The State of Forklift Automation:
Are We There Yet?

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Introduction

Capital equipment budgets are finally returning to pre-2008 levels and many fleets are overdue for an infusion of new trucks. At the same time, the drive to reduce material handling costs persists. In a 2012 Crown survey of more than 300 material handling professionals, 71 per cent cited the need to drive down costs as the biggest material handling challenge facing their organisation.

Because automation is one of the most powerful weapons the industry has in the battle against costs, and capital equipment budgets may be available to support new projects, many organisations are wondering if now is the right time to make the move to forklift automation.

Despite the success of automatic guided vehicles (AGVs) in manufacturing, automated vehicles have not been widely adopted in warehousing. This is because the warehouse environment presents challenges not found in manufacturing and some early adopters have been disappointed with the amount of support required to keep forklifts retrofitted with AGV technology operational.

So, is now the right time to implement forklift automation, moving quickly to reap the benefits of this exciting technology and possibly creating competitive advantage? Or, is it wiser to wait for the technology to mature, minimising the risk of an unsuccessful deployment that could disrupt operations and have a negative return on investment?

This is the question forward-thinking material handling executives are facing. The answer, of course, will depend on an organisation's goals and risk tolerance and the characteristics of the material handling challenge. The purpose of this paper is to help each organisation address that question. It reviews the current state of the technology, and for those who decide to move forward, outlines the considerations that must be addressed prior to adoption.

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Forklift Automation Technology – The Present State

Before examining the present state of the technology, it is helpful to note the major differences between manufacturing and warehousing processes as these differences shape the vehicle requirements for each application.

Manufacturing processes are predictable and repeatable, making them an ideal candidate for automation. In addition, manufacturing has relatively consistent daily output compared to a typical warehouse. Forklifts supporting these processes typically move products from one station to the next or from manufacturing to shipping at regular intervals. Vehicles travel the same well-defined path over and over with no need to navigate around other vehicles or congestion. AGVs have been designed and built specifically for this purpose. They often have no operator cab or controls and bear little resemblance to a traditional forklift.

In contrast to the straightforward, rigid installations that thrive in manufacturing, warehousing requirements are more complex and less predictable. Automated forklifts need to be able to go anywhere within the warehouse, may have to travel to multiple locations to fulfil a single order and must adapt to varying workloads, often hour-to-hour. This requires a much greater degree of vehicle intelligence and mobility and limits the utility of vehicles that operate only in automatic mode as they don't have the adaptability required.

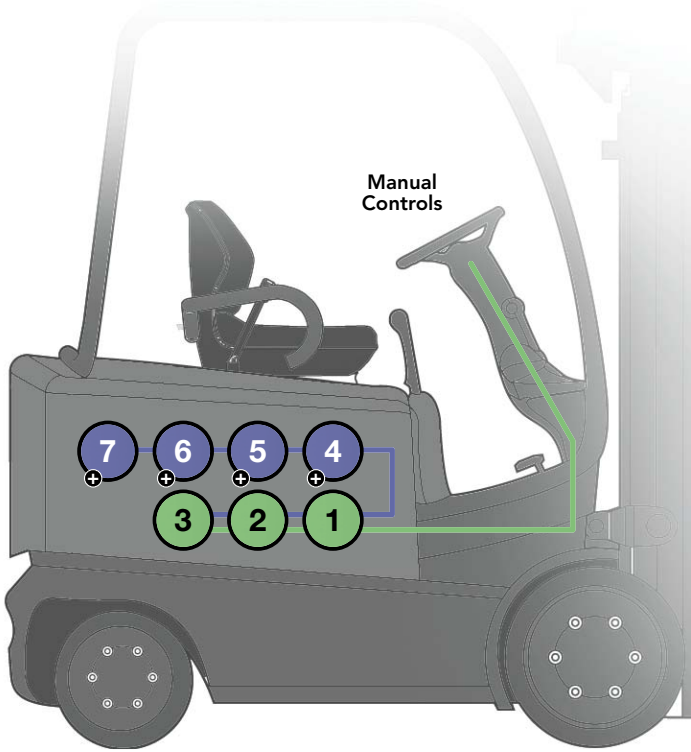
That has resulted in the emergence of a new type of vehicle that can function both in manual—operator driven—and automatic modes. Because of the complexities inherent in creating dual-mode vehicles, they are not yet being fully purpose-built for warehousing. Instead, they are being produced by retrofitting or adapting manual forklifts with sensors and controls that interface with the truck's electronics to enable automated operation.

While this is moving the industry forward and allowing early adopters to evaluate the potential of forklift automation in real-world conditions, it does create several issues that need to be considered.

