AGVs in the Warehouse

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MAG
Mobile Automation Group

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Leading Mobile Automation system and component suppliers

Mission: Promote growth and effective use of mobile automation systems in manufacturing, warehousing, distribution and other key markets

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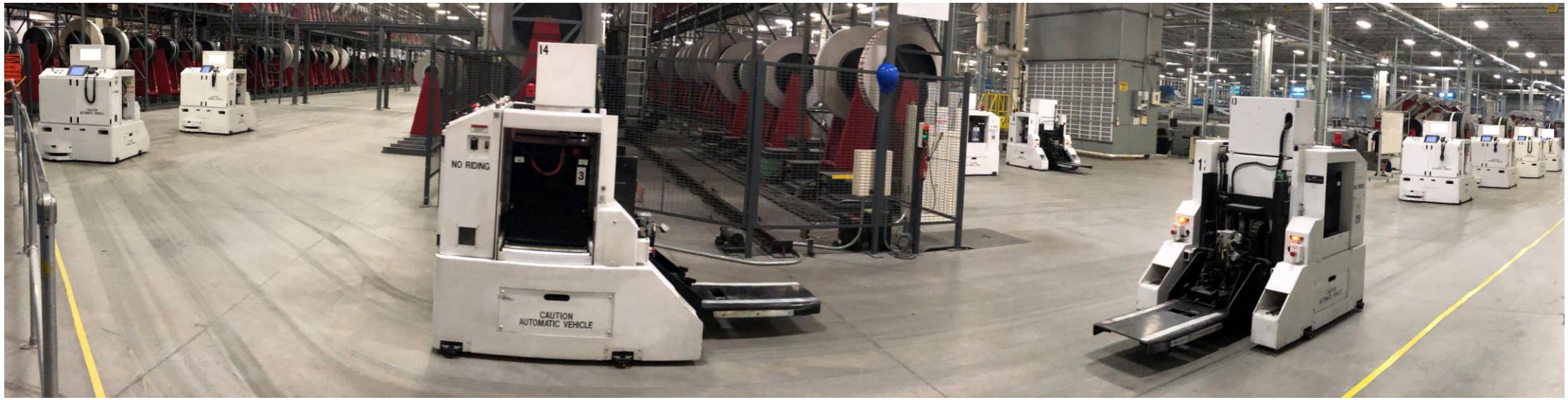
Increasing process efficiency and improving business profitability

AGVs are used in the factory, warehouse, distribution, or shipping areas across multiple industries to automatically transport and store all kinds of products and materials.



Defined…

An **Automated Guide Vehicle (AGV)** is a driverless transport mobile automation vehicle with a handling device to move goods (from point A to B) in production, warehouses, or distribution.

An **AGV System** integrates 1 or more AGVs in a solution under a single control system. An AGV system can be stand-alone or part of an overall logistics solution.

Why AGVs?

AGVs bring a wide range of benefits compared to manual transport & handling

- Reduced costs & manpower
- Virtually no product damage
- Improved accuracy and product traceability
- Increased throughput (consistent workflows)
- Reduced operator injury (safety)
- Flexible solution, easy and fast installation
- Minimum downtime thanks to 24/7 usage
- Better use of space
- Low maintenance
- Scalable for capacity increase and workflow changes

Where can you use AGVs in your Operation?

Goods Receiving
Raw Materials Handling

Transport ***to*** AS/RS
(Automated Warehouse)

As an AS/RS
(with aisle transfer)

Transport ***from*** AS/RS
(Automated Warehouse)

Raw Materials Transport
to Production

End-of-Line Transport

Coil/Roll Handling

Transport to
Picking/Shipping

What industries work well for AGVs?

