ΣSynX: Smart logistics, and Development of Picking Solution

**Logistics, Thermal & Drive Systems
Mitsubishi Heavy Industries, Ltd.**

Mitsubishi Heavy Industries, Ltd. (MHI) is proceeding with the development of "ΣSynX," which is MHI's standard platform for synchronizing and coordinating diverse machine systems, as well as the demonstration of ΣSynX core technologies using "SynX-Vehicle," a machine embodying a new concept of automated guided forklift (AGF). Many of the operations in warehouse logistics require engagement of numerous workers. Having developed an "automated picking solution" in which ΣSynX is applied to automate the case picking operation in warehouses such as beverages, we have made it commercially available to Japanese customers since September 2022.

This report presents MHI Group's efforts to smart logistics infrastructure, with a focus on automated picking solutions.

1. Development of ΣSynX

ΣSynX is a compound word consisting of three smaller parts: "Σ (summation)," "Syn (synchronization/coordination)" and "X (future)." As indicated by the word anatomy, ΣSynX is MHI's standard platform for synchronizing and coordinating diverse machine systems. The core technologies of ΣSynX include "Forecast Planning," "Remote Maintenance," "Human-Machine Coordination," "System Platform," "Verification & Evaluation" and "Remote Control," as shown in **Figure 1**.
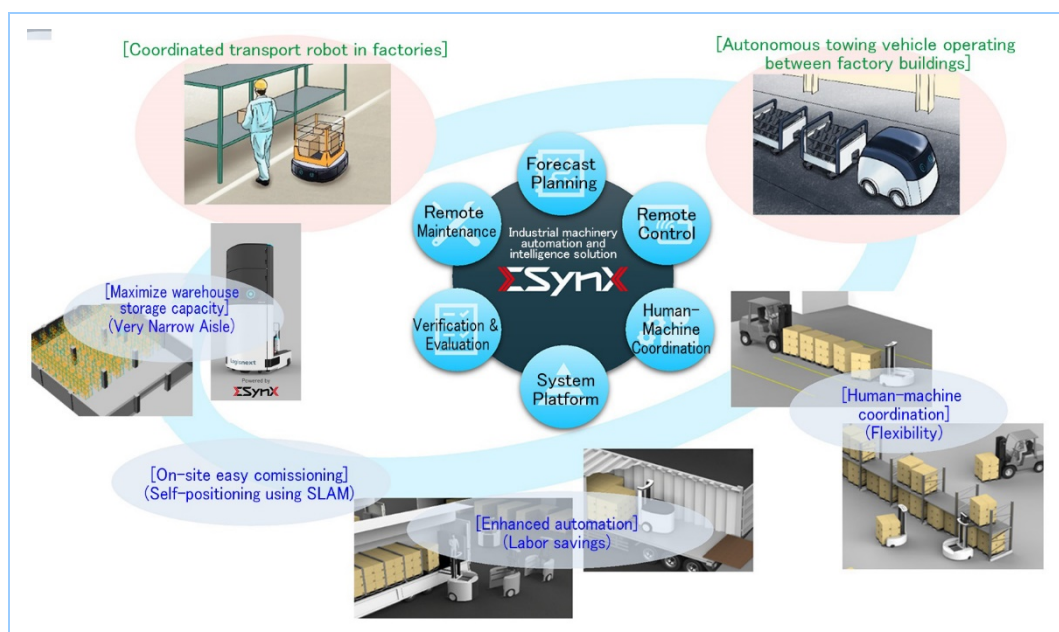

Figure 1　ΣSynX and its core technologies

As an example of its application to logistics equipment, "Forecast Planning" includes movement planning systems such as group control that effectively manages automated guided

forklifts (AGFs) and automated guided vehicles (AGVs). "Human-Machine Coordination" includes the technology to avoid a collision when detecting the presence of humans or objects, or the non-verbal human interface technology that enables communication between humans and machines. As applying ΣSynX's core technologies to various types of logistics equipment makes it possible to flexibly handle the ongoing situations, the logistics solutions we provide will produce high productivity and safety.