Sensor Durability

Sensors used by the vehicle's safety system are typically mounted on the outside of the truck, making them susceptible to damage when the truck is operated in manual mode. Operators accustomed to driving without sensors may fail to provide for the added clearance they require and sensitive electronics are easily damaged. They are also expensive to replace. It can cost a great deal to replace one sensor and the truck cannot be used in auto mode until damaged sensors are replaced.

Some trucks are now being designed with sensors installed inside the body of the truck, providing protection against damage;



Manual Controlled Forklift
1. Vehicle Control Module
2. Traction Control Module
3. Motor

Dual-Mode Controlled Forklift
1. Vehicle Control Module
2. Traction Control Module
3. Motor
4. Automation Control Module
5. Safety Control Module
6. Navigation Control Module
7. Wireless Interface Module

⊕ Extra subsystems are required to convert a manual forklift for automatic operation.

however, this is still the exception rather than the norm. To meet most users' expectations for reliability, this higher degree of integration between the forklift and the sensors must become the standard.

Forklift Electronics
The forklift's electronics have not been designed to interface with automation systems. Extra electronics and harnessing are required from the automation supplier to interface the truck's controls with the automation system, increasing complexity and reducing reliability. Additionally, the electronic hardware and harnessing required for automation may not be designed to withstand the same levels of shock and vibration as electronics built for manual forklifts.

Distributed Responsibilities
Dual-mode forklifts typically feature technologies from at least two companies: sensors and electronics from an automation company mounted on a truck from one of the leading forklift manufacturers. Automation companies don't have the large-scale manufacturing capabilities required to produce their own dual-mode trucks and forklift manufacturers have not yet developed their automation capabilities to the point of being able to produce true dual-mode vehicles. In some cases, a system integrator may also be involved, adding a third party to the mix.

The result is a system that relies on technologies from multiple companies which can present problems when things don't work the way they are supposed to. One of the most frustrating experiences for any organisation investing in a complex system with components from multiple manufacturers is being told by all parties that the problem is not with their system. Even if one party is willing to take responsibility for the full system, they may not have the expertise to solve the problems they encounter. These limitations may not be insurmountable but will force additional planning and preparation prior to implementation and may limit future scalability and reliability. Most operations will benefit from a careful examination of both the environment and the processes involved before unleashing automated forklifts. Even then, the tasks these vehicles can be reasonably expected to perform may be very limited, based on the current state of the technology.

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Evaluation Criteria

Forklift and automation manufacturers are making significant investments in research and development to move the technology forward. Some of the limitations mentioned earlier may have been resolved by the time you read this paper. With technology changing so quickly, it is important to identify a set of criteria that can remain consistent as the technology evolves. Here are four attributes that can serve as the basis for evaluating a warehouse automation system:

Reliability

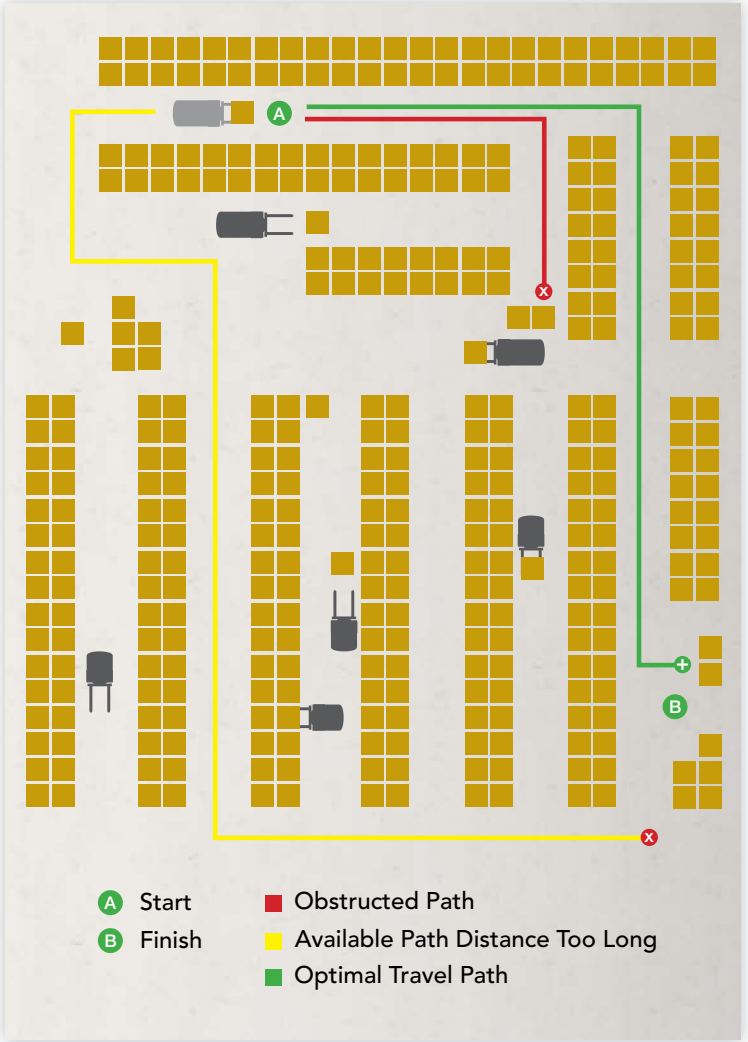
Reliability is job one for any forklift, whether manual, automatic or dual mode. As already mentioned, sensors and other automation components that hang off the vehicle unprotected are susceptible to damage, which can create problems. As dual-mode vehicles get more sophisticated, sensors will increasingly be protected by the truck body, minimising the reliability issues inherent in many current designs. In addition, automation electronics should be fully integrated with truck electronics to minimise interface issues and extra subsystems.