Food & Beverages

Pharmaceuticals / Health Care

Distribution & Logistics

Paper & Print

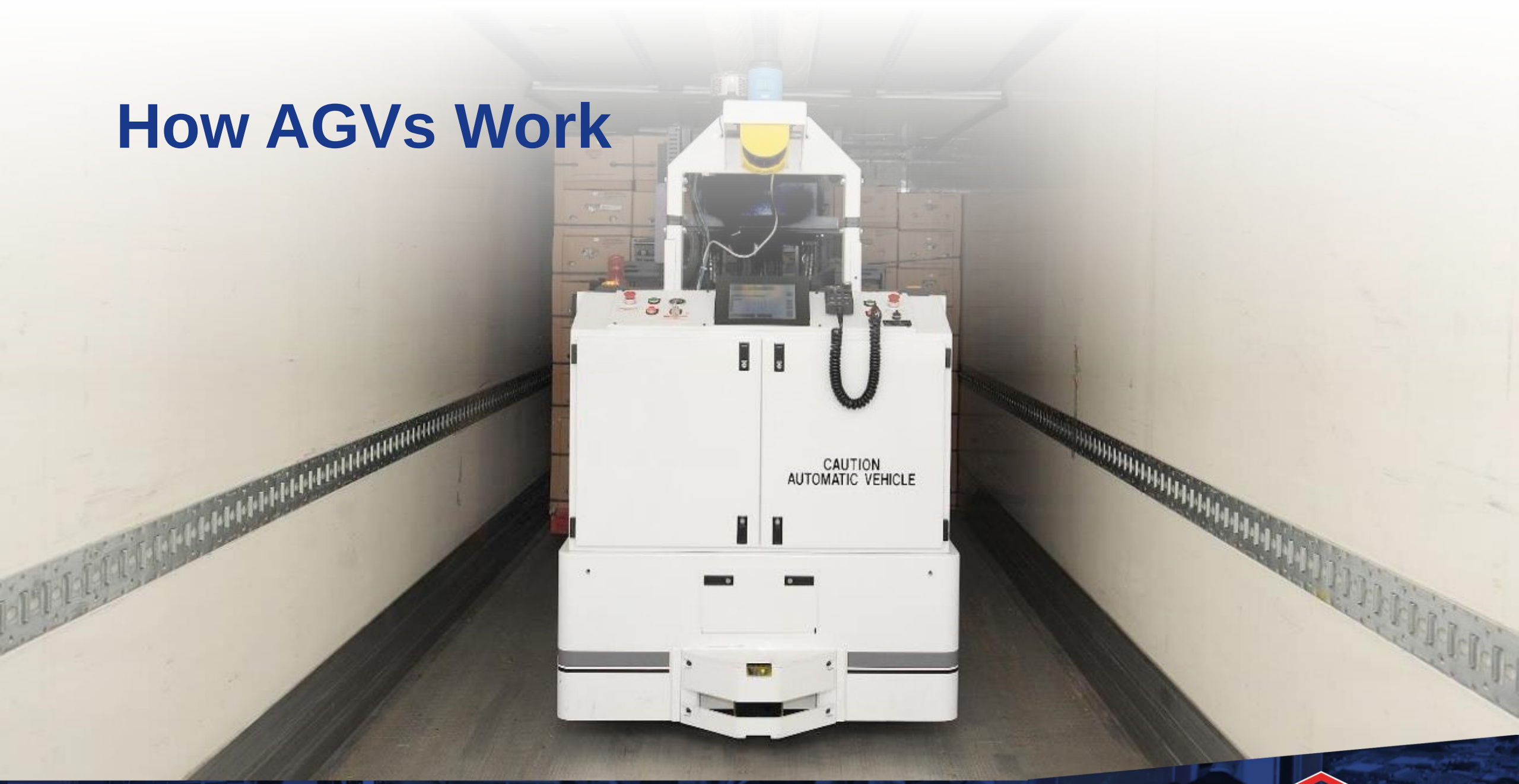
Plastics & Chemicals

Production & Assembly

Tobacco Production

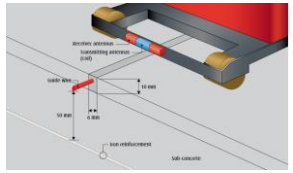
Manufacturing

How AGVs Work



AGV Guidance

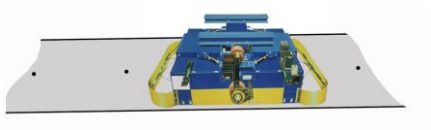
Wire



Powered wire embedded in the floor for the intended guidepath

Sensors on the AGV follow the signal in the wire

Magnet

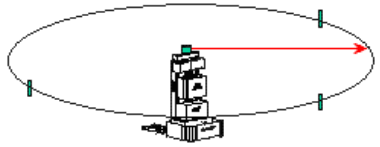


Magnets embedded in the floor within the planned guidepath

Magnets are surveyed in the coordinate system

Magnet sensor on AGV tracks along the magents and uses encoder feedback to calculate its postion

Laser



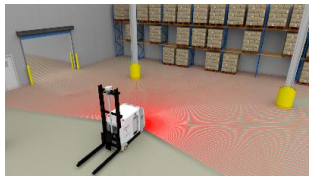
Laser targets installed within the facility

Targets are surveyed and downloaded to the AGV traffic manager and on board software

AGV is equipped with a laser scanner

AGV uses data returned from targets along within encoder data to calculate its position in the facility

Intelligent (Natural Target)



Natural fixed features and reflective tape are identified on a map

AGV navigates using a safety sensor approx 4” above the ground or long range sensors installed on top of the AGV

AGV uses data returned from sensors to calculate its location in the facility

AGV Power

Lead Acid - Flooded	Lead Acid Sealed	NiCAD	Lithium	TPPL	Hydrogen Fuel Cell
Lowest cost battery	Mid-Price Battery	Faster recharge times	Faster recharge times	Better price than Li Ion with many of the same benefits	Most costly technology
More robust than Sealed batteries	Temp range <100°F	High efficiency charging	High efficiency charging	Better Efficiency	Refueling infrastructure required in the facility