2. "SynX-Vehicle" with a new AGF concept

The ΣSynX-applied new AGF concept machine "SynX-Vehicle" was designed based on the forklifts of Mitsubishi Logisnext Co., Ltd.. In order to maximize the warehouse storage capacity and the number of cargo handling, the width of its vehicle body was downsized to that of a pallet, successfully minimizing the aisle width between shelves. The driving speed was also enhanced by improving the vehicle stability and adopting a new turning mechanism. Owing to these downsizing and new turning features, the current development model run through a 1.8-m-wide aisle between shelves, in contrast to a 2.7-m-wide one by a manned forklift. The resulting additional installation of shelves in extra space created by the reduced aisle width can improve the storage density by 20% from the conventional level.

In logistics warehouses, the cost of labor is said to account for about half of the business operating cost. In refrigerated warehouses, the refrigerator electricity costs are said to account for 5 to 7% of OPEX. The automation enabled by employing AGFs in warehouse logistics helps reduce the cost of labor. The increased storage density can also decrease power consumption in logistics warehouses in a relative sense.

Figure 2 shows an exterior view of SynX-Vehicle. The new ΣSynX functions are implemented in SynX-Vehicle for verification. SynX-Vehicle's unique mechanisms are also verified. The obtained results will be reflected in the products of Mitsubishi Logisnext Co., Ltd..

Figure 2　A new concept AGF "SynX-Vehicle"

3. Automated picking solution

3.1　Overview

As shown in **Figure 3**, the operations performed at the site of a logistics warehouse require involvement of many workers, as exemplified by the following work: (1) "picking" in which products are picked according to instructions, (2) "inbound/outbound processes" that pertains to goods coming in the warehouse from the truck loading berth and going out in the reverse direction, and (3) "truck loading/unloading" to get goods in or out of the truck.

With regard to (1) "picking," MHI has developed an automated picking solution system in which AGFs, AGVs and palletizers work in a coordinated manner. This automated picking solution system has been on the Japanese market and customers for warehouse logistics since September 1, 2022.

The automated picking solution is a solution that automates and makes intelligent use of ΣSynX to perform picking tasks that were previously performed efficiently and thoughtfully by workers. As shown in **Figure 4**, our originally developed optimization engine and Warehouse Control System(WCS) have enabled AGFs, AGVs and palletizers to work efficiently in a

coordinated manner. As a result, the number of transfer/picking operations is reduced with no heavy AGV traffic, thus realizing a higher throughput (improved processing capacity). As the AGFs or AGVs employed in this solution do not require any large-scale construction or modifications (such as on the floor), it is possible to introduce them to today's increasingly prevalent multi-tenant warehouses or accommodate a sudden change in the warehouse layout. In the future, this solution will contribute to solving problems faced by logistics sites, such as the recent shortage of operators and picking of heavy items, and to reducing human errors through automation and intelligence of picking operations in which a large number of workers are engaged.

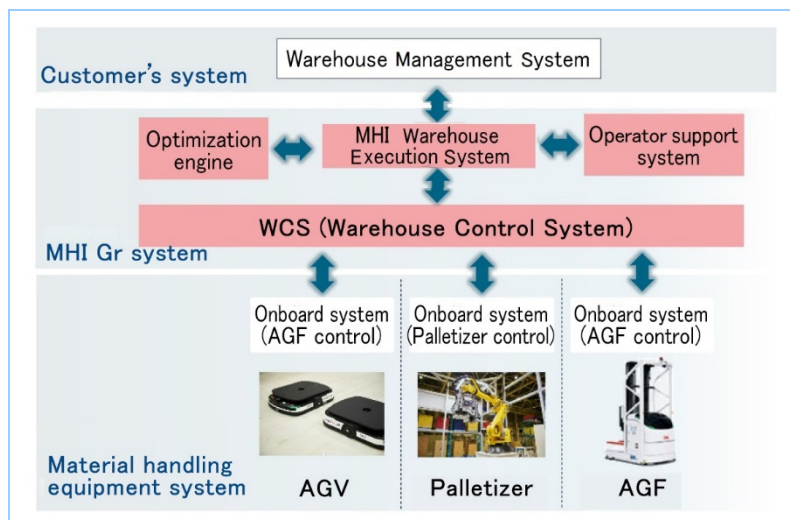**Figure 3   Solutions in detail (in the case of a beverage warehouse)**

Figure 4   ΣSynX integrated control system and optimization engine

3.2   Features of the automated picking solution

This newly developed picking solution is characterized by the following two points: (1) evaluation and verification by logistics simulation, and (2) "smart picking" using optimization technology.

