AUTOMATED STORAGE AND RETIREVAL SYSTEM (ASRS)

Training Report

by

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Guided by

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Harsh Mittal

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- ➡ Sense of ownership in what we do

Introduction

Automated storage and retrieval systems, sometimes known as ASRS or AS/RS, are made of a variation of computer-controlled systems that automatically place and retrieve loads from set storage locations in a facility with precision, accuracy and speed under a defined degree of automation. Systems vary from smaller automated systems to larger computer controlled storage/retrieval systems totally integrated into a manufacturing and/ or distribution process. More generically, ASRS is the system which is used to improve the storage systems used in the industries to handle, store and retrieve materials with precision, accuracy and speed with defined degree of automation under compact footprint.

This training report is based on the EIL's ASRS system for HMEL, GGSPAP, which is the world's largest ASRS system.

Within an AS/RS environment we would find one or more of the following technologies:

- **Unit-load AS/RS** – Machines that store large loads (usually 1,000+ pounds), typically on pallets with storage rack structure, reaching 100 feet or more tall. The unit load stackers is typically a large automated system designed to handle unit loads stored on pallets or in other standard containers. The system is computer controlled, and the S/R machines are automated and designed to handle the unit load containers
- **Fixed-Aisle Unit- Load** - In fixed-aisle unit-load AS/RS systems, pallet racks are arranged with narrow aisles between them. A crane travels between these aisles moving both vertically and horizontally to retrieve and store product. The crane is fixed to a single aisle of pallets.
- **Moveable-Aisle Unit- Load** - Moveable-aisle unit load AS/RS works much the same way as fixed-aisle unit-load AS/RS. It consists of a crane moving between narrow aisles of pallets along some kind of track. The key difference is that it is not fixed to a specific aisle. This capability allows a single piece of equipment to service multiple aisles and, ultimately, a greater working space.
- **Mini-load AS/RS** – Operating the same as a unit-load AS/RS, a mini-load AS/ RS handle lighter loads, usually weighing less than 1,000 pounds. Instead of full

pallets, mini-load AS/RS handles totes, trays, and/or cartons. Sometimes, these systems are called “case-handling” or “tote-stacking” systems.

- **Vertical lift modules (VLMs)** – VLMs consist of a column of trays in the front and back of the module with an automatic inserter/extractor in the center that stores and retrieves the required trays. VLMs can be built quite high to match the available overhead space in a facility. Multiple units can be placed in 'pods' whereby an operator can retrieve items from one unit while the other units are moving. Variants include width, height, load, speed and a control system. The VLM is a board controlled automated vertical lift module. Inventory within the VLM is stored on front and rear tray locations or rails. When a tray is requested, either by entering a tray number in the built-in control pad or by requesting a part through software, an extractor travels vertically between the two columns of trays and pulls the requested tray from its location and brings it to an access point. The operator then picks or replenishes stock and the tray is returned to its home upon confirmation.
- **AMR Based High Density ASRS** - An **autonomous mobile robot-based high-density automated storage and retrieval system** is designed in a way that uses three-axis AMR robots to travel vertically up storage rack to retrieve the required inventory tote or case. The AMR stores the inventory or tote on itself, and then navigates down the rack and on the floor to any one of the remote order picking workstations. The AMR rides up the workstation’s ramp, and the integrated pick-to-light and software system indicates which item and how many to pick. The operator then places the appropriate item and quantity into one of the batched orders and the AMR leaves for its next assignment
- **Shuttles** – Shuttles are used for the automated handling of totes, trays, cartons or all three in the same system – for either warehousing or manufacturing. **Shuttle-based AS/RS** delivers inventory via a shuttle or “bot” that runs on a track between a racking structure. They can operate on a single level or multiple levels, depending on the needs of the operation, and can be battery- or capacitor-powered. The shuttles deliver the tote or carton to a workstation integrated with the system. When an item is requested, the shuttle drives to the location of the product and retrieves

the tote or carton that contains the requested item. The shuttle will then take the tote/carton directly to a workstation or transfer it to a conveyor to convey the tote/carton to a workstation. Different shuttle models utilise different designs to provide different benefits. For example, one model is vertically oriented to optimise floor space. The shuttles move on the perimeter of the rack and then move into an aisle to extract a tote and delivers it to its integrated workstation.

- **Horizontal carousels** – Ideal for storing small parts and pieces, horizontal carousels are comprised of a series of bins that rotate horizontally around a track. A horizontal carousel is a series of bins which revolve on an oval track. Every bin has shelves which are adjustable to .75 inches (19 mm) and can be configured for a myriad of standard and special applications. An operator simply inputs a bin number, part number or cell location and the carousel will rotate via the shortest path. Multiple horizontal carousels integrated with pick to light technology and inventory management software (a pod of carousels) are used for order fulfilment.
- **Vertical carousels** – Rotating vertically, like a Ferris wheel, vertical carousels house a series of shelves or carriers to provide high-density storage. VLMs can be built quite high to match the available overhead space in a facility. Multiple units can be placed in 'pods' whereby an operator can retrieve items from one unit while the other units are moving. Variants include width, height, load, speed and a control system. The VLM is a board controlled automated vertical lift module. Inventory within the VLM is stored on front and rear tray locations or rails. When a tray is requested, either by entering a tray number in the built-in control pad or by requesting a part through software, an extractor travels vertically between the two columns of trays and pulls the requested tray from its location and brings it to an access point. The operator then picks or replenishes stock and the tray is returned to its home upon confirmation.
- **Cube-based storage** – Ultra-high density goods-to-person piece picking system which utilises robots to store and retrieve inventory bins from a cubical storage grid.

Automated storage and retrieval systems are used in a variety of areas to support processing and picking throughout a facility:

- **Order picking**: Retrieving and presenting required inventory to pickers
- **Storage**: Providing dense long-term buffering for small or large items that are slow- to medium-movers
- **Kitting**: Providing an area to group component parts for assembly
- **Consolidation**: Providing a dynamic area to hold parts and items until all pieces of an order can be merged ready for shipment. Often used for consumer, B2B and store orders.
- **Assembly**: Storing work piece components for later production
- **Production**: Storing tooling and component parts for manufacturing processes
- **Replenishment**: Storing excess inventory for restocking of ancillary picking systems
- **Security**: Providing an enclosed storage environment with software access controls
- **Retail**: Providing a large quantity of parts and items at a customer service desk. Keeps workers in front of customers instead of walking and searching in back rooms.

Automated storage and retrieval systems provide a variety of benefits:

- **More efficient use of floor space**
- **Ability to reclaim unused vertical space**
- **Increased inventory storage density**
- **Improved ergonomics and safety, resulting in fewer accidents**
- **Increased throughput**
- **Reduced labor costs**
- **Fewer labor constraints due to labor shortages**
- **Often modular design for maximum flexibility**
- **Increased order picking accuracy**
- **Improved product security for premium inventory**

Uses and applications of ASRS systems are as follows:

1. **Goods-to-Person for Order Picking and Packing:** Picking, packing, and processing orders is one of the most time-consuming tasks in the order fulfilment process. In fact, the process of walking and manually picking orders can account for more than 50 percent of the time associated with picking. AS/RS offers an alternative to this through the use of Goods-to-Person (GTP, or G2P) order picking. In a goods-to-person order picking system, the worker does not physically move from product location to product location to pick an order. Instead, a mini-load AS/RS crane, shuttle, AMR, carousel or VLM is able to retrieve the necessary stock from storage and delivery it directly to the worker, who operates in a pick/pack station. Once the appropriate amount of product has been picked, the stock is returned to storage and the next item needed for the order is delivered to the worker for picking. This can be done on a full-case or split-case basis, depending on the operation. In either scenario, the AS/RS can sequence product so that it makes the most logistical sense allowing cases of heavy product to be placed on the bottom of a pallet, for example, or organising product so that similar products are together or in sequence to match a store's layout, shipping zone, and cut-off time, to name just a few options.

