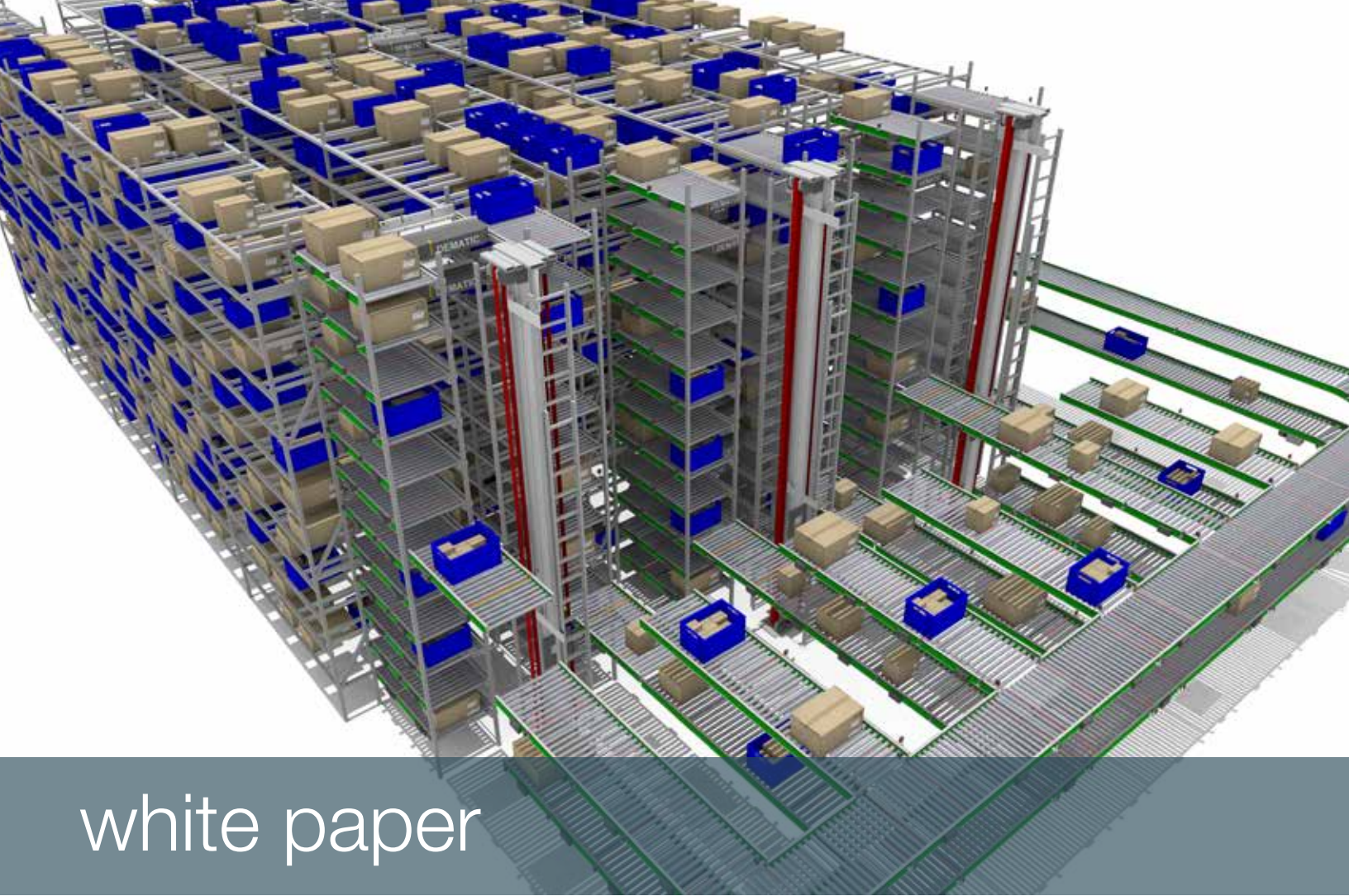




white paper

Dematic Multishuttle 2

An In-depth and Independent Review
from a Supply Chain Consultant

MWPVL International, Inc.
Supply Chain and Logistics Consultants



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

Introduction

March, 2013. This white paper provides an unbiased review of the Dematic Multishuttle 2 system (hereafter referred to as multishuttle) which is an important goods to person material handling technology that is making strong inroads into split case and full case distribution centers in Europe and North America. This article provides an overview of the multishuttle solution and how it works. We discuss who is using this technology, the benefits being derived, and the real-life productivity / accuracy results being achieved in the field. Our intent is to help your company better understand if multishuttle technology may have a potential fit for your distribution center operation.

Legal Disclaimer

“MWPVL International has reviewed this article with Dematic to ensure its factual accuracy, however we have retained the right to express our opinions. It is important to note that this white paper and all white papers within the MWPVL Knowledge Center are not paid endorsements or advertisements in any way. We provide this information to industry as our way of giving back to the community. All pictures appearing in this white paper are courtesy of Dematic.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

Dematic - Company Background

Headquartered in Luxembourg, Dematic is a system integrator and supplier of automated material handling systems. The company has approximately 4,000 employees and sales of 1 Billion Euros per year. The history of Dematic goes back to 1819 when Demag was founded in Wetter, Germany. In 1973, the company was incorporated by Mannesmann which was a diversified German conglomerate. The company then acquired Rapistan (an integrator and manufacturer of conveying and sorting systems in the U.S.) and Australian racking supplier Colby and in 1997 was rebranded as Mannesmann Demag AG. In 2001 Siemens bought the firm to form Siemens Dematic AG only to spin off the distribution / logistics division as Dematic GmbH & Co. KG in 2006. Also in 2006, the investment firm Triton bought a majority shareholder position in the firm. In 2010, Dematic acquired HK Systems, an American material handling and automation systems company. Today the company engineers, manufactures, installs and services a wide range of material handling and logistics automation technologies to over 35 countries on all continents.

