."

The project confirms Pesmel's ability to provide efficient, cost-effective solutions for storage, handling, sorting, or any combination. "Adapting and customizing Pesmel's Material Flow How® concept is a key benefit that enables us to efficiently meet our customers' needs," Matikainen concludes.

Case Kotkamills: New sheeting center has an automated warehouse at its heart

In August 2024, MM Kotkamills' new sheeting center with two sheet cutters in Kotka, Finland was inaugurated. Pesmel's next generation in-mill logistics and warehouse automation is a core part of this 30-million-euro investment.



Figure 6 & 7: Up-ended roll stacks sorted on warehouse conveyor right after ARW for one touch "pick – turn - load" shipping process.



Photographer: Jukka Koskinen Copyright: MM Kotkamills

Previously, MM Kotkamills relied entirely on external third-party companies to provide cartonboard sheeting to their customers. With the investment, the majority of this sheeting can now be done in-house at the mill site, providing an efficient process with no unnecessary or unproductive handling. “Our new sheeting center with its modern technology enable automatic processing of cartonboard reels from production to sheeting,” says Marko Pekkola, Managing Director of MM Kotkamills.

“We are able to serve our customers faster and ensure even better quality of the cartonboard as the sheeting takes place in parallel with the production and the cartonboard reels do not need to be transported outside the mill for sheeting,” continues Kalle Mäkelä, Production and Maintenance Director at MM Kotkamills.

Meeting intermediate reel storage requirements

The space available for this sheeting center and its 6,500-ton IRS (Intermediate Reel Storage) was very limited. Traditional floor stacked reel storage was too cumbersome and required too much space due to the heavy reel handling equipment needed to turn the reels from a horizontal to a vertical storing position and back again for the sheeters. With Pesmel's rack storage, the warehouse reels can be kept in a horizontal position all the way from the slitter winder through the IRS to the sheeter unwinding.

One vertical stacker crane on the side of the rack slides and lifts reels into a 14x9 array of horizontal storing channels. Reels are transferred in from production and out onto conveyors that feed them one at a time to the sheeter unwinds. The whole process is fully automated according to production schedules.

Pesmel's TransRoll™ enable the sheeting center's location at mill

Intense data-driven cooperation between MM Kotkamills and Pesmel was required to complete the dimensioning process and to fit the IRS between the PM hall and the sheeting center. Firstly, the physical dimensioning of the reel warehouse and its connections was carried out.

Figure 8: For MM Kotkamills, the centralized automated high-bay warehouse enabled the sheeting function to operate in parallel with production.

Secondly, the equipment and control system were customized to ensure the required handling capabilities. This meant running simulations with actual and target production data. The production mix and volumes, and their impact on equipment utilization rates, were analyzed. The actual simulation was carried out using the Pesmel WMS Digital Twin, which was later also used to train operators in running the system virtually. The WMS (Warehouse Management System) is the key element in integrating the information systems in the mill and the Sheeting Center to track the material flow and manage the online IRS inventory control.

“We chose the TransRoll™ concept because Pesmel was able to tailor an ideal solution for our specific needs,” says Teemu Nikkonen, MM Kotkamills' Strategic Development Manager. “The available space was very limited. As the reels are moved and stored horizontally all the way, we were able to keep the system simple. The stacker crane, the only moving element in the system, handles the reel movements inside this intermediate reel storage.”

Material flow with flexibility and innovation

Pesmel's WMS is the link that connects the entire material flow process. “Our technology is enabling something bigger,” says Kaj Fahlund, Pesmel VP Pulp & Paper. “We play a vital part in optimizing the entire process stream and improving the customers' cost efficiency.”

For both Pesmel and MM Kotkamills, the sheeting center project was an example of exemplary cooperation and forward thinking on both sides. “MM Kotkamills' investment was a great opportunity to provide the next generation in-mill logistics and warehouse automation to one of our many valued customers,” Fahlund concludes. “The project has been a perfect match between two innovative and unique companies.”