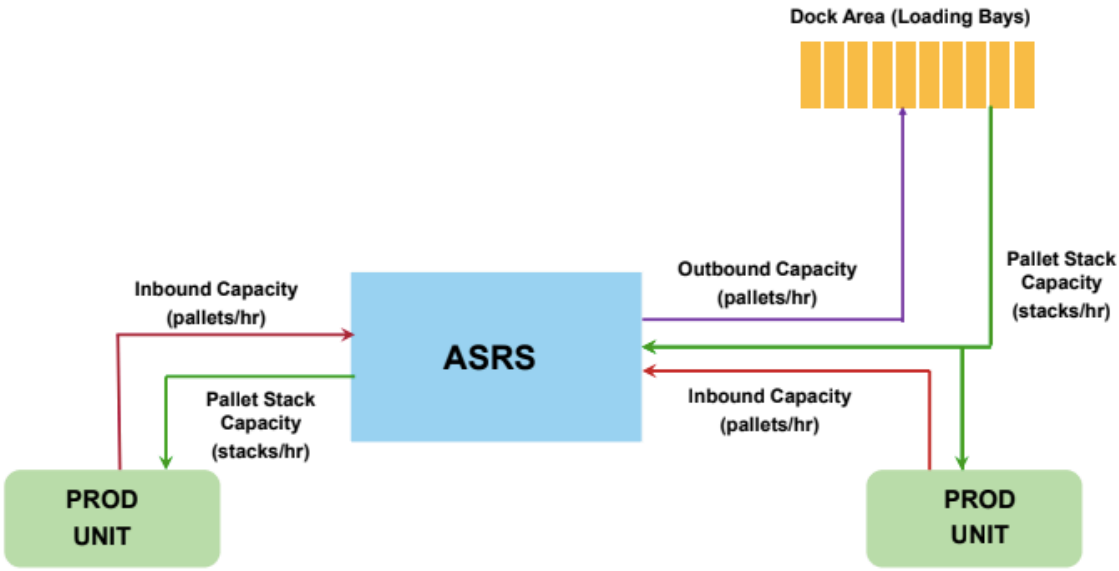
2. **Staging Orders for Shipping:** The impact of e-commerce and omni-channel delivery on the order fulfilment process can not be overstated. Customers are now able to shop and place orders around the clock, and they want their product delivered fast and on time. But even if an operation accepts and processes orders 24/7, there are often constraints to shipping windows: Due to worker shifts, for example, or exorbitant night and weekend delivery fees. To make up for these constraints, an operation can pick and process orders continuously and use an AS/RS to place them in a buffer storage to stage them until the shipping window is open. This saves time and allows an operation to continuously produce, even when orders can not physically leave the facility.

3. **Managing Buffer Storage:** In a typical warehouse, different processes take different amounts of time to complete. If these discrepancies are not properly managed, then all it takes is a poorly-timed piece of equipment or zone slowdown in any stage to bring an entire operation to a standstill or mass slowdown. Buffering aims

to prevent such a breakdown by ensuring that enough supplies/product are always on hand in different stages to keep an operation running. But while buffering makes sense, poorly managed it can become a logistical nightmare, requiring miles of conveyor to properly buffer and stage. AS/RS has the potential to replace these conveyor buffering systems, allowing an operation to efficiently store buffer product and retrieve it as necessary. Depending on the specifics of the operation, this buffer management can be put in place in multiple areas of an operation's workflow, whether that is staging product/raw material as it is delivered ("Inbound Receiving Buffer") or storing inventory exactly where it will be needed along the production line ("Assembly Line Point-of-Use Buffering") or (Order Consolidation) holding multiple portions of an order picked in different zones and then consolidating them for final packing and shipping.

4. **Storage and Point of Use Storage:** One of the primary benefits of AS/RS is its ability to store product in a way that makes the most efficient use of available space, especially over the long term. By implementing AS/RS, an operation can automate their long-term storage of raw material or product and retrieve what they need, when they need it. By integrating the AS/RS with their Warehouse Execution Software (WES) it is also possible to intelligently utilise and optimise inventory via FIFO (First in First Out), LIFO (Last In First Out), lot numbers, expiration dates, order cut off times, packaging requirements and many organisation and industry specific requirements.

Basic Scheme Of ASRS



This image describes the basic scheme of an typical ASRS, where there are two production units, which may or may not be producing/outputting the same product and at the same rate, and the ASRS software identifies the entries based on their quality as well as date of production and stores and retrieves the product according to both of the parameters. The basic design of the software system is on the principle of FIFO or First In First Out. The outbound pallets after being retrieved from the storage facilities are transported to the Docking or the Shipment area, using various shuttles. The whole process, minimises the human labour intervention, and thus increasing efficiency as well as safety and security of both raw material and finished product.

Basic Steps in ASRS

1. **PICK-UP**: The items/ finished products are picked up automatically using pallets from the bagging lines, which are then transferred to the storage area and stored according to their quality/grade and date of manufacturing. (Transfer of Palletised Load from

2. **TX & STORE**: The items, are transferred from the production unit, to the when reach the storage facility, are stored on the principle of FIFO, using automated cranes. (Stored in designated Storage Bins, in particular racks).

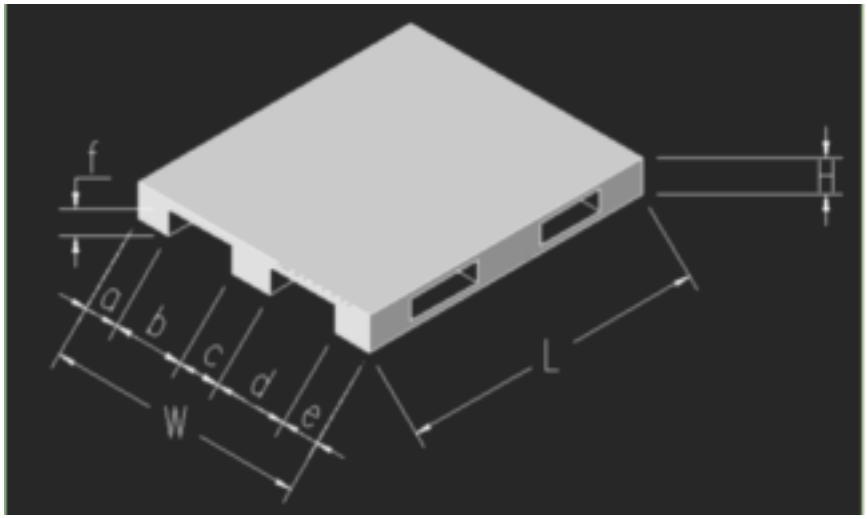
3. **Retrieve and TX:** The items are then transferred from the storage facility to the shipment area or the Docking area, where the final retrieved product is transferred to trucks, ships etc.

4. **WMS:** warehouse management system (WMS) is a software application designed to support and optimise warehouse functionality and distribution center management. These systems facilitate management in using simplified automatic technologies useful in daily activities like planning, organising, staffing, directing, warehouse-keeping and controlling the utilisation of available resources, to move and store materials inside, around and outside of a warehouse, while supporting staff in the performance of material movement and storage in and around a warehouse, without causing any large scale disruption to business resources. (Controlling inbound movement, outbound movement and storage operations through software / control systems such as WMS or FMC softwares).