Automated Goods to Person Technology - Background Information

The vast majority of warehouses distribution centers are conventional operations whereby inventoried items are putaway and stored in fixed equipment such as shelving bins, flow racks or pallet racks. When outbound orders are released, operators travel through the warehouse to retrieve and pick the item-quantities being ordered. Once the order is complete, goods are typically transferred to a packing area to prepare the order for shipment. This process repeats itself throughout the day across millions of warehouses around the world. While some operations reduce travel time by using conveyor systems to move goods between picking zones and from picking to packing, even conveyor-based operations require the person to go to the goods - i.e. people travel to the storage locations where the inventory is being stocked.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

Order picking travel time as a percentage of total direct labor hours varies significantly from warehouse to warehouse. It can be as low as 10% and as high as 60%. Large distribution centers with high SKU counts and small order sizes generally have the highest percentage of direct labor cost generated from order picking travel time. A good example of this type of operation would be a parts distribution center such as in the automotive aftermarket industry. In short, the higher the number of hours spent traveling during the order picking process, the better the business case is for goods to person technology.

The concept of goods to person material handling systems is nothing new. Different approaches to bringing goods to the person have been around since the 1970's. For example, the use of horizontal and vertical carousels has been around for decades and remains a viable goods to person technology to this day. In the 1990's, miniload ASRS cranes with telescopic extension arms emerged. These high speed miniload cranes automatically store and retrieve totes in high density storage systems but the fundamental issue remains that throughput capacity is constrained because one crane works all vertical levels within the storage aisle. This



led to the next generation of multishuttle technology whereby each vertical level in the storage system is concurrently serviced by a carrier thereby significantly increasing the throughput capacity of the system. This new generation of goods to person technology is quite simply better, faster, more ergonomic, more intelligently designed, more reliable, more flexible and more scalable than any other solutions that have previously been on the market.

Today, the speed and accuracy of warehouse order picking enabled by multishuttle technology is unprecedented. When deployed in the appropriate distribution center profile, multishuttle technology can be a game changing technology that is a key enabler for supply chain competitive advantage.



Dematic Multishuttle 2

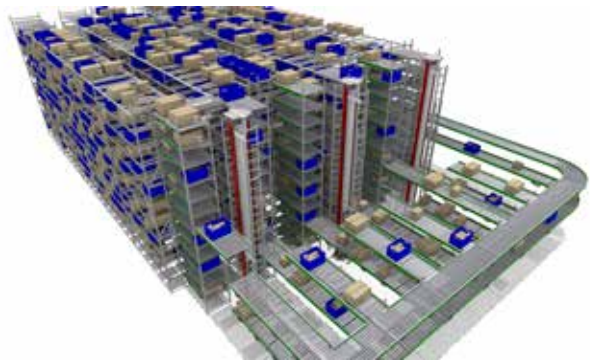
An In-depth and Independent Review from a Supply Chain Consultant

Multishuttle 2 Solution Overview - How It Works

Dematic is now on their second generation of multishuttle technology which they call Multishuttle 2. The basic components of the multishuttle system are:

1. A Staging / Rack Buffer. This refers to the fixed rack storage locations where inventory is stored after it has been received into the warehouse or from the production facility.

- The racking system can be single deep or double deep such that unit loads can be accessed by multishuttle carriers on either side of the 2-deep storage location. This helps to improve workload balancing across the system.



It is also possible to increase the depth of the storage locations further depending on the length requirement of the telescopic load extractor arms.

- A vertical lift is deployed at one or both ends of the racking system to transport cartons/totes/trays to all vertical levels within the storage system. The number of vertical lifts required is a function of the putaway and retrieval cycle transactions being handled by the system. Think of the vertical lift as a conveyor system that runs vertically instead of horizontally.
- Goods are transferred to and from the vertical lift entry/exit points of the racking system by a powered horizontal conveyance system (See below).

2. A Multishuttle Carrier.

- A multishuttle carrier is a small cart-like vehicle that is designed with a centralized “belly” which is used to transport cartons, totes or trays (we will refer to these as entities going forward). The carrier has 4 wheels and it runs along a rail system similar



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

to how a train runs on rails. The carrier receives its power from busbars within the rail system.

- Simple device by design since there are no computers on board the device.
- No traffic control systems required because one carrier works within its level or its own zone within a each level.
- No batteries required therefore no downtime for battery charging.
- Low energy consumption requirements by design.
- Multishuttle carriers come in 3 different configurations as follows:
 - Multishuttle standard - is equipped with telescopic load extractors with a fixed length, width and height. This type of vehicle is most suited to storage environments that hold a standard-sized entity (e.g. a tote) for all inventory.
 - Multishuttle belted - is equipped with a belt conveyor load deck. With this configuration, the belly of the carrier has a solid conveyor belt that is used for handling cartons where the quality of packaging may be an issue. The conveyor belt eliminates the possibility that the bottom of the carton may open up in any way causing product damage.
 - Multishuttle Flex - is equipped with a telescopic load extractor that expands and contracts to accommodate a range of load sizes.
 - Dimensions of the Flex carrier are 38" wide x 45" long (970 mm x 1150 mm) .





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- The multishuttle carrier is equipped with a pair of telescopic extractor arms that reach into the storage locations to store and retrieve cartons, totes or trays of merchandise. Since the software knows the dimensions of each entity being stored in the system, the multishuttle can stop at each dynamic storage location with precision such that the extension arms can reach into the location to “grab” the inventory. Each telescopic extension arm has a small load capture finger that flips down behind the backside of the entity being retrieved. When the telescopic arms retract, the entity is pulled onto the belly of the multishuttle carrier.
- Once the entity is positioned on the belly of the multishuttle vehicle, the vehicle moves at speeds up to 787' per minute (4.0m/s) to the vertical lift drop-off station(s) positioned on each level. In most systems, the multishuttle carrier always remains on one level so that it services one aisle only.



However, it is also possible to transfer roaming carriers to multiple vertical levels in the storage buffer via the vertical lift.