Weekly Maintenance charge cycle and battery watering is required	Lowest charge current	Increased Charge Currents	Increased Charge Currents	No Battery Swap Needed	Combines hydrogen and oxygen to produce electricity
Best suited for multiple hours of run time before recharging	No maintenance required	Quarterly maintenance is required (charging and maintenance checks)	No Maintenance Charge Required	No Watering	Water and heat are a byproduct
Usable capacity is 80% - swap and 40% - in AGV charging	Best suited for multiple hours of run time before recharging	Best suited for short-frequent charging	Wide operating temperatures	High Rate Performance	Refueled manually once or twice a day
	Usable capacity is 80% - swap and 40% - in AGV charging	Usable capacity is 8-10%	Best suited for multiple hours of run time before recharging	Extreme shock and vibration resistance	Refueling can be accomplished in less than five minutes
			Usable capacity is 60%	Minimal gasing	
				Perfect for in AGV charging	

AGV Charging

Manual Swap

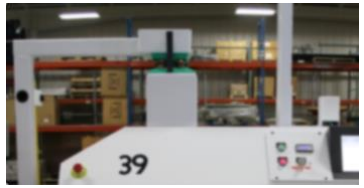
Mobile Cart or Cart on track

AGV automatically routed to recharge location when swap is required

Operator manually exchanges battery and releases the AGV into the system

Operator plugs the battery into the charger to recharge battery

In AGV – Overhead



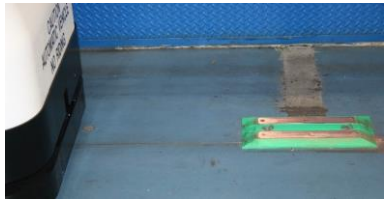
Charge plate and Collector

AGV automatically routed to recharge station when charge is required

AGV arrives at charging station and initiates the charging process

AGV stays powered on during charge. Once complete, the AGV is released into the system automatically