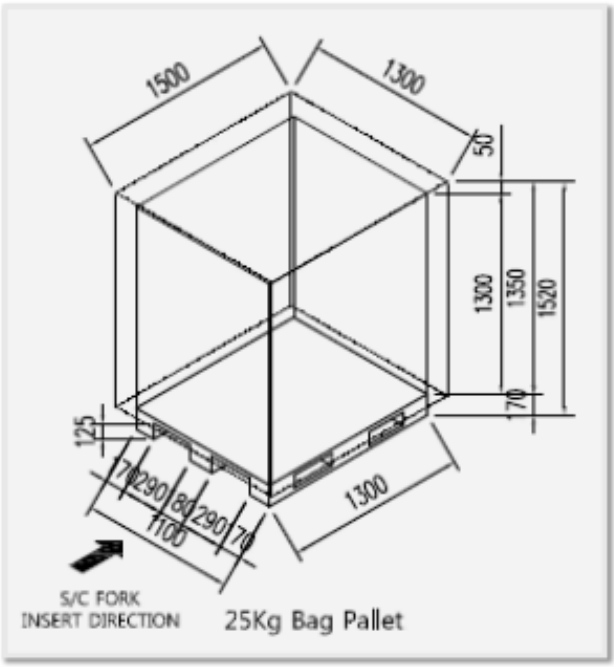
Pallet Details

The Pallet is a flat transport structure, which supports goods in a stable fashion while being lifted by a forklift, a pallet jack, a front loader, a jacking device, or an erect crane. A pallet is the structural foundation of a unit load which allows handling and storage efficiencies. Goods or shipping containers are often placed on a pallet secured with strapping, stretch wrap or shrink wrap and shipped. Since its invention in the twentieth century, its use has dramatically supplanted older forms of crating like the wooden box and the wooden barrel, as it works well with modern packaging like corrugated boxes and intermodal containers commonly used for bulk shipping.

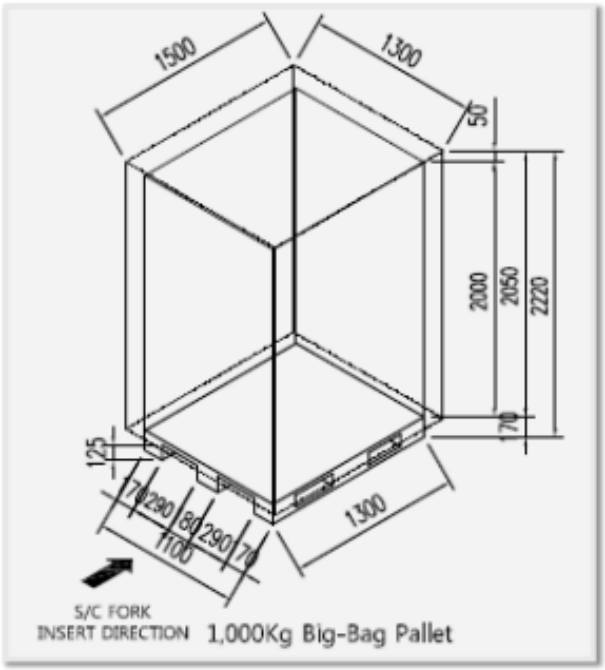
The Pallets used in HMEL Project are either 2 way or 4 way, made of either wood or plastics.



This results in two basic Unit Loads possible in HMEL, a 25 Kg Bag Pallet and a 1000 Kg Bag Pallet. Their detailed dimensions and sizing are shown ion the figure below.



25 kg Bag Pallet



1000 kg Big-Bag Pallet

Advantages Of ASRS

1. **Maximised storage capacity within limited space**

ASRS allows storing maximum number of items in a limited space as it uses vertical as well as horizontal stacking, and thus storage efficiency increases drastically as compared to conventional storage mechanisms in warehouses. Conventionally 2-3 pallets were stored in a column in the ware house, whereas using ASRS, roughly 22 Pallets can be stored in the same column, thus increasing storage capacity by at least 633.33%

2. **High velocity of material flow without wasting time**

While using ASRS, the inflow and outflow rates increases exponentially, as delays due to labour inefficiency are done away with, and there are no delays at any stage from production to shipment, thus minimising time and increasing production.

3. **High efficiency in supply chain management via real time inventory monitoring**

Decreased time, decreased losses due to human error and increased storage make the system more efficient and each and every process of the supply chain can be easily monitored, thus increasing the efficiency.

4. **Efficient and accurate work process by avoiding errors caused by manual work**

Whole of the mechanised system, thus avoid any potential human errors, while working with manual labour, thus making the system more time and cost efficient.

5. **Safe, convenient, and reliable operational environment**

As the whole environment is mechanised, it reduces other risks, involved with human labours, while working in industrial environment, as well as the computerised environment makes it more reliable and trustworthy.

6. **Ease of expansion in storage capacities (especially for RSB Type rack)**

Increasing storage capacity on the go becomes comparatively very easy, while using ASRS.

7. **ROI achievement by reducing labor, management, and hidden cost**

Since the ASRS system is software operated, and works on the FIFO principle, thus ensures that older product is delivered first, thus reducing expiry costs, also labour costs

are drastically reduced as well as the number managers required and there hidden operational costs while working with human labour are reduced, as well as the system becomes much more efficient and fast.

8. **Reduced pilferage and enhanced security**

The other losses like pilferage and other potential loses involved while working and managing with human labours are reduced increasing efficiency and reducing costs simultaneously.

Disadvantages of ASRS

- **Requires Knowledge, Skill and experience to Operate**

To work with ASRS system, requirement of skilled labour to operate the state of the art machines is a must.

- **Initial Capital cost is High**

The initial costs for building the ASRS systems, and allied equipments is very high, as it requires various Stacker Craine, Shuttle cars, rail tracks, fork trucks, as well as high performance software and systems, which makes these systems very expensive initially.

- **Maintenance cost is also high**

The ASRS systems require regular maintenance, which are not required while working with human labour, thus resulting in higher maintenance costs, and making them costlier.

***Thus there is a trade-off between efficiency, output, storage capacity and costs, while deploying ASRS systems*.**

Use Case of ASRS

The use of ASRS depends if the organisation is facing the following problems :

1. If the organisation is running out of space, then the ASRS can help in increasing storage capacity in the same space, by a factor of roughly 600.
2. To reduce the labour and allied costs like pilferage, ASRS are the best solutions.
3. To have a more robust control system, and more control over the inventory.
4. In places where labour is acute, or the labour charges are high, these automated systems can help a lot.
5. If workers are spending excess time traveling during a shift to access inventory.
6. If workers is spending time in visually searching for the correct item
7. If picking errors are on the rise.
8. If Company management is struggling to keep up with order cut- off time, or hiring seasonal workers to keep up with demand.
9. If valuable inventory is often found damaged and is frequently misplaced.
10. If operators are at risk of injury!

In general, if an organisation having enormous inbound and outbound flow rates, and is lacking storage capacity, and wants to further increase inventory, these systems, can be helpful in reducing costs, increasing efficiency and improving production capacity and storage in the same space. The only major drawback of these systems is that they require high initial one-time investment to be set up. (A large company/organisation wanting to reduce labour and allied costs, and increase storage and efficiency).

The main factors to consider while opting for ASRS are as follows:

A. Storage Capacity in rack
B. Inbound & Outbound Capacity
C. Unit Load Dimension and Weight
D. Type of Empty Pallet & Dimension
E. Number of SKU
F. Max. Height Restriction for Warehouse

G. Total no. of Loading Stations

H. Number of loading Bays

ASRS at HMEL

This is the largest ASRS system in the world, with the consultancy provided by Engineers India Limited, developed for HMEL. The facility has a storage capacity of 1,50,872, with two ASRS systems. The main components of HMEL ASRS system are :

1. **Pre Engineered Building (PEB)**

In structural engineering, a pre-engineered building (PEB) is designed by a PEB supplier or PEB manufacturer with a single design to be fabricated using various materials and methods to satisfy a wide range of structural and aesthetic design requirements. This is contrasted with a building built to a design that was created specifically for that building. Within some geographic industry sectors pre-engineered buildings are also called pre-engineered metal buildings (PEMB) or, as is becoming increasingly common due to the reduced amount of pre-engineering involved in custom computer-aided designs, simply engineered metal buildings (EMB)

2. **Storage Racks**

These are the racks or the shelves where the palletised bins are stored.

