Automated Guided Vehicles (AGVs) vs. Autonomous Mobile Robots (AMRs): Debunking the Myths
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Introduction

Automatic Guided Vehicles (AGVs) or Driverless, Automatic Guided Industrial Vehicles, as they are officially labeled by the American National Standards Institute (ANSI) have long been recognized as a successful solution to automatically move material to, from, and through manufacturing facilities, warehouses, distribution centers, and everywhere in-between. AGVs have been accomplishing this for over half a century. One of the most apparent values of AGVs is that they replace non-value-added repetitive material movement.

AGVs have been known by an alphabet soup of names, and companies have tried to standout in the crowd with their own branding of AGV. Some examples include LGV (laser guided vehicle), SGV (self-guided vehicle), AGC (automatic guided cart), or even E’GV (Egemin guided vehicle). These brandings generally are a subset of the whole of what AGVs are. Think of a classroom being a subset of a whole school, and likewise an LGV is a subset of AGVs, being that they only use laser guidance for navigation.

Over the past few years, a new name began appearing: AMR (Autonomous Mobile Robot). As the new kid on the block, AMRs have received a lot of attention, claiming to be the next great thing in automatic, driverless mobile vehicles/robots (but not AGVs).

The reality is that AMRs, like AGCs and SGVs, are a subset of AGVs focused on a specific navigation technology, physical size/payload capabilities, environment, and routing abilities. Misinformation about AMRs paints a picture of AGVs as antiquated technology and thus obsolete. This myth is built on the selective omission of the leaps in AGV technology in the last 10 years, such as vision-based guidance, dynamic routing, and 3-D sensors (to name just a few).

This white paper dispels the myths that claim AMRs to be superior to AGVs.
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**MYTH: AGVs and AMRs are completely different machines.**

While the AMR manufacturers would like you to think otherwise, AGVs and AMRs have very similar functionally. They both can transport an item to and from a location. Most AMRs focus on transporting totes only, while AGVs tend to focus on full pallet loads. Both AMRs and AGVs work well in systems where human intervention is needed to lift or pick loads. But AGVs are required for automated picking/lifting, transport, and automatic placement of product.

**REALITY: AMRs are a subset of AGVs.**

**MYTH: All AGVs use wire navigation.**

The fundamental difference between AGVs and AMRs involves navigation. When AMR companies compare AMRs to AGVs, they say that all AGVs use wire-guided navigation, creating a perception of “old” versus “new” technology. While historically AGVs would follow routes usually from wires or magnets embedded in the floor of the facility, today’s AGVs use the navigation type that best fits the application. While this commonly means laser or camera-based navigation, it can also still mean wire navigation.

An AGV’s actual navigation path is determined by software directing the machine where to go. The software in an AGV is a combination of fleet management and onboard software. This allows each AGV to know it is on a path that other AGVs are not on and if a path is blocked, other machines can reroute. Some AGVs have the ability to adjust their path if an obstacle is blocking a portion of the travel path.

**REALITY: AGVs use the type of navigation that best fits the application.**
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**MYTH: AGVs use a fixed path.**

AGVs travel on guidepaths, but they do not always take the same path to get from A to B. The guidepath is like the streets in a city, with many ways to get from one location to another. The AGV software makes intelligent choices based on traffic, travel distance, and other variables to route each machine through the most efficient guidepath of “streets.”

Keeping with the street metaphor, AGVs are like cars and are required to drive on the street (guidepath). ANSI safety standards (the standard that AGVs follow) state that an AGV must travel on a predetermined path. This means the AGV can’t leave the street and use a shortcut even if there is space for it to fit. AGVs use the streets that have already been determined as the understood travel path. While AGVs are like cars, AMRs are more like bikes in this scenario and are more easily able to cut off of streets using a shortcut as they would do a lot less damage and take up a lot less space. The difference is that the AMR (bike) can carry a stack of papers or maybe a pizza. The AGV (car) can take 10,000 papers or 900 pizzas. That’s a big difference.