On AGV



Charge plate and Collector

AGV automatically routed to recharge station when charge is required

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Automatic Swap

AGV automatically routed to autoswap location for swap

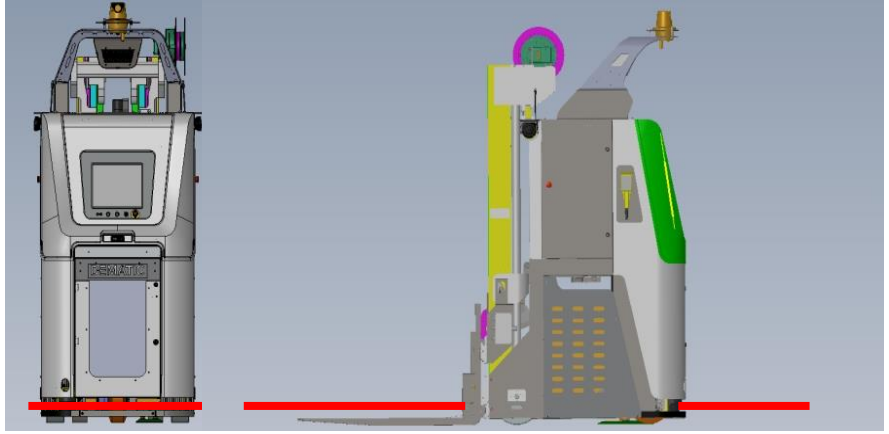
Auto Cart removes the depleted battery and installs fully charged battery

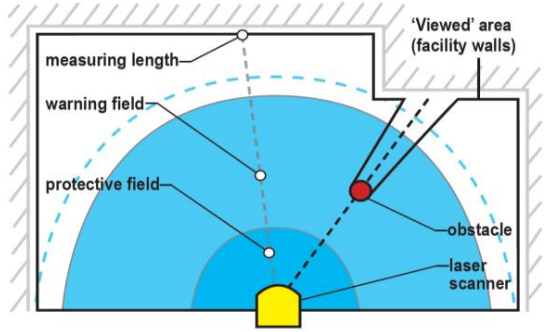
AGV is released into the system

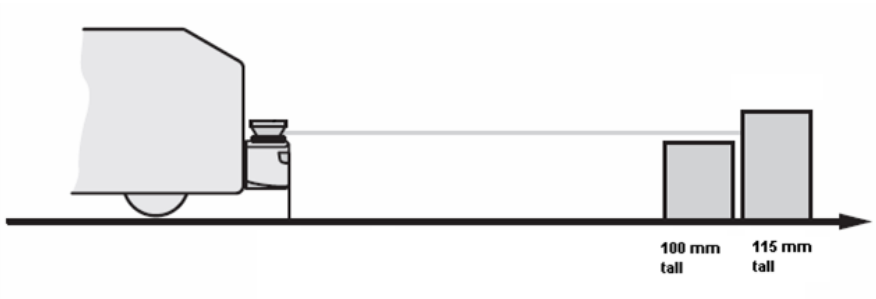
Cart places the depleted battery back in the rack and recharging begins

AGV Safety

- Built for Redundancy
- Programmable Safety Scanners
- E-Stop Buttons
- Visual Travel/Turn Indicators
- Audible and Visual Alarms
- Safety Relay
- Safe, warning and stop fields