(1)   Evaluation and verification by logistics simulation

Our picking solution makes use of simulation at each of the stages of customer proposal and development. **Figure 5** shows an example of a simulation model. Pallets are stacked on the storage racks installed in the AGF's driving area. The cases, all containing products of a particular type, are stacked on each pallet. Roughly 40 to 180 cases constitute a unit pallet (i.e., fully loaded pallet) of a product, with the number of cases varying depending on the product type. When receiving instructions for a picking operation, an AGF takes a pallet of a specified product from a rack and gives it to an AGV. The AGV then transfers it to a palletizer, which is in charge of stacking the required types of products in required quantities on a pallet for

shipment. The completed pallet is then transferred by an AGV to the area assigned for ready-for-shipment pallets. The remaining products after picking operations are returned and placed on the storage racks by AGVs and AGFs.

As described above, by building a simulation model and performing simulation using the customer's picking instructions as the input, it becomes possible to evaluate what type of layout can realize efficient transfer/picking operations and estimate the number of required units such as AGFs and AGVs. **Figure 6** gives an example display of simulation results. It is possible to assess, for example, if the designed performance can be achieved, or how many cases can be automatically picked against a given number of picking operations on each working day, or the work that can be automated is worth the work of how many workers.
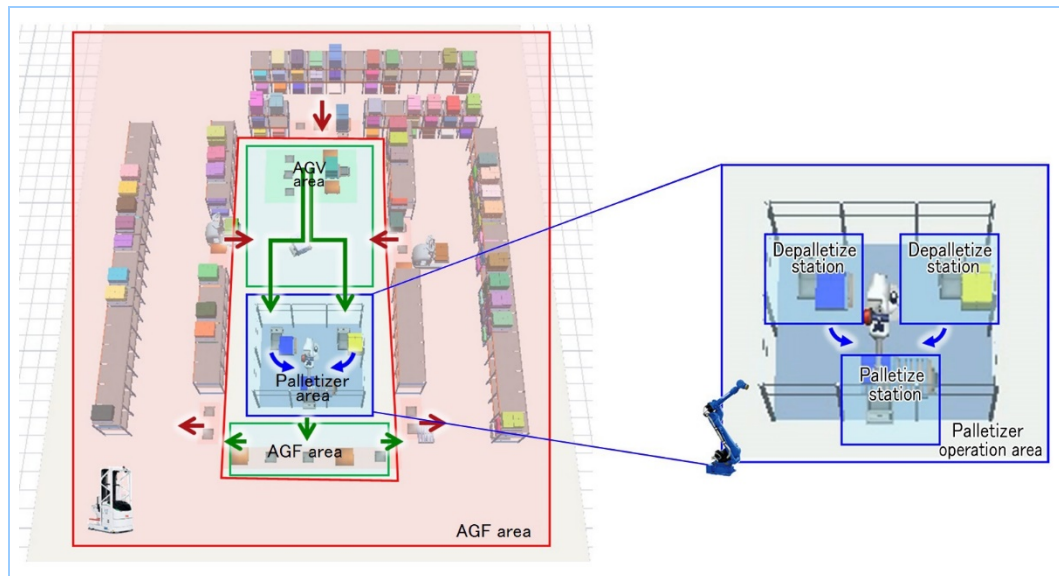