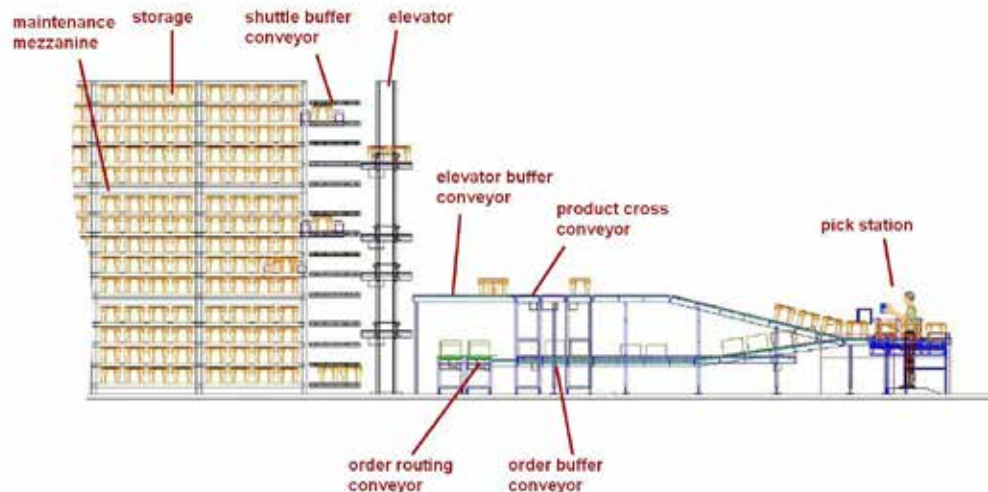
- It is important to note the high horizontal travel speed of the multishuttle device as compared to other types of automation. In general, faster speeds mean less mobile devices are required and therefore a higher throughput rate can be achieved with less equipment and less congestion. It also implies less equipment maintenance over time. These are all fundamental benefits of shuttle technology as compared to other goods to person technologies.
- Once the entity is conveyed to the vertical lift, it can be lowered to an output drop-off point such that a conveyance system can take over to move the entity to a designated workstation.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- The Multishuttle Flex can handle tote boxes that conform to the following physical properties:
 - Maximum weight of 110 pounds (50 KG)
 - Tote length range of 7.9" to 34.4" (200 - 875 mm)
 - Tote width range of 5.9" to 25.6" (150 - 650 mm)
 - Tote height range of 1.9" to 23.6" (50 - 600 mm)
 - The Multishuttle Flex can also handle cardboard cartons that conform to the following physical properties:
 - Maximum weight of 110 pounds (50 KG)
 - Tote length range of 7.9" to 33.4" (200 - 850 mm)
 - Tote width range of 5.9" to 24.6" (150 - 625 mm)
 - Tote height range of 1.9" to 23.6" (50 - 600 mm)
 - Multishuttle systems can be deployed in operating temperatures between 0° to 40° C
3. Buffer Conveyance System: This refers to the powered conveyor system that moves cartons/ totes/trays with inventory into and out of the staging / rack storage system.
- Within the racking storage buffer system, multishuttle carriers travel on rails powered by busbars.





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- Outside of the storage buffer system, entities are moved by powered conveyors such that incoming and outgoing inventory is transferred at high speed and precision to designated pick-up and drop-off locations within the system.
4. Work Stations. This refers to the stationary work area where the operator is positioned to perform picking for one or multiple orders.
- A workstation typically includes provision for:
 - One incoming product tote/case/tray. High speed load exchange rates allow new incoming product totes to be presented within 1 second of the outgoing product tote being taken away.
 - A pick display to provide picking instructions to the operator
 - One or multiple outbound order totes that can be picked concurrently
 - A put to light display for each order tote to confirm the placement of goods to the correct order tote in the context where the operator picks multiple order totes concurrently.
 - Note that workstations are ergonomically designed to ensure that the operator can achieve maximum accuracy and productivity while working in a comfortable position with minimal lifting, stretching, bending and reaching. Also, workstations can be designed to be at floor level only, or they can be designed to be multi-level depending on the needs of the business.
 - Workstation with a goods to person 1: 1 High Rate Configuration
 - The pick transaction is performed from one incoming product tote and the put portion of the transaction is performed to one order tote.
 - This configuration is generally deployed where the multishuttle system needs to handle the processing of





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

10,000 - 100,000 orders per day. The most common application is for orders with a small order size because the order tote is needed for say only one order line. The operator can work faster because there is no need to put to multiple order totes.

This is typical in the Internet order fulfillment industry

- Workstation with a goods to person 1: Multiple Configuration
 - Operator picks from one product tote and puts to multiple order totes.
 - Completed order totes exit the work station for transfer to packing, typically by being pushed off to a takeaway conveyor.
 - Product totes containing residual inventory after the pick task is completed are returned to the storage buffer.
 - The put portion of the transaction is typically performed for up to 6 order totes whereby 3 order totes are positioned on both sides of the incoming product tote. Having said this, systems are also designed around servicing 24 orders concurrently. As well, the concept of “put walls” allows orders to be batch picked and then put into a wall of totes whereby the wall could have 36 - 48 totes with each tote representing an outbound order.
 - This configuration is generally deployed where the multishuttle system needs to handle the processing of 5,000 - 50,000 orders per day.



5. Software and Controls. Refers to the underlying software and hardware technologies required to manage the multishuttle system. The software controls how inventory is stored and retrieved within the storage system, and how outbound orders are prioritized, processed and sequenced by the system.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- A material flow system, also known as a warehouse control system (WCS), is used to receive goods into the multishuttle storage buffer. The system also manages the prioritization and release of putaway and retrieval tasks to be executed by the multishuttle carriers. Lastly, the WCS manages the order picking and put processes at the workstation. All transactions are fed up to the ERP or WMS system that runs the distribution center.
- Note that the level of software sophistication for a multishuttle application is relatively low as compared to a robotic solution such as Kiva. With Kiva's system, a complex software program is needed to continuously reslot where each shelf pod is placed into storage. Kiva needs to continuously optimize the slotting of the pods to minimize the travel time for the pod to get to the picking station. With the multishuttle application, goods are actually stored randomly in the storage buffer. With a multishuttle system, the workload is ideally equally distributed across all levels of the storage buffer hence concentrating fast moving SKUs is actually not recommended. As such the software stores goods randomly by design.

In the next section, we will explain more about the benefits being achieved by companies that have invested in this solution.

Why Are Companies Buying the Multishuttle System?