3. **Stacker Cranes**

A stacker crane is a type of overhead crane system that utilises a non-hoist load handling device (e.g., a mast that is suspended from a bridge trolley and equipped with forks or a gripper). In addition to the load handling device, the main system components include guide rails, an electrical supply system, and a data transmission/control system. Together, they enable the system to travel, pick up items, and lift/lower them within the facility. These functions make stack cranes a popular solution for automated storage and retrieval operations in industrial and commercial warehouses

4. **Rail Guided Vehicles/Shuttle Cars**

RGV Systems are fast flexible rail systems which make it possible to transport large quantities of heavy good over long distances at low cost with high efficiency.

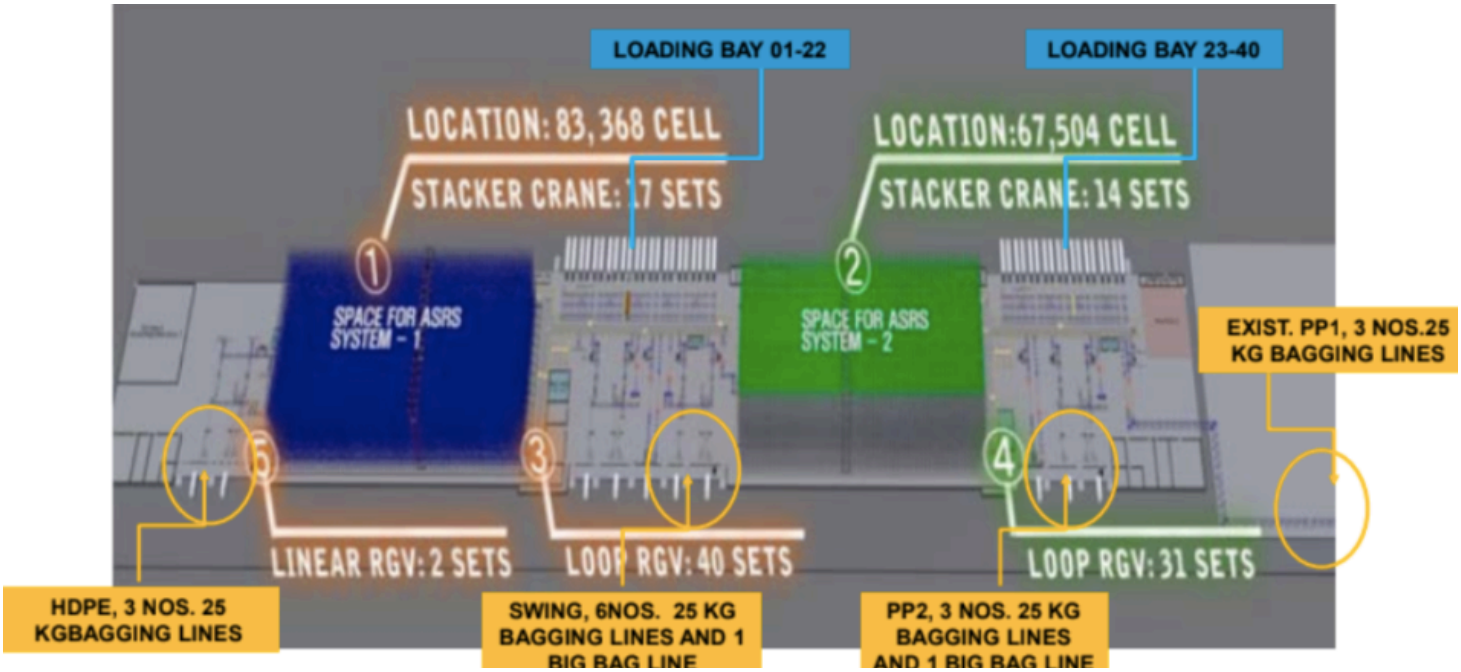
RGV systems are vital for Storage, Handling, and Order fulfilment in a wide range of industries. Due to their widespread application, they are also seen as mission critical to daily operations for many large industrial plants.

5. **Conveyors System**

A conveyor system is a fast and efficient mechanical handling apparatus for automatically transporting loads and materials within an area. This system minimises human error, lowers workplace risks and reduces labor costs — among other benefits. They are useful in helping to move bulky or heavy items from one point to another. A conveyor system may use a belt, wheels, rollers, or a chain to transport objects.

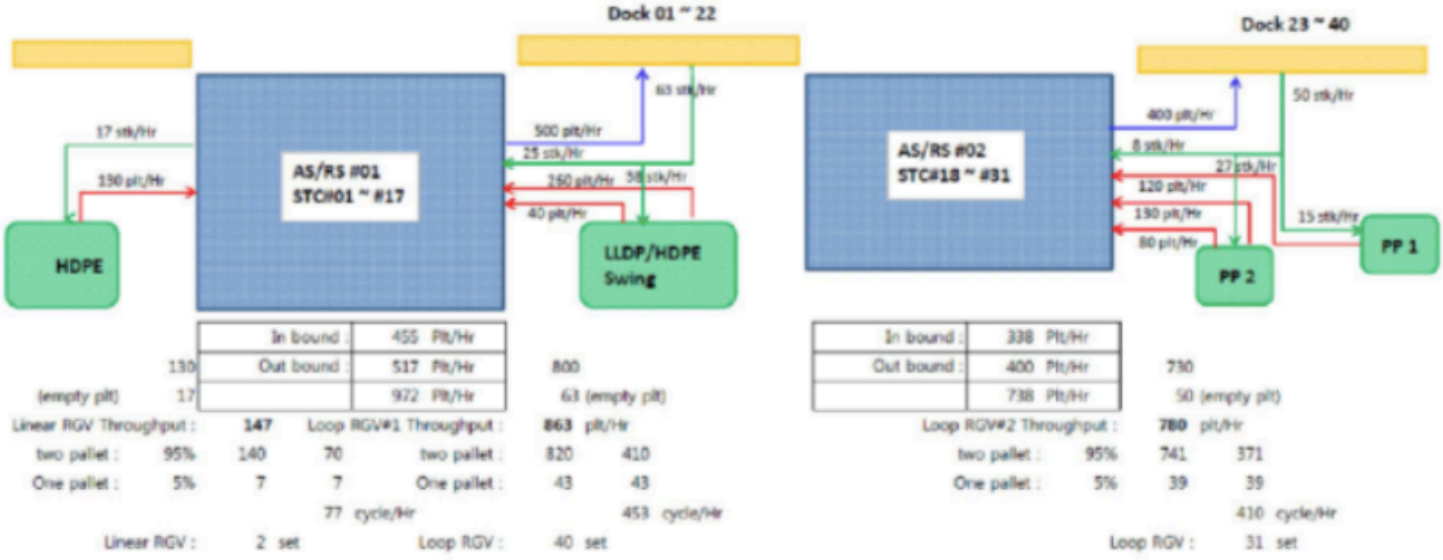
6. <u>Warehouse Management System (WMS) Software</u>

A warehouse management system (WMS) is a software solution that offers visibility into a business' entire inventory and manages supply chain fulfilment operations from the distribution center to the store shelf.



