In the summer of 2016, Stora Enso announced their intention to invest in Imatra mills in order to increase capacity for their production of extrusion coated products, and further enhance their position as a leading global supplier of premium paperboards. As a part of this announcement, along with the new polyethylene (PE) coating plant, the decision to invest in a new Automated Roll Warehouse (ARW) was also mentioned.

THE NEED FOR SIMPLIFIED INTERNAL LOGISTICS
Before this investment decision had been made, Stora Enso Imatra mills had been utilising external warehousing to store their intermediate roll buffer as there were warehouse space limitations at the mill with the traditional clamp truck warehouse concept in use. This meant multiple clamp truck handling phases between the base paper production, PE coating processes and shipping. Such a decentralised process inventory was challenging to control, very labour intensive to manage, and impacted the quality. All PE coated rolls had to be fully wrapped twice – first, to protect them during the clamp truck maneuvering within the intermediate storing process, and secondly, the PE coating was applied before customer shipments. For the automated roll warehouse, the target was to integrate a big enough intermediate roll buffer in the mill area between the production, converting and shipping processes, whilst being able to cut the costs through simplifying and automating the internal logistics. After lengthy feasibility studies comparing different alternatives, the Pesmel TransRoll deep channel rack storage concept proved to be the most cost effective solution to meet this need.

ALTERNATIVE CONCEPTS FOR AN AUTOMATED WAREHOUSE
For the last few decades, the synonym for an automated warehouse in the paper industry has been the overhead crane concept, where the overhead cranes (instead of clamp trucks) stack rolls on the floor into vertically stacked piles by vacuum gripper (unwrapped rolls) or by mechanical gripper (wrapped rolls). Most known suppliers for this warehouse concept are crane manufacturers such as Konecranes and Demag. By eliminating clamp truck traffic from the warehouse, the storing density can be improved by 30-40% when driving aisles are not needed. The crane-stacked roll pile heights are normally limited to less than ten times the roll diameters in
order to keep the stacks stable (e.g. a 1.5m diameter equates to 15m high stacks); this doubles the piled roll stack heights compared to clamp truck operated warehouses. But the roll handling and sorting capabilities have been the bottleneck of the overhead crane concept. With vacuum grippers, a crane can handle only one roll at a time, and with mechanical grippers, the multi roll handling is very limited due to strict tolerance demands with roll diameter differences. Therefore, overhead crane concepts require quite extensive conveyor systems to serve the cranes, especially in cases where more than two cranes are needed due to the handling capacity requirements. This makes mill layout integration both difficult and expensive.

Automated storage with rack concepts, widely used in other industries, were earlier considered unsuitable and expensive for paper mill usage due to the unusual pallet storage adaptations needed for paper rolls. But the deep channel technology that has been developed specifically for paper rolls has greatly expanded the rack storage concept’s capabilities. With deep channel technology, rolls are stored on horizontal roll stacks directly on the v-shaped supporting channels on both sides of the center aisle where the stacker cranes move. This kind of rack structure enables an unlimited number of connections from the long side of the storage, where any channel on different levels can be used as in- or out-take lines for the warehouse, as needed. This enables simplified layouts with less conveyors compared to using overhead crane concepts to move roll flows in and sort them out.

At Stora Enso Imatra, the integration of this new central distribution buffer (requiring eight connection points in total) was far simpler and less space consuming with a TransRoll rack concept than any other alternative. Furthermore, any future expansion would be straightforward by simply adding length to the rack – achievable without disturbing the production process.
Stora Enso Imatra mills’ new 30 000 tons Automated Roll Warehouse with 8 connection points

1. Production from 3 board machines, at machine floor level, roll flow in random order from production winders.  
4. Raw mother rolls for PE coater #2, roll flow over the railroad to ground floor.

2. Finished and wrapped customer rolls from the new PE plant, at ground floor level, after Kraft wrapping of finished rolls for shipping.  
5. Raw mother rolls for PE coater #6, roll flow on ground floor.

3. Finished (PE coated) unwrapped customer rolls, at ground floor level, buffered to wait Kraft wrapping of finished rolls for shipping.  
6. Automated truck trailer loading (main gate) for satellite PE plant on ground floor.

7. Finished PE coated rolls to shipping dock, over railroad rails to ground floor in shipping warehouse.  
8. Automated trailer loading (reserve gate) for satellite PE plant on ground floor.

Table 1. The above Table shows how integration into the mill layout required eight IN & OUT connection points in total for the new automated roll warehouse in Stora Enso Imatra.

Project manager Tommi Myller, Stora Enso Imatra mills, comments:  
“This new automated roll warehouse simplified a lot our internal logistics. Now we need only one operator to control the process to buffer and sort the production between paper machines, PE coating and shipping. This is a big step forward from the earlier days of decentralised operations with multiple clamp truck drivers and supervisors to manage and handle the intermediate inventory.”

TRANSROLL CONCEPT’S KEY ELEMENTS

This automated warehouse in Imatra operates both as an intermediate roll buffer for rolls to be delivered to PE extrusion coating, and also as a shipping roll buffer for finished customer rolls. The volume was defined to be ~30 000 tons with a wide roll dimension range (diameter 800-2100, width 400-3200, mass 400-8700 kg).

There are two stacker cranes on the one middle aisle of the storage. This demonstrates the redundancy in the system. One stacker crane can be parked at the service area, while the other one continues to serve the production area. Two pre-sorter cars were added to the new PE plant side to handle the in-take and sorting of the finished PE coated rolls, and to deal with the automated truck trailer loading. These four roll set moving units are the only powered elements in this system beside the connecting conveyors. The rack itself is a static structure which supports the cladding (walls and roof).

Rolls lie on their bellies in V-shaped channels – as though in a cradle. Rolls are not pushed or dragged, they are lifted up and lowered down directly from channels or from the conveyors taking rolls in or out by

Figure 3. Project Manager Tommi Myller from Stora Enso (photo: Stora Enso, Mikko Nikkinen).
the stacker crane’s satellite pick-up cradle, which can handle mixed sets of rolls in different sizes (both width and diameters), and whether wrapped, unwrapped or partially wrapped – all at the same time.

**TOTAL COST OF OWNERSHIP (TCO) DEFINES THE SELECTED CONCEPT**

When comparing different types of automated warehouse concepts, it is crucial to consider the TCO of each alternative. This means both the CapEx and OpEx cost, related to the warehouse concept itself, but also to the systems and structure needed for its integration into the existing mill operations. This means having the ability to integrate the automated warehouse in the middle of the production process with a minimal number of conveyors and civil engineering to feed the roll flow in and distribute it out to converting and shipping. Here, system suppliers like Pesmel, who can offer the full spectrum (including conveyor system and all warehouse concepts), tend to have the upper hand compared to part suppliers who are only able to focus upon their own core area. This advantage was obvious in the Stora Enso Imatra installation, where the automated warehouse was integrated into the production operation with eight automated IN/OUT- connections at different floor levels, and with very limited space in which to operate.
Figures 5 & 6. Two stacker cranes moving roll sets on the mid aisle of the rack. Two pre-sorter car moving roll sets between the rack, PE plant and automated truck trailer loading.

Figures 7 & 8. Pre-sorter car’s satellite pick-up cradle taking a roll set in, and the stacker crane’s satellite pick-up cradle storing rolls on a v-shaped deep channel.