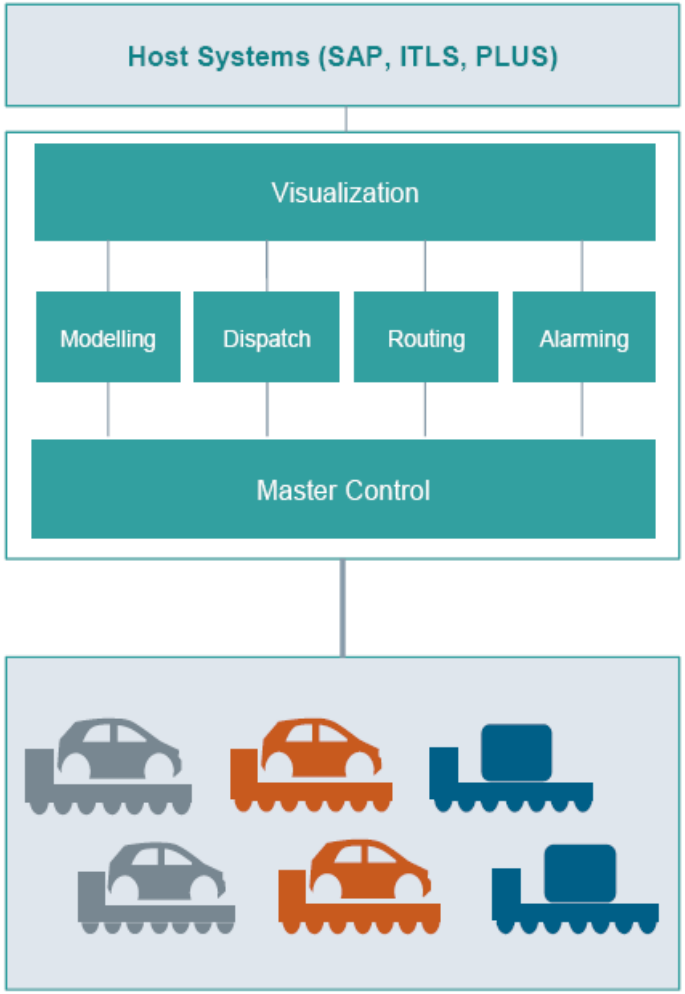


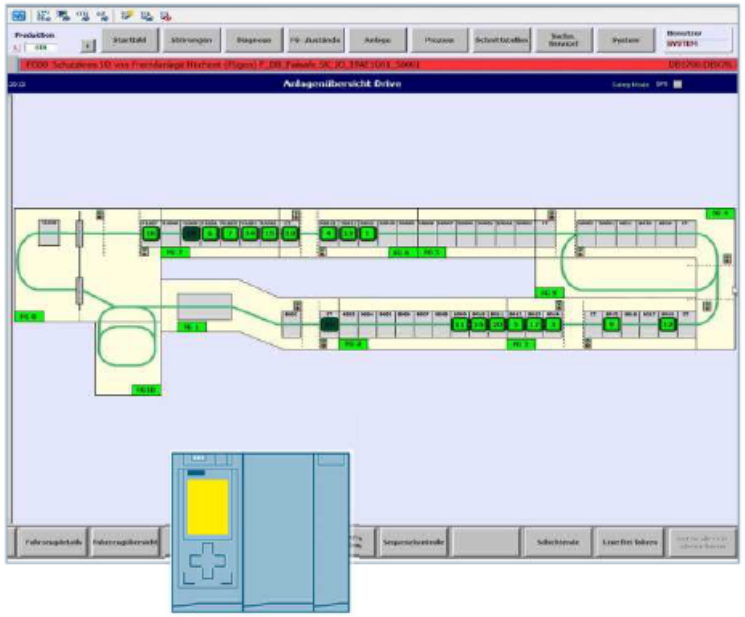


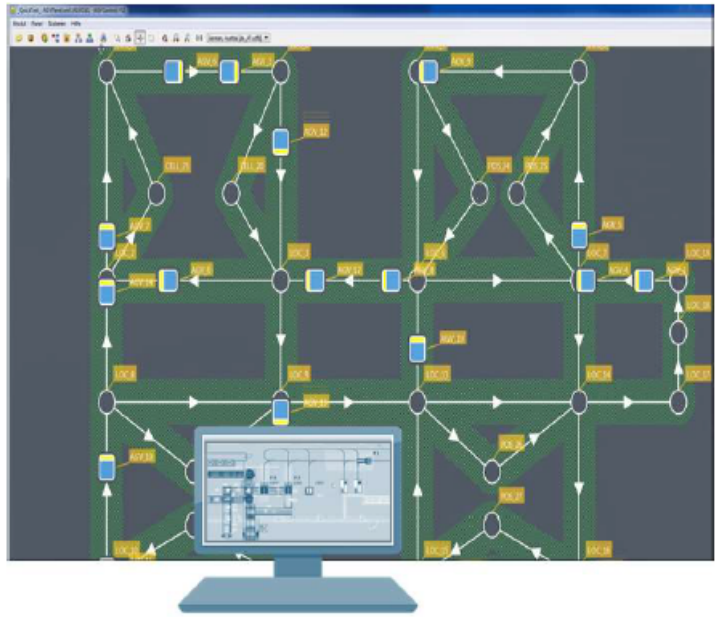
AGV Software

Three basic software components:

1. Transport management (transport generation, order assignment, optimization) to make optimum use of AGVs
2. Traffic control (AGV routing, transport optimization, node locking for collision avoidance)
3. Supervision/Maintenance (visualization and diagnosis)







- Siemens offers both: PLC-controlled (PLC+WinCC) and PC-controlled (Windows+WinCC OA) fleet management
- Integrated safety functionality
- Scalable architecture enables system expandability
- Open interfaces to AGVs simplifies integration of different suppliers

Why/When to Consider AGVs

Customer-Specific Application Data/Requirements

The choice of an AGV depends on a number of your specifications:

- **Environment**: Layout, available space, humidity, temperature
- **Load**: Load type (pallet, containers, coils/rolls, boxes, trays, racks, boxes, etc.), dimensions, weight, fork pocket, cargo overhang
- **Transport**: Distances, capacities (transports per hour), intake-discharge-matrix (number of positions, floor-to-floor, conveyor to conveyor / floor, shelf)
- **Rack**: Shelf height, headroom, overhangs, ...