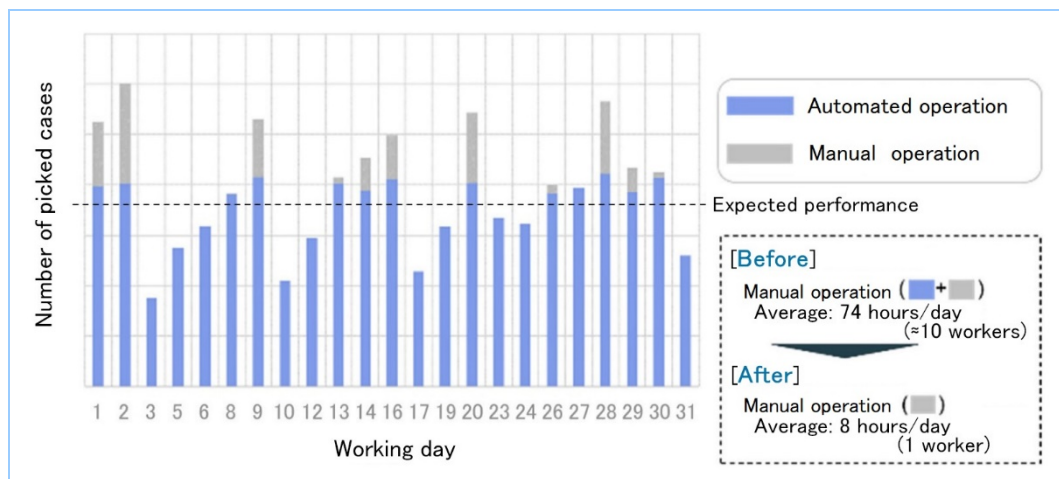**Figure 5   Logistics simulation model**

Figure 6   Throughput assessment by logistics simulation

(2)   "Smart picking" using optimization technology

The other feature, which is shown in **Figure 7**, is "smart picking" enabled by optimization technology. Our picking solution was developed in such a way as to perform optimization in three tasks. In "loading on a pallet", the picking order is rearranged to minimize the number of pickings required before the completion. Secondly, in "placing a pallet", where to store a product is determined in such a way as to cause no heavy AGV traffic, thereby preventing the decline in the throughput. Lastly, in the "prioritizing orders", the return of pallets is prioritized according to the situation, reducing the idle time of the AGF.
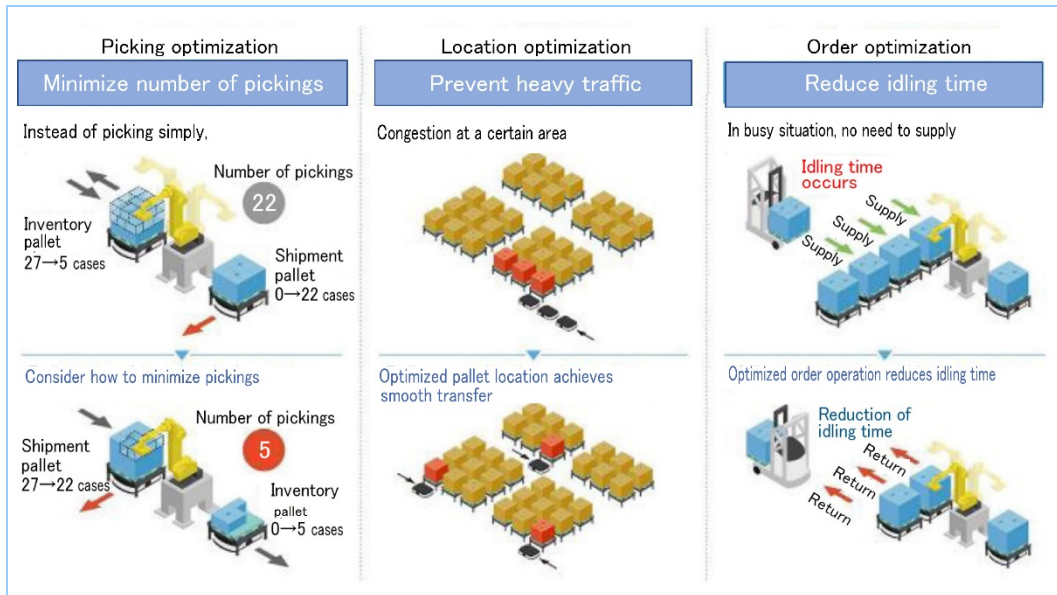
Figure 7   "Smart Picking" enabled by optimization technology