< In & Out Throughput of Tender >

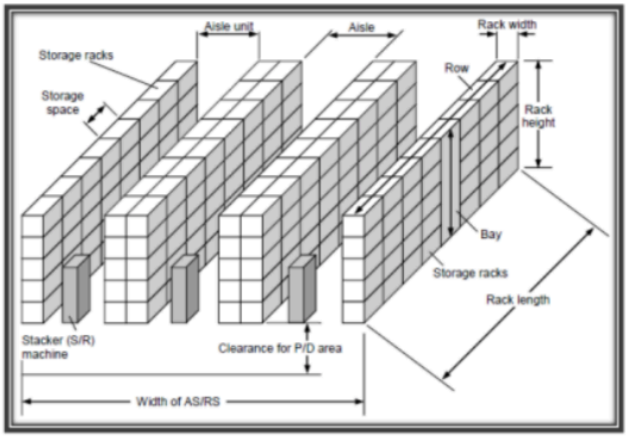
		Inbound		비율	Outbound		
		25kg bag	Big bag		Total	25kg bag	Big bag
A	• LLDPE/HDPE Swing (2 X 400 KTPA)	260	40	39%	320	277	43
B	• HDPE (1 X 450 KTPA)	130	0	17%	180	180	-
C	• PP2 (1 X 500 KTPA)	130	80	28%	200	124	76
D	• PP1 (1 X 500 KTPA) (Existing)	120	0	16%	200	200	-
		640	120			781	119
		760			900		900



		In bound :	455 Plt/Hr		800		In bound :	338 Plt/Hr		730
	130	Out bound :	517 Plt/Hr				Out bound :	400 Plt/Hr		
(empty plt)	17		972 Plt/Hr		63 (empty plt)			738 Plt/Hr		50 (empty plt)
Linear RGV Throughput :		147	Loop RGV#1 Throughput :		863 plt/Hr		Loop RGV#2 Throughput :			780 plt/Hr
two pallet :	95%	140	70	two pallet :	820	410	two pallet :	95%	741	371
One pallet :	5%	7	7	One pallet :	43	43	One pallet :	5%	39	39
			77 cycle/Hr			453 cycle/Hr				410 cycle/Hr
Linear RGV :		2 set		Loop RGV :	40 set		Loop RGV :			31 set

	ASRS-1	ASRS-2
No. of Rows	34	28
No. of Bays	56	55
No. of Tiers	22	22
Length	175 m	172 m
Width	92 m	75 m
Height	45 m	45 m
Storage Capacity	**83,368**	**67,504**

TOTAL STORAGE CAPACITY =
1,50,872



	ASRS # 01	ASRS# 02	Total
Pellet Positions	83,368	67504	1,50,872
No. of S/R Crane	17	14	31
No. of Linear RGV	40	31	71
No of Loop RGV	0	2	2
No. of Shuttle Cars	12 Sets (10 Sets with 2 Pellets , 2 Sets with 1 Pellet)		
No. of Loading Bays	40 nos.		
No of Dock Levellers	40 nos.		

RACKS		
Rack Classification	:	RSB (Rack Supported Building)
Rack Type	:	Single deep
Rack Module Type	:	Load Beam Forming Rack Type
Footprint of Rack part	:	AS/RS #1 : 91,000 (W) x 173,780 (L) x 43,167 (H) mm AS/RS #2 : 75,100 (W) x 170,680 (L) x 43,167 (H) mm
Rack Height	:	40,550 mm
Storage Capacity	:	1,50,872 locations
Aisle Width	:	1,800 mm

Components in ASRS

- **SR CRANE**

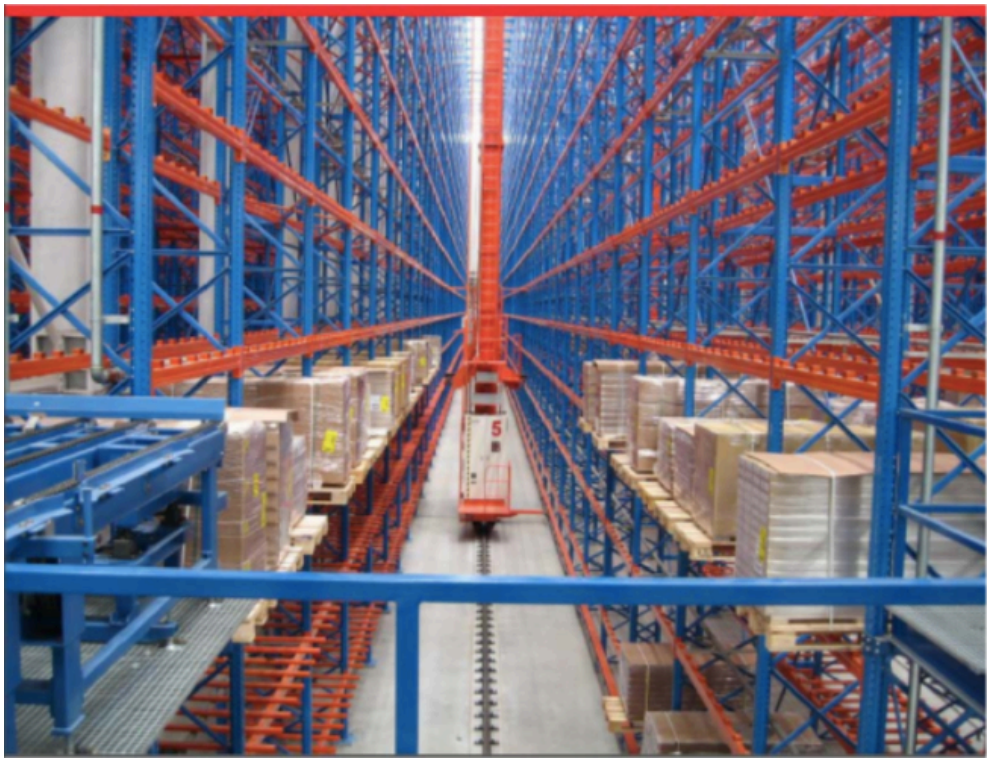
Stacker Cranes are automated machines that perform the storage and retrieval of goods while working within the racking system. We design our Stacker Cranes to allow full control of your warehouse activities ensuring error-free, smooth, fast and safe storage and retrieval operations. Our own portfolio is developed to meet the market´s latest requirements for flexibility, energy efficiency, reliability and performance.

By specifically selecting their design characteristics, we ensure that our extensive range of Stacker Cranes can operate with diverse loads, from 1kg to 10 000kg, arranged in single or multiple deep storage configurations. They may reach up to 50m high storage locations and achieve speeds up to 6m/s.

This equipment can also be designed to operate in special working conditions, such as freezing, high humidity and clean or harsh environments

Main configurable characteristics:

- Storage configuration: single, double or multiple deep;
- System configuration: one/several stacker cranes per aisle or aisle switching curving stacker cranes;
- Type of handled load units: pallets, containers, totes, cartons, frames…;
- Number of load handling devices;
- Load capacity: total weight; Stacker crane type: single or double mast;
- Maximum operating height;
- Stacker crane performance;
- Working conditions.