- **Floor**: Wheel load, flatness, abrasion, transitions, max. Tilt, electrical resistance, incline/decline, etc.

…the more matches, the better

- Repetitive, ‘non-value add’ material transports
- Multi-shift & 24/7 operations
- Material flows with many buffer spaces
- Complex production processes
- Processes where tracking the material is important
- High Damage Rates/Inventory Loss

AGVs vs Conveyor, AS/RS

Space	Provide reliable horizontal transportation without impeding other traffic (No blocking like with conveyor)
Economical	Long distance delivery without fixed assets such as conveyor
Agile	Intelligently completes complex multi-point moves
Flexible	Capable of interfacing to a variety of stands, automation, and manufacturing operations; multi-aisle use (vs. AS/RS)
Dynamic	Easy path modifications for changing environments/operations
Redundancy	Natural redundancy built in due to multiple AGVs on same guidepath Manual backup options

Types of AGVs

AGV Types

Automated Guided Cart (AGC)

Basic AGVs was basic functionality

- Transport
- Lifting table
- Cart

Tugger AGV

AGVs for towing carts or trolleys

- Transport
- Multiple cart use
- High weight capacity

Counter Balanced (Fork) AGV

Counter Balanced Fork-based AGVs

- Fork over
- Straddle
- Very Narrow Aisle (VNA)
- Reach Truck
- Narrow Aisle Truck
- Drive In Racking