The main reasons that companies are investing in multishuttle technology are discussed below:

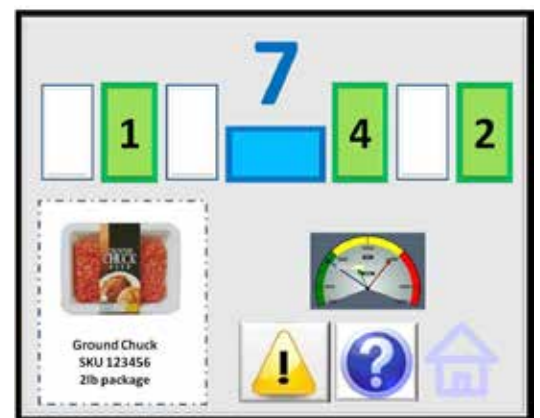
- 1. Improved Labor Productivity.** The impact of goods to person technology on labor needs to be fully understood since this will most likely be the most important contributor to your company's business case assessment.
 - First off, if goods are being stored in a standard entity (such as a tote) then a labor process needs to be introduced to the distribution operation whereby operators open up incoming vendor master cartons at the point of receiving. The product is then removed from the master carton and inserted into an empty tote and the operator enters the received item-quantity into the screen at the work station. The tote is then released to a conveyor for transfer into the storage system. This repack labor is a source of incremental hours that are a penalty against the labor savings described below.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- The elimination of putaway / storage labor hours is a positive labor savings because incoming goods are automatically stored into the storage buffer.
- The process of replenishing pick locations is eliminated because the multishuttle does not require fixed picking locations. This will provide a positive labor savings for conventional distribution operations that have an existing labor process to replenish fixed picking locations.
- The elimination of travel time from the order picking process. This will undoubtedly provide the largest reduction of labor hours since order picking travel time typically represents between 25 - 35% of the total direct labor hours in a distribution operation. We mentioned earlier that this range can be as much as 10% to 60% depending on the type of operation. For most companies, travel time accounts for between 25% to 35% of direct labor hours. Note that we define direct labor hours as being all hours spent touching product including receiving, putaway, replenishment, order picking, packing, shipping and inventory control. Direct labor excludes supervision, housecleaning, maintenance, and clerical functions.
- Improved picking productivity. In addition to eliminating order picking travel time, the actual time spent picking the order is improved because of ergonomic workstation design.
 - Incoming product totes are presented within one second of elapsed time from when the previous product tote is taken away from the picking workstation. An easy to read display tells the operator the exact quantity to pick. The operator then puts units to one or multiple orders depending on the design of the workstation. If the operator is picking say 6 orders at a time then put to light technology is used to guide the operator through the quantities to be put into each order tote/carton. With the put to wall concept the operator can batch pick an item and put to many orders using a cubby hole mailbox-type system.





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- With ergonomic workstation design, there is minimal time required to perform the order picking process. As such, there is little or no time loss due to bending, reaching, cutting open cases, scanning products, scanning locations, repacking cartons to fit the order, retrieving cases that are stuck in the back of a flow rack or placed out of reach, etc. All of these extra events can easily add between 30 seconds to 5 minutes to the time required to pick a single order line. Multiply these seemingly innocent penalties against thousands of order lines per day and the labor cost for inefficiencies associated with conventional operations can be significant.
- In our opinion the highest split case order picking rates currently being achieved today are with goods to person multishuttle systems. Rates of 300 - 1,000 order lines per hour (i.e. line items being picked) are commonplace. The number of units being picked per hour will of course depend on the average number of units per order line which varies from business to business. The reason that there is a wide range of pick rates is due to the variance of product types being handled. Some products are difficult to grasp or are heavy (e.g. large shampoo bottles) and this will tend to slow people down. The comparable productivity rate in a conventional distribution operation is in the range of 50 - 200 order lines per hour so this helps to put things into perspective. Most other goods to person automation systems have productivity rates in the range of 150 - 300 order lines per hour because workstation ergonomics are not optimized.
 - ▶ To further illustrate this point, let us say that an operator can pick 1,000 order lines per hour with an optimized workstation. This works out to 3.6 seconds per pick task. Now let us say that the same operator requires 6.6 seconds per pick task in a non-optimized workstation - a difference of only 3 seconds. In this example, the operator's pick rate drops from 1,000 to 545 lines per hour. In effect, inefficient workstation design causes the labor force and the number of workstations to double up.
- Less time spent on peripheral functions such as inventory control and slotting.
 - This may or may not represent many labor hours but it is worth mentioning. The process of inventory control is made far more efficient due to the fact that the



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

multishuttle system provides near-perfect picking accuracy. Most companies will maintain a cycle counting function but this task can be done by the system by simply weight checking each time that a product tote has been emptied. If the system thinks that a tote should be empty yet the weight of the tote indicates that it is holding inventory, then an exception has been identified and this can be dealt with by an inventory control person. This is far more efficient than having an inventory control person walk through the warehouse performing a count of inventory at bin locations during a designated quiet time.

- Lastly, any time spent on slotting and re-slotting the pick line goes away because there is no need to set up fixed pick locations within a multishuttle system.

2. Improved Order Accuracy. The near-perfect picking accuracy of a multishuttle system is one of its key selling points.

- Since the warehouse control system (WCS) is managing the flow of goods to the order picker, the operator cannot pick the wrong item. Keep in mind that goods are placed into totes at the time of receiving. The tote is bar coded and the warehouse control system tracks its movement into, within, and outside of the storage system. When an item is needed for an order, the WCS invokes the transfer of the tote to the operator in the sequence that is required. As such the operator is focused on picking one SKU at a time. There is no need to scan an item or a bin location. The only opportunity to pick the wrong item comes about if the tote is sub-divided into multiple sections as is sometimes done when storing small parts. Here the operator may reach into the wrong sub-section of the tote to retrieve the wrong item. Aside from this situation, it is virtually impossible for the operator to pick the wrong item because the system always presents the correct item-tote to the operator.
- The operator can however pick the wrong quantity or unit of measure. Let us say that the receiver who repacks the goods from the vendor master carton into the tote makes a mistake and puts inner packs of 12 units into the tote rather than breaking open the inner packs and putting loose retail units into the tote. When the tote arrives at the picking station, the operator is focused on the quantity to pick which appears on their computer display terminal. Instead of picking 1 inner pack the operator now picks 1 retail unit and then puts this single retail unit into the order tote. One way to catch



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

this mistake is to have a check weigh scale for each order tote such that the expected weight of the tote is compared against the actual weight and if there is a % discrepancy then a warning is invoked. This technique is in fact widely used as a means of ensuring picking accuracy since the pick mistake is identified immediately at its source. As well, there are visual display tools that can be provided to the receiver to make sure the correct unit of measure is always being stored into the totes.