Figure 8 shows the simulation evaluation results of the optimization effect. When compared with the case with no optimization, throughput can be improved by about 30% without increasing the number of AGFs, AGVs and palletizers in operation. Our automated picking solution can thus realize smart logistics automation. by implementing the picking know-how conventionally considered by workers into the system for efficient operations.
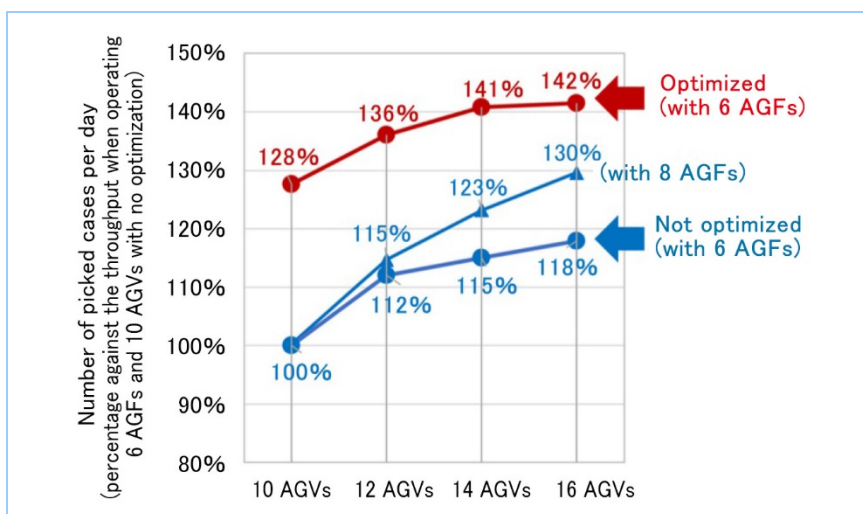

Figure 8   Throughput improvement by applying optimization technology

3.3   Demonstration by LogiQ X Labo

As shown in **Figure 9**, "LogiQ X Lab" demonstration facility for picking solutions has opened at "Yokohama Hardtech Hub (YHH)", which is a co-creation space operated by MHI in Yokohama. Tours of the demonstration facility will be open to customers from October 2022, to support them in considering the adoption of automation and workforce reduction at their warehouse logistics sites. Like this "picking demonstration area" and the "advanced development area" will also be extended. Moving forward, we will further develop new solutions for the inbound/outbound processes, truck loading/unloading and others.
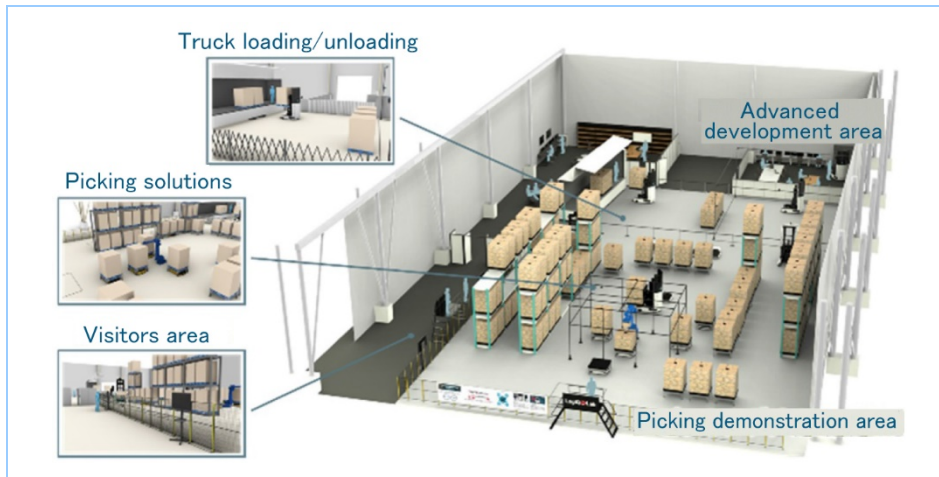
Figure 9   "LogiQ X Lab" demonstration facility at Yokohama Hardtech Hub

▌4. Future prospect

Leveraging the collective strengths of MHI Group, MHI and Mitsubishi Logisnext Co., Ltd. will continue to work on the development of products such as ΣSynX's automation solutions for inbound/outbound and loading/unloading processes, thereby offering optimal solutions to various issues in the logistics industry.

Going forward, the technologies to be demonstrated using new concept AGFs (such as group control, human-machine coordination and remote monitoring) will be gradually applied to Mitsubishi Logisnext Co., Ltd.'s laser AGFs. MHI Group will continue to unite and make full use of its comprehensive strengths. While using agile development to flexibly handle alterations such as in the specifications in the middle of the development process, we will provide solutions that can directly lead to solving customers' problems in a timely manner.