Roller Deck AGV

Conveyor deck AGV

- Unit load
- Multiple load
- Transfer to conveyor

AMR

Conveyor deck AGV

- Unit load
- Multiple load
- Transfer to conveyor/person

Hybrid AGV

Dual-use vehicles

- Counterbalance
- Tugger
- VNA
- Reach Truck

Hybrid AGV Automation Pack

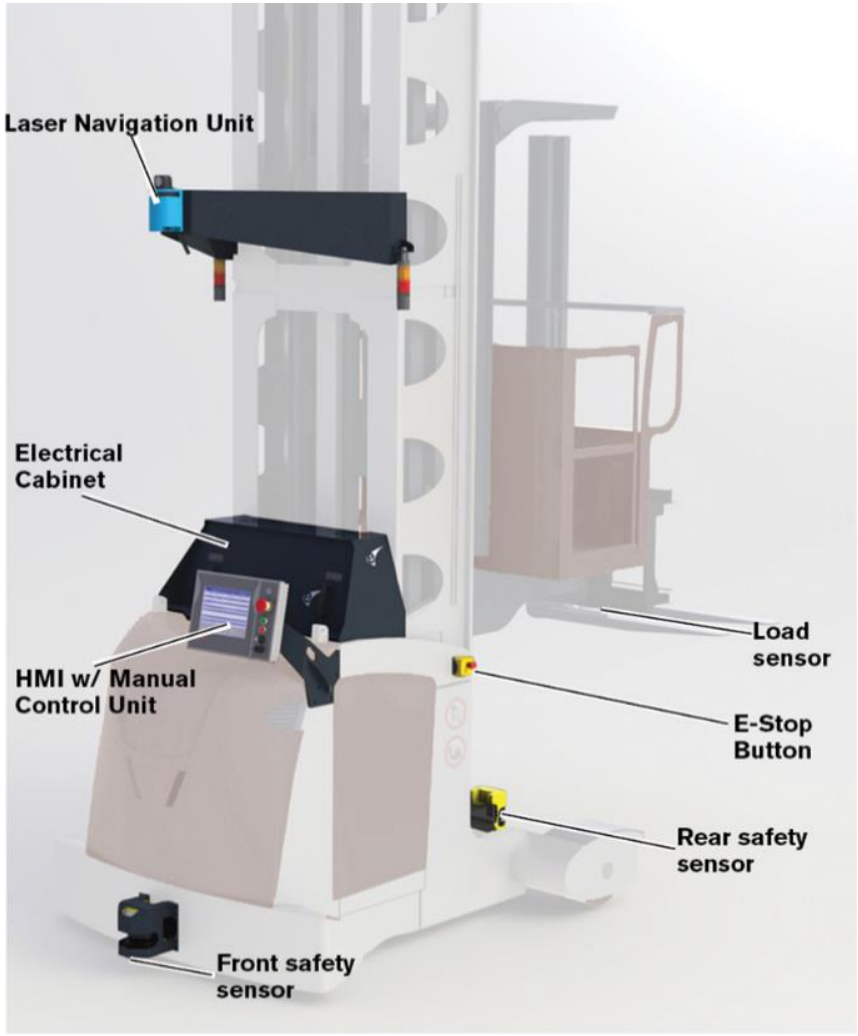
Automation kit gives full AGV functionality and creates dual use machine

- Drive
- Navigate
- Pick and handle goods autonomously

Cost savings on maintenance vs fork trucks

Shorter delivery times due to less engineering

Manual driving with truck remains possible



Other AGV Types

ROI for AGVs

Example ROI

- Example
  - 24/7 Operation
  - 3 Shift
  - $60,000/yr
  - 5 Operators Per Shift
- ($60,000) x (5 Operators) x (3 Shifts) = $900,000 Yearly
- ($1,750,000 AGV System) / ($900,000 Savings) = 1.94
- **2 Year Payback**

Beyond the initial labor ROI…

Labor	100% Labor reduction, overtime, and turnover cost
Product Damage	Elimination of facility equipment damage by conventional fork trucks
Shipping Accuracy	Reduction in miss-shipments and wrong product picked
Energy	Potential savings associated with lights out operations
Safety	Elimination of fork truck related accidents
Financing	Leasing options are available

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