- While no system is perfect, multishuttle technology combined with order weigh checking provides as accurate of a system that exists on the market today. Accuracy rates for multishuttle goods to person systems are generally in the range of 1-2 errors per 10,000 order lines. The only way to improve accuracy further is to implement a fully automated robotic system which remains (to the best of our knowledge) a futuristic concept for split case distribution operations.

3. Order Profile Independence. One of the concerns about deploying any automated material handling system is the system's ability to adapt to changing order profiles. Some automation systems are suited to processing a small number of orders with many order lines. Some automation systems are suited to processing many orders with few lines per order. If there is a change in order profiles over the passage of time, then the automation technology may no longer be appropriate for the distribution operation. The multishuttle system is an automation technology that is not constrained in any way by order profiles. Whether an order is comprised of 1 tote or 500 totes has no impact on the system because one or more operators can pick the same order in parallel. Thus the system provides the flexibility of handling different business profiles.

- This point is especially relevant for retailers that need to handle multi-channel retail store orders and consumer web-orders with a single material handling system.
- On the flip-side, the multishuttle system is constrained by the physical dimensions and weight of goods that can be stored in within the system so it is not without its limitations.
- Since automation requires a high capital expenditure , it may not be a good investment to use multishuttle technology for all items being stocked in the warehouse, particularly in the context where product variety is very high. To obtain the maximum return on investment, it may be a good idea to assess which SKUs to store within the system. If



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

one had to generalize, the target would be to use the multishuttle system for qualified SKUs that generate the most order lines. The ideal SKUs for a multishuttle system are items that have high order line frequency with low cube velocity because they require low levels of storage capacity yet they generate high levels of labor savings.

- Depending on the environment, putting 100% of the items into a multishuttle system may drive up the capital investment requirements for marginal gain. As such, some systems are engineered to handle a subset of items based on an analysis of SKU profiles that are most suited for a multishuttle system. Of course there are always exceptions. For example, if products are high value or require high security then it likely makes sense to handle 100% of the SKUs within a multishuttle system. Similarly, in manufacturing environments, production output changes daily and the use of multishuttle technology as a buffer and sequencing systems will likely make sense for all products being handled.

4. Ability to Handle SKU Proliferation. One of the most challenging aspects of distribution today is the proliferation of SKUs that must be handled in the warehouse. Most companies are good at adding new SKUs but not so good at deleting old SKUs and dead inventory.

- When a conventional distribution center needs to add new SKUs, there is a perpetual battle that takes place because the amount of floor space imposes a real constraint on the number of fixed pick locations that the operation can support at ground level. The options are typically:
 - Reduce the bin sizes of existing fixed pick locations so that more pick locations can be supported at floor-level. This creates the inherent disadvantage that replenishment labor hours will be increased because less inventory can fit into the pick locations.
 - If floor space is available to extend the picking line, then the length of the pick line can be increased. This option will cause order picking to be less efficient because travel time for all orders increases as a function of the length of the pick line.
 - Establish pick locations for new SKUs in vertical levels of the storage system and use a man-up mobile vehicle (e.g. a man-up order picking truck) to access vertical pick locations. Ideally slower movers are slotted into these higher vertical levels to minimize the time spent traveling vertically. The disadvantage of this option is that



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

the time spent to pick an order line from a vertical bin location is typically 1.5X - 3X more than the time spent picking the same SKU at floor level.

- With a multishuttle system, the ability to add new items is unconstrained as long as the multishuttle system has the capacity to handle more product totes. The multishuttle system is however constrained by the physical number of totes / cases that can be stored in the racking systems but this is a function of the capacity that is designed into the system. A good system design will support the concept of scalability such that storage capacity can be increased by adding more vertical levels, more racks per aisle or more storage aisles.

5. Reduced Space Requirement. A multishuttle system is designed to take full advantage of the vertical height of the building up to 40' of clear stacking height. The density of the storage system is improved over a conventional distribution operation because of the reduction in space dedicated to operating aisles.

- In a conventional operation, the warehouse is designed with operating aisles and cross aisles to allow mobile equipment to store and retrieve inventory (and to support vehicle passing as required). Operating aisles can range from 36" - 72" (915mm - 1830mm) for environments where personnel work; and from 72" to 156" (1830mm - 3962mm) for aisles that are accessed by mobile equipment such as forklift trucks. It is not uncommon for a conventional distribution center to utilize only 25% of the overall cubic capacity of the building because of the space dedicated to aisles, cross aisles, and docks.





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- With the multishuttle system, storage capacity is densified because operators and mobile equipment no longer need to access operating aisles to store and retrieve inventory. Instead the multishuttle carrier is the vehicle that performs this work hence the aisle widths only need to accommodate the width of the multishuttle carrier (38" or 965mm). It is also important to note that the multishuttle system makes full use of the vertical storage height of the building up to 40' (12.2m). This is an important advantage over other types of automation systems that mainly take advantage of floor space; or that require expensive structural mezzanine systems to capture vertical storage capacity. The bottom line is that multishuttle technology requires a smaller footprint to get the job done, which is an important advantage for any space-constrained building.

6. System Flexibility / Expandability / Scalability / Security.

- Flexibility is provided because system throughput capacity can be increased by adding more than one multishuttle carrier per aisle.
- Flexibility is also provided by allowing a company to grow into the system. One can start with a roaming system and then transition to a captive system. A roaming multishuttle carrier can work across multiple vertical levels within the storage system via the vertical lift. Hence it is not necessary to invest in one carrier per aisle and vertical level if the volume does not justify the investment. With a captive system, one or more carriers work within one aisle / vertical level. The system can be designed to transition from roaming to captive.
- Scalability can be achieved because the rack structure is expandable which is important in case the system needs expanded within an existing operation or relocated to a new building. It is possible to add vertical levels to increase the height of the racking system if the building height supports this. It is also possible to add rack bays to increase the length of the operating aisles. It is also possible to simply add more operating aisles. Lastly, racking structures can be built over traffic aisles and docks to capture lost warehouse space.
- From the standpoint of security, consider that all inventory stored within the racking storage buffer is in a secure storage environment. For distribution environments handling high value or high security product lines, this type of automation is ideal because it



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

minimizes the number of people that have access to the inventory. Essentially the goods are handled at receiving and at picking which takes away a minimum of 2 - 4 extra product touches that typically take place within a conventional environment.