Even the best-designed vehicles require regular maintenance. Service support and parts availability are sometimes regarded as issues that can be addressed post-installation, but problems can result in automated vehicles sitting idle for extended periods because of long lead times for parts. Unfortunately, the service and parts infrastructure required to support automated forklifts is still immature and the rapid evolution of the technology suggests it may remain that way in the short term. There is no guarantee manufacturers will not introduce new products featuring completely different technology a year from now, making parts for today's systems difficult to source or requiring costly system upgrades.

Flexibility

This is the challenge that dual-mode vehicles are designed to address. The warehouse is not a static environment, so it is often not enough for automated vehicles to handle the basic tasks they are initially brought in for. In addition, workloads can vary significantly based on time of day, season or other factors. If processes in the warehouse change can the forklift adapt? How will changes to the WMS or other warehouse technology affect automated vehicles? How easily can automated vehicles be converted for manual operation to address peak volumes? How quickly can temporary staff, required during peak periods, be trained to drive these sophisticated dual-mode vehicles?

One relatively simple issue that highlights the lack of flexibility in current systems



The goal for automated forklifts is to be able to analyse multiple routes to a destination and select the path that is most efficient while navigating around other trucks and congestion.

is congestion. Navigation technology is currently limited in its ability to dynamically adapt to changes as simple as pieces of shrink-wrap or cardboard left on the floor. Lacking the intelligence to navigate these "obstacles," the vehicle will stop and wait, requiring a person to physically remove the obstacle and restart the vehicle.

The less flexibility a system has, the greater the risk of it quickly becoming obsolete. A much shorter return on investment period is required to justify systems that lack flexibility.

Scalability
Many organisations moving forward with forklift automation will conduct a pilot prior to widespread implementation. Pilots have to be carefully designed and evaluated to ensure that the results achieved can be scaled across the organisation and that the test doesn't severely disrupt day-to-day operations. In general, complexity increases with the size of the warehouse. Trucks may be required to make more complicated decisions such as choosing the best of multiple potential routes and being required to operate smoothly around other trucks, some automated and some manual.

This is where it becomes critical to have a long-term automation strategy—a vision for how automation will support material handling in your organisation in the future.

The more able the technology is to evolve in support of that long-term vision, the longer your investment will be protected.

The stability of the technology should also be considered. Technologies are getting better with each new generation but not all new technologies will be compatible with what exists today. If, for example, you deploy a laser-guided system and the industry standardises on a different guidance technology, you may have to replace the entire system to adapt to emerging industry standards. As yet, standards do not exist in this area.

Safety
If reliability is job one, safety is priority one. While operators are not perfect, they make multiple accident-preventing decisions every minute that are simply beyond the capabilities of any current automated technology. Things as simple as pivoting the head to scan an environment, engaging in a short conversation with another driver or anticipating a problem before it is encountered are all common occurrences that help ensure safe operation.

To meet industry safety standards, automated vehicles must be equipped with audible warnings and lights, and have built-in sensors to detect obstructions; however, these systems are still rudimentary

Operators have a number of advantages over automated vehicles in their ability to adapt to unexpected situations, including the ability to communicate with other operators.

compared to a manual vehicle with a driver. Automated vehicles compensate by moving at slow speeds and shutting down whenever an obstacle is perceived.

A good practice with any automation project is to conduct a detailed audit to create a safety plan that includes training and procedures specific to the new technology. This may require some changes to employee responsibilities and processes to, for example, eliminate or minimise situations where aisles become cluttered with storage that creates hazards for the vehicle.

Moving Forward

While the technology is still maturing, forklift automation is showing the potential to generate significant improvements in material handling productivity in the long term. For those organisations seeking to move forward with forklift automation, the following considerations can help increase the likelihood of a successful deployment.