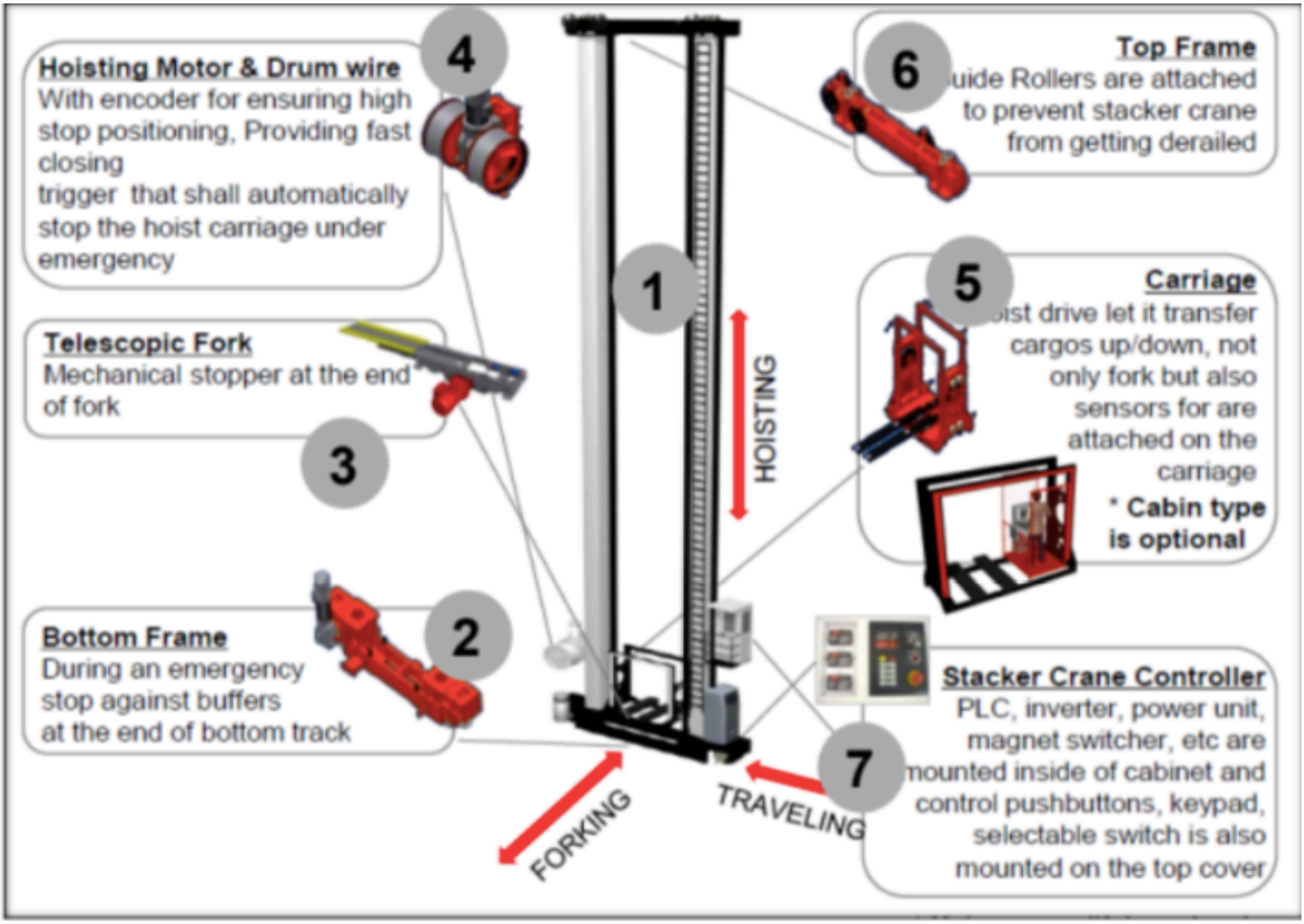


S/R CRANES		
Construction	:	Double Mast
Fork Type	:	Single deep & Twin Fork
Operation	:	Automatic, Semi-automatic, Manual
Track	:	Floor Mounted Rail
Travelling Speed	:	240 / 5 m/min
Hoisting Speed	:	50 / 5 m/min
Forking Speed	:	60 / 5 m/min

Mast

Carriage Assembly

Fork Assembly


Hoisting Motor & Drum wire
With encoder for ensuring high stop positioning, Providing fast closing
trigger that shall automatically stop the hoist carriage under emergency
4
Telescopic Fork
Mechanical stopper at the end of fork
3
Bottom Frame
During an emergency stop against buffers
at the end of bottom track
2
1
HOISTING
FORKING
TRAVELING
6
Top Frame
uide Rollers are attached to prevent stacker crane from getting derailed
5
Carriage
ist drive let it transfer cargos up/down, not only fork but also sensors for are attached on the carriage
* Cabin type is optional
7
Stacker Crane Controller
PLC, inverter, power unit, magnet switcher, etc are mounted inside of cabinet and control pushbuttons, keypad, selectable switch is also mounted on the top cover

- **LINEAR RGV**
- **LOOP RGV**

Rail Guided Vehicle (RGV) is a flexible transportation vehicle developed by SMC's own technology. It can link multiple destinations and be a good & economic alternative of conveyor by its characteristic that it can eliminate complex and fixed layout of conveyors, which enables simple and easily maintainable transportation system.

In a system multiple vehicles can be operated according to the transportation requirement. RGV system constitutes of transportation rail, vehicles and controller. RGV rail can be installed linear or circular.

RGV is controlled by distribution control system and can be expanded easily as the system parameter changes. This characteristic cannot be obtained in normal conveyor system.

Features

- Independent operation of vehicle by individual controller on each vehicle
- Low noise & vibration
- Modular design of drive unit to enable less parts and easy maintenance
- Relatively accurate positioning by an encoder
- Distribution control system

Application

Super high speed-RGV application

- Driving speed 265m/min, C/V loading speed 30m/min
- Inactivity server motor & S-curve urgent acceleration/deceleration
- Installation of absolute encoder in external timing belt

Automated guided vehicles (AGV) increase efficiency and reduce costs by helping to automate a manufacturing facility or warehouse. The first AGV was invented by Barrett Electronics in 1953. The AGV *can tow objects* behind them in trailers to which they can autonomously attach. The trailers can be used to move raw materials or finished product. The AGV can also store objects on a bed. The objects can be placed on a set of motorised rollers (conveyor) and then pushed off by reversing them. AGVs are employed in nearly every industry, including, pulp, paper, metals, newspaper, and general manufacturing. Transporting materials such as food, linen or medicine in hospitals is also done.

An AGV can also be called a laser guided vehicle (LGV). In Germany the technology is also called *Fahrerlose Transportsysteme* (FTS) and in Sweden *förarlösa truckar*. Lower cost versions of AGVs are often called Automated Guided Carts (AGCs) and are usually guided by magnetic tape. AGCs are available in a variety of models and can be used to move products on an assembly line, transport goods throughout a plant or warehouse, and deliver loads.

The first AGV was brought to market in the 1950s, by Barrett Electronics of Northbrook, Illinois, and at the time it was simply a tow truck that followed a wire in the floor instead of a rail. In 1976, Egemin Automation (Holland, MI) started working on the development of an automatic driverless control system for use in several industrial and commercial applications. Out of this technology came a new type of AGV, which follows invisible UV markers on the floor instead of being towed by a chain. The first such system was deployed at the Willis Tower (formerly Sears Tower) in Chicago, Illinois to deliver mail throughout its offices.

LINEAR RGV		
Type	:	Linear
Overall dimension	:	3.0 m X 2.5 m X 1.35m (H)
Load Weight	:	2X1070 kg (2 Pallets)
Positioning	:	Bar Code
Positioning accuracy	:	± 5 mm
Travelling Speed	:	180 / 5 m/min
Loading Speed	:	25 m/min

LOOP RGV		
Type	:	Loop
Overall dimension	:	3.0 m X 2.5 m X 1.35m (H)
Load Weight	:	2X1070 kg (2 Pallets)
Positioning	:	Bar Code
Positioning accuracy	:	± 5 mm
Travelling Speed	:	180 / 30/ 5 m/min
Loading Speed	:	25 m/min

- **SHUTTLE CONVEYOR**

Shuttle conveyors are troughed belt conveyors mounted on trolleys with wheels which travel on rails. They receive feed from feed hoppers located above them and in turn feed bunkers placed below them and spaced at desired distances.

A Shuttle conveyor has the same components as a belt conveyor like idler sets, drive pulley, take-up cum tail pulley, belt; drive consisting of a gearbox, couplings and an electric motor, skirt board, scrapers and technological structures. It can be unidirectional or reversible.

In addition, a shuttle conveyor has its own long travel drive. Usually the axle of the wheel adjacent to the conveyor drive and the same adjacent to tail pulley is directly driven through a hollow shaft mounted geared motor or through a drive consisting of Electric Motor, Gearbox and Coupling. The power supply to the drive motors are accomplished by festooning cable arrangement since travel length in relatively small.