7. High System Uptime / Low Risk / Quick Failure Recovery. With any type of automation system, it is important to investigate what happens if Murphy's Law happens - i.e. if it can go wrong, it will go wrong. If a complete system shutdown is required in the event of a failure then this represents a much higher risk proposition than a system that allows a quick component swap-out with minimal impact to the operation.

- With the Multishuttle system, the failure of a multishuttle carrier vehicle represents a relatively painless exercise. Since the vehicle is working in vertical level within the storage buffer system, the vehicle needs to be removed from the level. As such, the level is powered down and the vertical lift is used to bring the “sick” carrier down to floor level to a hospital bay where it can be repaired. In the meantime, a “healthy” spare carrier can be elevated up to the level to take over. Downtime for one level in the system is about 15 minutes which is a low risk solution in our books.
- Also, the racking system can be designed to provide an operator platform / catwalk every 7' (2.1m) of width to provide an access walkway to manually access inventory held in the racks. This internal walkway means that under no circumstances is inventory held in the system ever inaccessible. This is a very important advantage for companies that are concerned about automation systems that are designed such that human access to inventory is not supported in the event of system downtime. Numerous solutions pose this challenge and it remains one of the foremost stumbling blocks to companies adopting automation technologies. With the multishuttle system, this is effectively a non-issue.





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

Which Companies Are Buying Into Dematic's Multishuttle System?

As at 2013, there are approximately 60 multishuttle systems with 4,800 carriers in operation around the world. Below is a shortlist of companies that have invested in multishuttle technology at the time of publishing this white paper.

1. **Alloga AG** is a Swiss 3PL company that was founded in 1957. The company is specialized in servicing clients in the healthcare industry. Alloga invested into the multishuttle system at its Burgdorf, Switzerland distribution center to support a pharmaceuticals client with the main goals being to improve productivity, efficiency, accuracy, capacity, operating costs and safety. The company deployed a 2-aisle double deep multishuttle system with 10 vertical levels to store up to 8,000 totes.



The system is designed to store over 10,000 SKUs that include restricted narcotics.

- All orders requiring less than full case SKU quantities are routed to the multishuttle system where 20 multishuttle carriers work within the storage buffer (one carrier per vertical level x 2 aisles). The system can process up to 800 outbound containers per hour, a significant achievement relative to the company's conventional order processing environment which preceded the multishuttle system.
- Workstations are designed to allow order pickers to work up to 4 outbound orders concurrently with weigh checking measures designed into the picking system to ensure mistakes are not made (due to the restricted and sensitive nature of the pharmaceuticals being handled). Picking rates are in the range of 400 order lines per hour with pick errors running at below .01%.
- The company processes about 1,800 orders per day for 2,500 SKUs through the multishuttle system which was designed from the onset to enable a doubling of throughput volume in the same footprint.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

2. Bigler AG is a Swiss meat producer with a new production facility located in Büren an der Aare, Switzerland. The company deployed a Dematic multishuttle system with the capacity to hold 7,000+ containers. Bigler's main goals were to handle an increasing range of products, a growing customer demand for smaller order sizes, and shorter delivery times at reduced operating expenses.

- Bigler invested in 32 multishuttle carriers to work 9 vertical levels with the capacity to handle 1,600 inward and outward inventory transactions per hour in a refrigerated environment.
- Phase 1 of the system was designed to handle an output of 1,000 order lines per hour.
- A phase 2 expansion will provide additional pick stations on a second level to support output of 1,800 lines per hour. You can see a video of this operation [here](#).

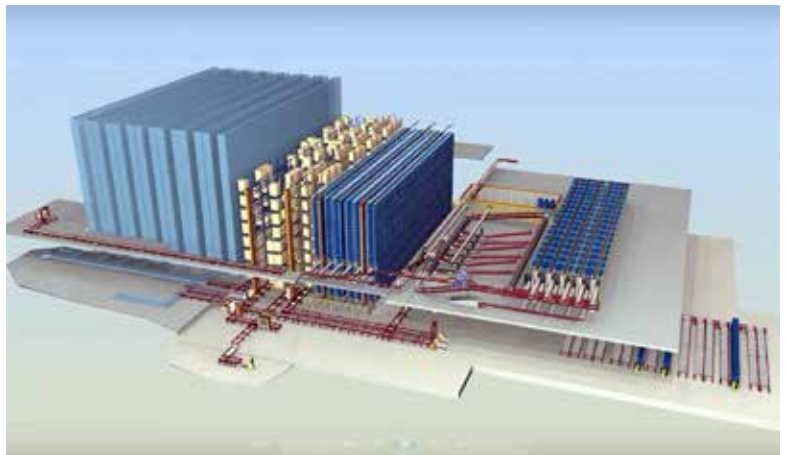
3. Bischofszell Nahrungsmittel AG (BINA) is a leading food manufacturer located in Bischofszell, Switzerland. The company implemented multishuttle goods to person sequencing system at its 'Convenience Gate' distribution center which is their centralized food distribution hub.

Here they service over 750 retailers, caterers, canteens and industrial companies throughout Switzerland with over 1,000 tonnes of fresh food products that are manufactured daily.

BINA's goals were to reduce logistics costs,

enhance customer service levels, and expand storage capacity. The facility went live in 2009 and consists of:

- A 90' (27'm) tall High Bay Warehouse (HBW) with 9 ASRS cranes to store 12,000 pallets of ambient and refrigerated finished goods inventory and raw materials.





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- 104,400 containers of refrigerated inventory for small items are held in 26,000 rack bays in an automated small goods warehouse (ASW) serviced by 3 miniload ASRS cranes. The ASW acts as a production buffer to stage incoming inventory from production and from external suppliers. This feeds the multishuttle system to guarantee FIFO sequence.
- A 6-aisle multishuttle system provides a storage buffer to enable the sequencing of goods for over 120,000 split case units picked per day. Check weighing is integrated into the pick process to further validate pick quantity accuracy. In effect the multishuttle provides the engine that enables up to 2200 containers per hour to be delivered in the optimal sequence to the picking work stations to maximize order picking efficiency and accuracy. The entire system was deployed in just 18 months.

4. Bosch Rexroth AG is a specialized company in the field of drive and control technologies. The company operates a 91,500 sq. ft.(8,500 sq. m.) distribution center in Laatzen near Hannover, Germany. The need to handle growth and rising customer demands within a maximized distribution center were the main drivers behind the company's decision to implement the multishuttle system.