In your distribution or manufacturing facility (just like in your neighborhood), you don’t want an AGV with a multiple ton load to randomly decide to take a shortcut because it saw a “better” way to get where it was going. You want it to take the safer route of the street. The AGV can make dynamic adjustments, but still uses recognized travel paths.

**REALITY: AGVs have the capability to use either fixed or dynamic guidepath.**

**MYTH: AGVs are not meant for working alongside people.**

AGVs are among the original “collaborative robots,” operating alongside workers for decades. As AGVs use a more fixed guidepath than AMRs, they are more predictable in their operation. AGVs also follow ANSI safety standards, making them safer for worker/machine environments.

A hybrid AGV is specifically designed for people. This is a fork truck or tugger vehicle that is automated so it can be operated manually or as a fully functional AGV. There are even AGVs that operate by not following a specific guidepath, but instead follow a worker. As workers pick product, the AGV follows them, stopping when they stop to place the product onto the AGV.

**REALITY: AGVs are the original collaborative robots.**
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MYTH: AMRs are safer than AGVs.

As opposed to AMRs — whose sensors may not follow traditional safety standards and may not be safety rated — AGV sensors allow the machines to safely operate in close proximity with people.

AGVs don’t run into people, people run into them. Safety sensors and alerts (lights/horns) provide redundant safety — workers are aware when an AGV is near and AGVs stop when a worker or object is in the guidepath. AGVs can therefore safely work in the same environment as people and other equipment including fork trucks.

When sensors detect an object in the guidepath, the AGV first slows and then stops, depending on the distance to the object. These same sensors also assist in navigation. For example, they help determine the exact positioning for picking/putting objects within a rack or other location.

Some AGVs do not follow a guidepath, but instead follow a worker. When the worker picks product, the AGV stops so the worker can place the products onto the AGV.

REALITY: AGVs use redundant safety sensors that follow certified safety standards to operate around workers.

MYTH: AGVs can only do simple tasks.

An AGV can do anything that a fork truck can do, including transporting, picking, lifting, and storing materials. AMRs are more commonly used for transport only and can’t lift to the heights that an AGV can.

AGVs can operate in very narrow aisles and can pick/lift pallets over 40 feet in the air, which AMRs are unable to do.

AGVs can also automatically load a semi-trailer with pallets, picking up to four pallets at a time.

REALITY: AGVs can perform simple cooperative tasks to complex fully automated operations.
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**MYTH: AMRs are faster, smarter, and more efficient than AGVs.**

An AMR carrying light totes can operate at a safer speed than an AGV carrying 10,000 pounds. Depending on the application, AGVs operate in the same speed range as AMRs. But in automation, speed can be dangerous. Automated machines need to operate at safe, predictable speeds. The safety sensors on an AGV allow it to travel at speeds where it can quickly stop if a worker steps in front of it. These safety sensors keep workers safe, creating a collaborative robot area where workers and AGVs can operate alongside each other.

When considering an automation solution, it’s more important to look not at speed, but at throughput. AGVs and AMRs actually travel at about the same speed when carrying similar loads. The advantage of an AGV is how much it can carry. AGVs performing automatic trailer loading can carry up to four full pallets at a time. So, while AGVs may sometimes operate more slowly than AMRs or fork trucks, they make up for it in the total amount of product moved in a given period of time — throughput.

The intelligence of an AGV system is directly related to the complexity of the application. Simpler transport-only applications don’t need as much sophistication or intelligence as a system with 10,000 rack pallet locations. AGVs can carry more product (both in size and weight) than AMRs.

**REALITY: AGV speeds can vary from 3 feet/second to more than 10 feet/second. But speed does not matter, throughput does.**

**REALITY: AGV “smarts” vary depending on the application.**

**REALITY: AGVs, AMRs, and AGCs are components of an automated system. The efficiency comes from a well-designed system.**

**MYTH: AMRs are easier to set up.**

The ease of setting up or implementing an AGV or AMR system is directly related to the complexity of the system. As AMR systems are generally not as complex as most AGV systems, you might assume an AMR system is easier to set up. However, AGV systems have a shared system map stored locally in each AGV, so actual on-site installation can be a matter of minutes. This facility map is pre-loaded on the AGV, which accelerates the on-site testing and implementation of an AGV system.