Application

The vision of a warehouse with all tasks being performed by automated vehicles is not realistic at this stage in the development of the technology. That doesn't mean there aren't some tasks where automated vehicles can deliver an acceptable return on investment.

Tasks that require the operator to get on and off the truck multiple times in the same aisle to pick product may be good candidates for automation. Technologies that give the operator the ability to control the vehicle from the aisle can boost operator productivity while minimising the impact of the limitations imposed by the current state of the technology. The vehicle does not require a high degree of intelligence since the operator, who is in close proximity to the vehicle, is controlling it remotely. The truck should still be able to function like other trucks in the warehouse when operating in manual mode, addressing issues of scalability and flexibility.

Other tasks that may be appropriate for automation are those that are similar to the tasks AGVs handle in manufacturing—repetitive, horizontal travel along the same route, particularly when product must move longer distances.

In any application where the vehicle is expected to operate unattended, the potential for congestion should be evaluated as this has proved to be a problem for automated vehicles. This may require re-engineering some processes to ensure forklift paths are kept clear. Pallet quality and consistency—things operators adjust to almost instinctively—can also create problems for automated forklifts. Suddenly, damaged pallets have the ability to shutdown forklifts.

If automated forklifts are operating in an environment with operator-driven trucks, those operators will require special training on how to co-exist with automated vehicles. Some early adopters of forklift automation have found that operators get impatient with the speed of automated vehicles and navigate around them in ways that disrupt the operation of the automated vehicle, introducing another source of unexpected shutdowns.

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In each case, the safety, reliability, flexibility and scalability of the technology should be evaluated in the context of the long-term automation strategy. Technologies deployed today may not ultimately fit within that strategy, but the long-term strategy can help set expectations for a realistic lifecycle for these systems.

Organisation

One of the most important lessons early adopters have taken away from their initial experience with forklift automation is the resources required to support the deployment and ongoing operation of automated forklifts. In one case, an organisation found it had to dedicate one person to do nothing but restart automated vehicles that had shut down unexpectedly. And, this was just to support its pilot programme.

Dedicated resources may also be required for project and vendor management. Because of the nature of today's vehicles, it is usually necessary to deal with both the vehicle and automation vendors which has proved to be a full-time job in some cases. This is not to mention the internal issues that must be addressed to prepare the site and workforce for the introduction of automated vehicles.

Finally, IT integration should be addressed. The best practice is to involve IT during the evaluation phase so that solutions can be evaluated based on their impact on IT systems and resources, and IT can identify potential issues before equipment arrives on site.

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Conclusion

Forklift automation has made incredible progress in recent years. The technology is still maturing and is evolving to the point where it holds real promise to be an integral part of the warehouse of the future.

There are some tasks that may be appropriate for forklift automation today, if expectations are kept in line and proper resources are devoted to support its implementation and operation. Here are the questions every organisation should address when determining whether to move forward with the current generation of forklift automation technology or wait for the technology to evolve:

1. **Do we have an application that suits current forklift automation systems?**
   High-volume picking and predictable product movement over a well-defined path have emerged as the best applications for current-generation technology.

2. **Do we need vehicles that can operate in manual and automatic mode?**
   Traditional AGVs may be suitable for some applications but lack the flexibility many warehouses require, particularly those with seasonal peaks or other variations in workload. Vehicles that can accommodate both automatic and manual operation provide the flexibility required—if they are robust enough to operate reliably in each mode.

One of the applications that has emerged as a good fit for automation is high-volume picking where the operator is able to remotely advance the forklift, eliminating the need to climb on and off the vehicle multiple times in an aisle.

3. **Will new technology introduce any safety issues?**
   A safety audit is an essential first step in any automation project. If you can't answer this question in the negative, it may not make sense to move forward.

4. **Is our environment ready for automation?**
   Congestion and damaged pallets can derail a forklift automation project. Have sources of congestion been identified and eliminated?

5. **Who will assume service responsibility and what are their capabilities?**
   Current-generation systems often involve technologies from multiple companies. Define who has service responsibility for the system and analyse their ability to deliver in a timely manner.

6. **Do we have the internal resources to support the project?**
   Early adopters have discovered that more resources were required to support forklift automation than anticipated. These include management resources to support project planning and implementation, training resources, and dedicated personnel to ensure automated vehicles operate with minimal downtime.

For organisations that aren't quite ready to move forward with forklift automation, two developments hold particular promise for the future. The first is advances in positioning and tracking systems that will expand the tasks automated vehicles can safely and efficiently perform. The second is the eventual introduction of forklifts fully purpose-built for warehouse automation. Future generations of vehicles will have automation controls and sensors designed and built into the truck, rather than being added on, as well as more sophisticated positioning and tracking systems, thereby eliminating many of the issues with the current generation of systems.

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