- The facility has a high bay racking system that holds 3,000 pallets and a small parts automated storage and retrieval system (ASRS) that stores about 50,000 parts. About 30,000 pneumatic products comprising 1 Million individual items are consolidated at the distribution center for global distribution.
- A compact multishuttle system storing up to 1,200 containers in two 130' (40m) long aisles with 5 vertical storage levels per aisle and ten shuttle carriers was deployed to enable the facility to increase output from a maximum of 500 order lines per hour to 750 order lines per hour. 12 picking workstations are used to support the distribution operation which experienced a 50% increase in capacity and productivity due to its investment into multishuttle technology.

5. Ferdinand Gross is a German fastener and connectivity supplier with a distribution center in Leinfelder-Echterdingen, Germany. The main goal behind investing in a multishuttle system was to improve customer service to create a competitive advantage. This was achieved by enabling a faster order turnaround time that allowed the firm to extend the customer order



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

cutoff time by 3 hours. The system is unique because it contains both captive and roaming shuttle carriers.

- The multishuttle system can store up to 120,000 containers to hold a product variety of 72,000 standard parts, 24,000 customer-specific parts, and 11,000 tools. The system is 40' high (12m) x 66' wide (20m) x 99' deep (30m). The shelf storage buffer system consists of 30 vertical levels.
- The multishuttle roaming system is designed to store and retrieve the fastest moving parts with the use of 20 multishuttle carriers that service 59,000 storage locations at a rate of 615 double cycles per hour (i.e. parallel putaway and picking operations). Each aisle contains one multishuttle carrier that is transferred between vertical levels via the end of aisle vertical lift hence the term roaming.
- The multishuttle captive system is designed to manage both the roaming and the captive sections of the system. The captive system has 12 multishuttle carriers (one carrier per vertical level) servicing 4,992 storage locations at a rate of 514 double cycles per hour. The carriers extract product totes for transfer to picking stations similar to the standard system design.
- Ferdinand Gross is achieving 1,000 picks per hour with high density storage which can be expanded by another 60,000 containers. You can see a video of this operation [here](#).

6. Halfords is a British retailer of automotive, leisure and cycling products that operates a 320,000 sq. ft. (29,700 sq. m.) distribution center in Coventry, West Midlands, England. Halfords' recently consolidated two distribution centers and implemented the Dematic multishuttle system that consolidated picked totes into completed store orders to service over 470 retail stores across the UK and the Republic of Ireland.

- Halfords uses a combination of pick-to-light and voice directed picking to pick over 10,000 small part SKUs generating 200,000+ order lines per day into totes. Picking takes place on a 540' (165 m.) long double deck mezzanine that runs overhead the shipping doors. This effectively provides 70,000 square feet (6,500 sq. m.) of space that would otherwise go unused. On the first level, 3600 fast moving parts are picked from flow racks at a rate of 300 lines per hour using a pick-to-light system. On the upper level, 6,000 slower moving SKUs are picked from bin shelving at a rate of 200 lines per



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

hour using voice picking. This design concept enabled the company reduce the average totes per store order from 60 to 30.

- Completed totes from the small parts pick zones are conveyed into the multishuttle buffer which then releases the totes to shipping in a sequence that is store-friendly and also ensures that the heaviest totes are loaded to the bottom of the pallet. This improves the ergonomics of tote handling at the back room of the store.
- The entire distribution center runs on Manhattan Associates' WMS, which feeds orders to Dematic's DC Director WCS.

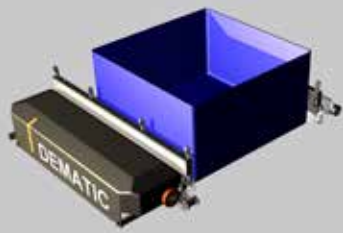
7. **SFS unimarket AG** is supplier of fasteners, tools, architectural hardware, chemical and technical products based in Switzerland.

- SFS implemented a massive 32,000 container multishuttle system at their new distribution center in Rebstein, Switzerland. The system is comprised of 5 aisles of double deep storage racking with 17 vertical storage levels. Only 3 multishuttle carriers are used to roam between the levels via the vertical transfer lifts yielding a throughput rate of 500 putaway cycles and 500 retrieval cycles per hour.



- To store 50,000 SKUs the system is designed to handle three different container heights with sub-compartments resulting in 18 different container types in the storage system. The daily throughput is on average 4,000 line items per day rising to a peak of 5,500. The installation is also unique because of the tight coupling of the SAP EWM (Extended Warehouse Management) and MFS (Material Flow System) down to the PLC level. You can see a video of this operation [here](#).

8. **Siemens** operates a production facility that manufactures more than 50,000 switchgear devices per day in Amberg, Germany. The company deployed the multishuttle system to increase productivity, ensure near-perfect product availability, and to free up 25% more floor space for production.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- The multishuttle system serves multiple purposes. First the company installed a 13' (4.0 m.) high pair of production line buffers for staging 540 containers. Three multishuttle carriers keep components flowing to an automated production process for coil winding systems, drives and contacts.
- In 2011, the system was expanded by two additional 260' (79.2 m.) long line buffers storing 1,000 containers with 6 multishuttle carriers. This expansion was actually installed above the production lines.
- A larger multishuttle warehouse holding 3,400 containers provides additional capacity to hold 3 hours of production output. This is a 2-aisle system with 4 multishuttle vehicles servicing 8 vertical levels. The inventory in this warehouse is turned over twice daily with 98.0% inventory availability.

9. Big W is a division of Woolworths Ltd. and is one of the largest chains of general merchandise discount stores in Australia. The company operates 176 stores and three distribution centers. In 2011, Big W deployed a massive multishuttle system at its 958,000 sq ft (89,000 sq m) distribution center in Hoxton park which services 64 stores (37% of the national volume).

- 44% of the DC throughput volume is full case merchandise which is handled as a conventional voice picking operation. 25% of the volume is vendor-prepared store-ready pre-allocated crossdock merchandise that ships immediately upon receipt. The balance of 31% is repack





Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

merchandise handled through the multishuttle system. At Big W, the multishuttle is equipped with 70 multishuttle carriers that perform over 30,000 storage and retrieval cycles per hour.