A reversing shuttle conveyor is, in short, a belt conveyor that is mounted on to a rail system. The conveyor has the ability to move along the rails in either direction and the belt can be switched for either direction, making this style conveyor great for evenly filling multiple hoppers or storage bins. The conveyor is typically half the length of the rails, giving it plenty of room for several discharge locations. Both functions, belt direction and shuttle movement, can be automated or controlled by an operator.

Shuttle conveyors are trough belt conveyors mounted on trolleys with wheels which travel on rails. They receive feed from feed hoppers located above them and in turn feed bunkers placed below them and spaced at desired distance.

The main Features are as follows:

A. The structural of steel frame is well welded to be strong and stable.

B. Controlled by local operation or by remote control station

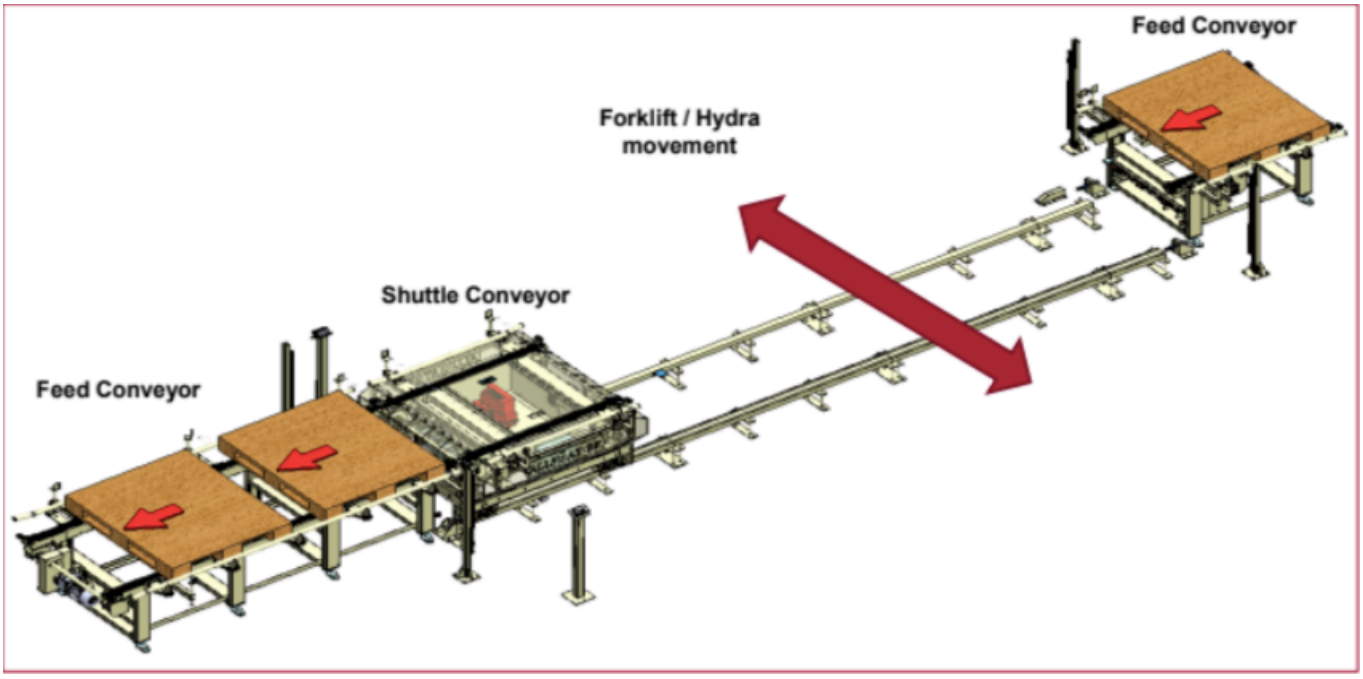
C. EXCT provide safety and limit switches to raise the safety standard.

D. Reversible Belt Direction: The reversing terminology refers to added control of the belt's conveying direction. The ability to control this means that the reversing

shuttle conveyor is not restricted to which end of the conveyor material can discharge from.

E. Controlled by Remote control station/Automation operation: Reversing shuttle conveyors can either be controlled from a remote location, such as a control room, by trained personnel, or automatically, through an automated program. This greatly reduces the labor cost of sorting and storing materials.

F. The conveyor has the ability to move along the rails in either direction and the belt can be switched for either direction, making this style conveyor great for evenly filling multiple hoppers or storage bins. The conveyor is typically half the length of the rails, giving it plenty of room for several discharge locations



WMS

A warehouse management system (WMS) is a software solution that offers visibility into a business' entire inventory and manages supply chain fulfilment operations from the distribution center to the store shelf. It is a software application designed to support and optimise warehouse functionality and distribution center management. These systems facilitate management in using simplified automatic technologies useful in daily activities like planning, organising, staffing, directing, warehouse-keeping and controlling the utilisation of available resources, to move and store materials inside, around and outside of a warehouse, while supporting staff in the performance of material movement and storage in and around a warehouse, without causing any large scale disruption to business resources.

Warehouse Management (WMS) solutions additionally enable companies to maximise their labor and space utilisation and equipment investments by coordinating and optimising resource usage and material flows. Specifically, WMS systems are designed to support the needs of an entire global supply chain, including distribution, manufacturing, asset-intensive, and service businesses.

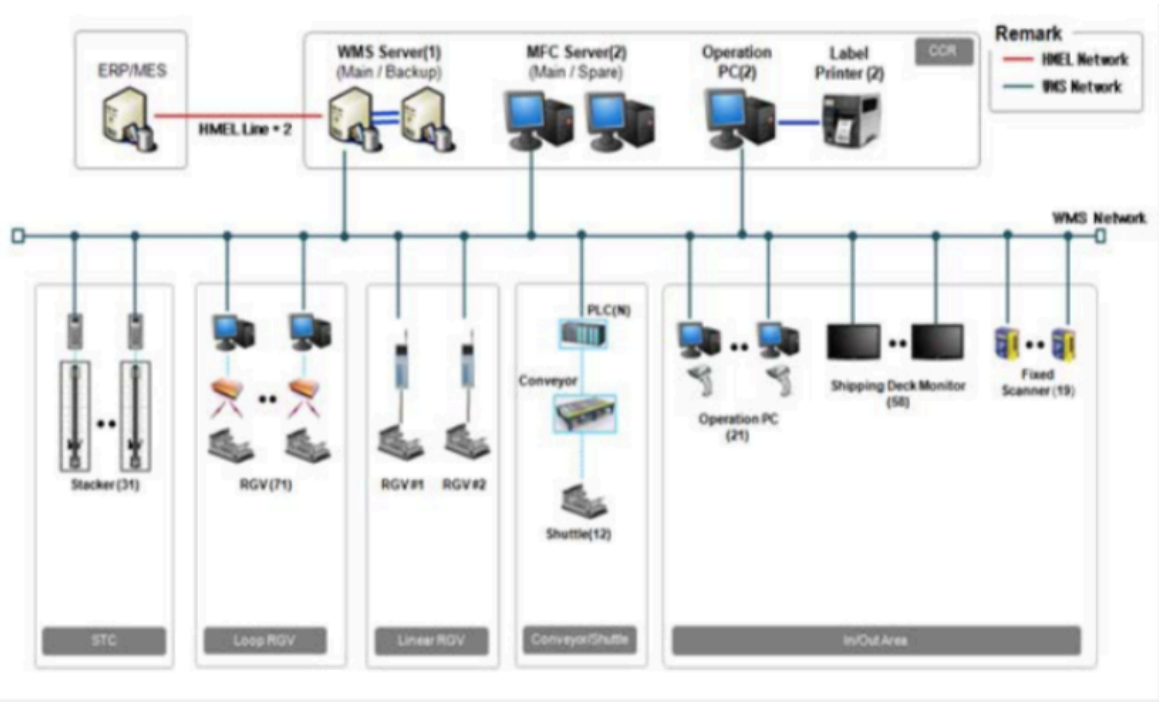
In today's dynamic, omnichannel, fulfilment economy, connected consumers want to buy anywhere, fulfil anywhere, and return anywhere. In order to be able to meet this need, businesses need the ability to respond quickly with warehouse management software that optimises fulfilment capabilities. Our industry-leading, cloud-based warehouse management system prepares you for tomorrow's supply chain, today. WMS Cloud extends supply chains to align inventory management and fulfilment services with modern purchasing methods, and offers real time visibility into an entire inventory—available via smart phone and browser—the only requirement being access to the Internet.