**REALITY: AGV system setup is based on the simplicity (or complexity) of the system.**
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**MYTH: AGV Systems aren’t flexible or scalable.**

AGVs can be a subsystem in an overall material handling automation plan, or a stand-alone solution. Business changes and your need the flexibility to adjust operations to change with it. AGVs are no exception and offer the flexibility of being a flexible automation solution. This means the AGV system can scale or flex with you. Adding new machines or reallocating AGVs from one area of a facility to another is quick and easy. The AGV software is shared so that changes can easily be made to one machine and replicated to all. New machines can be operational in minutes after arriving at the facility.

Because today’s AGVs use laser and camera-based navigation, modifying or changing a guide path is an easy operation. Simple software changes to the fleet management software can allow guidepaths to easily be changed or modified. Changing the guidepath only needs to be done once, and all the machines in the system get the change.

**REALITY: With today’s AGV software, making changes is quick and easy.**

**MYTH: AGVs aren’t easily redeployed to another location.**

Changing an AGV guidepath is a simple software adjustment that can be made in a matter of minutes. Redeploying AGVs to different locations is equally easy. This allows AGVs to be shared among multiple facilities or areas within a facility to alleviate seasonal demands.

Software on the AGV is shared so that guidepath or redeployment changes can be made to one machine and replicated to the entire system. Machines can be operational with the new path or in the new facility in minutes.

**REALITY: Operation managers can transfer AGVs between facilities and systems without any assistance from the AGV supplier.**
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*MYTH: Making a change to an AGV guidepath is a costly, expensive operation.*

AMRs also like to tout their ability to adjust a path on-the-fly to swerve around objects. If the AGV or AMR is transporting a tote, warehouse aisles might be wide enough for the machine to adjust its path, but not for transporting pallets.

AGV systems are designed to avoid items blocking travel paths. In the event an item or person does block the path, the AGV slows down as it approaches, and if the path continues to be blocked, the machine stops. The fleet management system is alerted. When the blockage is removed, the AGV continues. Alerts can be set to notify staff if an AGV is blocked for a certain length of time.

*REALITY: Using the AGV software, operation managers can adjust guidepath on the fly.*

*MYTH: AGVs are more costly than AMRs.*

AMRs have looked to create the perception of superiority over AGVs in price, claiming that AMRs are less costly than AGVs to install.

AMRs might use some sophisticated camera navigation, but so can AGVs when the technology is needed. Technology comes at a cost. Depending on the application, AGVs can use laser, camera, and even wire-based navigation. AMRs that use all camera-based navigation can actually be a more expensive solution with more technology than you might need for your particular situation.

AMR manufacturers claim that because AMRs don’t need wires or magnets or beacons or any other costly infrastructure modifications, getting started with them is fast and relatively inexpensive. The infrastructure changes needed for an AGV system vary based on the navigation style used. The cost of the overall solution is more based on the complexity of the application than the type of machine. Given that an AGV solution can be much more complex than an AMR solution, it’s not uncommon that the AGV would be more expensive. Comparable AGV and AMR systems, doing basic functionality, would likely cost approximately the same.

*REALITY: AGV machine costs vary depending on the equipment. AGV system costs vary depending on the complexity of the solution. The truest cost is total cost of ownership.*
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Conclusion

No matter what technology you use, make sure it is the right technology for your needs. In some applications, an AMR-based system might be the best for you; in others, an AGV-based system is the better choice. Don’t fall victim to thinking that you need the latest technology when what you actually need is the right technology.
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About Dematic

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Headquartered in Atlanta, Georgia, Dematic is a member of KION Group, a global leader in industrial trucks, related services and supply chain solutions. Across more than 100 countries worldwide, the KION Group designs, builds and supports logistics solutions that optimize material and information flow within factories, warehouses and distribution centers. The company is the largest manufacturer of industrial trucks in Europe, the second-largest producer of forklifts globally and a leading provider of warehouse automation.

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