- Repack SKUs are removed from vendor master cartons and inserted into totes where they are conveyed to the storage buffer and stored by the multishuttle carrier. Totes are retrieved and brought forward to picking workstations designed to accommodate the picking of 24 store orders concurrently. The operator picks directly to shipping cartons using put-to-light whereby 6 orders are to the left and right of the incoming product tote with a mirror setup behind the operator. Completed cartons can be routed to other pick zones as required or conveyed directly to shipping. Pick rates being achieved are in the range of 500 OMs/hr (order multiples) versus a rate of 120 OMs/hr being achieved with its previous mechanized pick-to-belt system.
- As a result of its successful project, Big W won the Australian Supply Chain Management Award and the Storage and Handling of Materials Award in 2012. You can see a video of this operation [here](#).

10. Tesco.com is the online grocery division of Tesco which is the United Kingdom's largest retailer. Tesco built a new 120,000 sq. ft. (11,150 sq. m.) distribution center in Enfield, England to support the processing of outbound customer orders for its home delivery network.

- At Enfield, customer orders are picked to totes by zone using smart zone routing conveyor systems for ambient and chilled goods. Finished totes are conveyed to separate ambient and chilled multishuttle systems which act as order consolidation buffers. Totes are initially staged inside the ambient and chilled buffers and then released from the buffers in the exact required sequence once the entire delivery load is available for loading.
- The multishuttle system enabled Tesco to offer more delivery slots to customers from earlier in the day because order picking and van loading processes are significantly faster.
- Other companies that have invested in multishuttle systems include: Zimmer; Eurocopter; Safeway; Net-a-porter.com; Merit Medical and HK Logistics



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

What is the Cost of a Multishuttle System?

Dematic does not publicly disclose system pricing, therefore for the sake of this article, we provide some approximate figures for informational purposes only. It is important to note that this information is based on our research and has not been confirmed in any way by Dematic.

- A basic rule of thumb budget figure (\$US) is \$650,000 - \$1.2 Million per operating aisle.
- This range includes the shuttle carriers, racking system, vertical lifts, input and output conveyors, control systems, software control system and integration, engineering, and installation.
- Higher throughput volumes will require more shuttle carriers which in turn will increase the price of the system. A shuttle carrier costs in the range of \$30 - 40,000 depending on the quantity being acquired.

When is the Multishuttle Is a Good Fit and Not a Good Fit?

In this section ,we explore where there is a strong fit for the multishuttle solution. This automation technology tends to have the best fit in the following types of distribution environments:

- 1. High Volume Retail Repack.** A good example of this type of operation is retail health and beauty care and general merchandise. Any distribution operation where stores order high volumes of split case merchandise (i.e. repack) is a good candidate to consider this type of system. Multishuttle systems can be a major improvement over traditional pick-to-belt systems due to labor savings and the reduction in space requirements. The elimination of labor-intensive putaway and replenishment labor combined with pick rates that are typically 2 times faster can result in a substantial labor reduction.
- 2. High Volumes of Small Orders.** A good example of this type of operation is web order fulfillment where there is a high volume of customer orders have 1 order line per order. The ergonomic workstation configuration enables ultra high order picking rates of up to 1,000 order lines per hour which greatly reduces the head count required in conventional and/or mechanized operations. The ability to scale the multishuttle system by adding more vertical levels, by extending the lengths of the aisles, or by a adding more operating aisles, makes this type of technology highly flexible for distribution operations that experience significant peaks and high annual growth rates.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

- 3. High Speed Order Turnaround Time.** The level of competition is intensifying across all industries. The winners will be companies that provide customers with the service that they want. Extending order cutoff times and providing support for a higher frequency of smaller orders, without increasing labor costs in the distribution center, can yield a major competitive advantage to help a company increase market share. Virtually any industry that faces increasing customer service level demands is a strong candidate for this type of automation.
- 4. High Security.** For companies that distribute high value (e.g. jewelry) or high security (e.g. pharmaceuticals) products, automation solutions provide an excellent fit. Unlike conventional systems, access to inventory is limited to staff who repack inventory into totes or who pick orders. These functions are stationary such that security can be established at each workstation. This is a major improvement over the situation where operators travel around the distribution center to access inventory.
- 5. High Product Variety and High SKU Proliferation.** The elimination of travel time during order picking in a goods to person picking system is a big benefit of multishuttle technology. This benefit is increased in environments where a large SKU variety is stocked causing a lengthy pick path in the distribution center. Companies that stock thousands of slow moving SKUs/parts and companies that are experiencing significant SKU proliferation are potentially good candidates for multishuttle technology.
- 6. Need for Buffering / Sequencing.** In production environments, there is often a need to stage daily output before being able to release the goods for outbound order processing. Thus a buffer is needed to allow the accumulation of finished goods inventory that can then be released in an optimal sequence for picking purposes based on customer shipping prioritization. In retail environments, a buffering system allows for the accumulation of totes such that they can be released in a store-friendly sequence or a required loading sequence. Also, it may be advantageous to reducing personnel injuries if the heaviest totes are placed at the bottom of the outbound pallet.



Dematic Multishuttle 2

An In-depth and Independent Review from a Supply Chain Consultant

Conclusions

After reading this article, we hope that you have a better sense as to why a company would or would not invest in Dematic's multishuttle system. The benefits of the solution are plentiful in that it is successful in all of the key areas that an automated material handling system needs to address - efficiency, accuracy, ergonomics, flexibility, scalability, redundancy, ease of use, quality of life and storage capacity utilization. Many automated material handling systems lack flexibility and rapid scalability. Many automated systems are such that if the system goes down then you don't ship orders. We especially like the fact that the multishuttle system supports the highest levels of throughput with built-in redundancy. We also like the fact that the multishuttle system is a low risk automation technology by design.

With all of these advantages, the Dematic multishuttle System is still not for everyone. We have discussed our opinions on why this is the case within the body of this article. Automation systems require significant capital expenditures so there has to be a reasonable business case to justify the investment into automation. If a well-managed conventional distribution operation is more economical for the business over the long run then this is the right strategy for the business, unless there are other drivers that point the way towards automation. As we have seen within this article, other drivers can include: the need for increased storage capacity; the need for very high security; the need for high speed order turnaround time; and the need for order consolidation and sequencing.

Marc Wulfraat is the President of MWPVL International Inc. He can be reached at +(1) (514) 482-3572 Extension 100 or by clicking [here](#). MWPVL International designs distribution centers and automated material handling systems and can help your firm evaluate technology solutions for your distribution operation.