A warehouse management system (WMS) is a software application that helps control and manage the day-to-day operations in a warehouse. WMS software guides inventory receiving and put-away, optimises picking and shipping of orders and advises on inventory replenishment. A warehouse management system can be a standalone application or part of an Enterprise Resource Planning (ERP) system.

In the beginning, warehouse inventory management systems could only provide simple functions, mostly just storage location information. Nowadays, the breadth of WMS functionality can vary greatly, from basic best practices in pick, pack and ship functionality to sophisticated programs coordinating advanced interactions with material-handling devices and yard management.

A warehouse management system can reduce the likelihood of errors that could occur when a product is shipped. The system can also help a company fulfil orders more rapidly and instantaneously trace ordered products within the warehouse.

In the end, the overall goal of warehouse management system software is to achieve a paperless environment that directs your employees automatically on the optimal picking, put-away and shipping of your products.



Features Of WMS

A WMS uses a database configured to support warehouse operations, containing detail describing a variety of standard warehouse elements including:

1. Individual stock keeping units (SKUs) that are handled and stored, e.g., weight, dimensions, case pack, automatic ID labels (bar codes, etc.), and inventory by location with manufacture date, lot code, etc. SKUs may include basic materials, fabricated parts, assemblies, and industrial and consumer finished goods, etc.;
2. Warehouse storage locations, e.g., individual location number, picking sequence, type of use (picking, reserve storage, etc.), type of storage (each, case, pallet), location size or capacity, storage restriction (flammable, hazardous, high value materials, outdoor, etc.), etc.
3. Dock doors, e.g., individual number, etc.
4. Expected labor productivity rates by function or activity, e.g., cases picked per man-hour, etc.

Daily management functions include

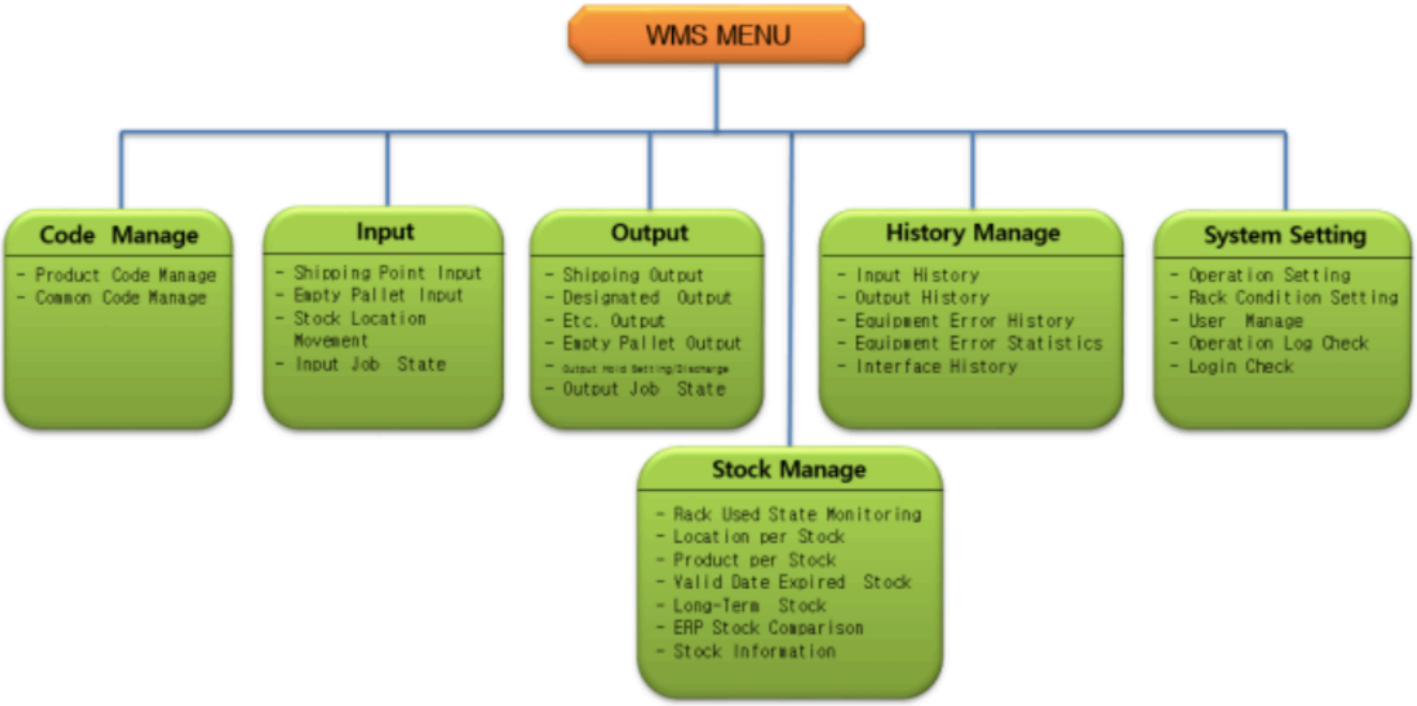
1. **Planning** – finalising the daily plan for receiving dock activity, selecting the workload/orders to be processed in the day or shift, (this may also be done by the business system), and calculating an estimate of the labor and vehicles required to pick and ship the orders to ensure the staffing is appropriate, and to notify carriers regarding to load and depart to meet customer requirements.
2. **Organising** – sequencing the orders to be picked. Organising orders for picking can be accomplished in many ways, meeting the needs of the user. The primary objective is to be intentional, and not to pick the orders in the sequence in which they were received unless the company wants to pay a carrier make sense for transportation and delivery. The initial way of organising was called wave planning or wave picking, with two objectives, a. to minimise need for dock staging space, by having orders arrive at the shipping dock in trailer load sequence, and b. to create an order of flow that will support monitoring the progress through the day and eliminate/reduce last minute requests for overtime or delay of carrier departure, etc.
3. **Staffing** – assign staff to work functions and areas, by wave, to minimise staging.
4. **Directing** – ensuring the documented processes and procedures are embedded in the WMS and are consistently applied, used and appropriate for the nature of the work and service level intentions of the company (e.g., International Standards Organisation 9000 (www.iso.org)). This function may also be used to divide individual orders into logical work units and the ability to assign them to separate individuals potentially for simultaneous performance, consistent throughput requirements and physical layout, e.g., separating individual case picking from each unit picking, and individual pallet load picking, to improve productivity and support Control.

5. **Controlling** – providing milestones for management to monitor progress through the day, providing the opportunity to respond to problems in a timely way, and report data for performance analysis.

Benefits of a modern, cloud-based warehouse management system

With the internet and digital technology having transformed how customers make purchases—disrupting supply markets, changing customer buying patterns, and adding complexity to the supply chain—fulfilment operations need to meet the changes with a digitally connected solution of their own.

In moving to the cloud, warehouse management systems can meet the connected consumer with a connected fulfilment solution that offers real time visibility, scalability, and market reactivity.



Conclusion

The training at Engineers India Limited was a great learning experience. It gave me an insight to the massive world of Oil & Natural Gas and the various equipments used in refinery and petrochemical plants.

Through this training, I have gained a deeper insight into automation, ware house management system, and their various allied equipments. The training taught me what are the factors while designing an automated system, the need and use cases of automated system, and their criticalness.

This knowledge and experience would be of immense help to me in future.