# Leadership in Global Supply Chain and Logistics Consulting



## Distribution Center Order Picking Technologies Compared

**Background Information**

Companies interested in making investments into technology to improve the productivity and accuracy of their warehouse order picking function have more technology options than ever to choose from. This article takes a high level look at the order picking technologies currently available and where they are most applicable based on the distribution center operating environment.

The order picking technologies that are reviewed in detail within this article include the following:

- Radio frequency handheld devices with scanners for data collection
- Visual RF Scanning technologies (whereby graphical images are displayed on an RF devices)
- Pick to Light
- Voice Directed Picking

Discussion on other order picking technology options such as carousels and semi-automated picking technologies are beyond the scope of this article. Our goal is to help the reader understand the realistic productivity, accuracy and capital expenditures associated with each of the main picking technology options used by distributors.

**Why Invest in Order Picking Technology?**

It is important to remember that the principle goals of any warehouse operation are to fulfill customer orders with the following goals in mind:

1. The Right Product
2. The Right Quantity
3. The Right Customer
4. The Right Time
5. The Right Condition
6. The Lowest Possible Cost

With the exception of bullet number 5, the reason to invest in order picking technologies is to significantly improve all of the other bullets listed above. The order picking function within a distribution center typically accounts for between 40 - 60% of total warehouse labor hours, therefore it is the one job function that most companies tend to focus on first because any improvements in the quality of order picking positively impact the customer's experience.

When we study the root causes of order picking errors in paper-based warehouse environments, we have deduced that the root source of warehouse errors can summarized as follows:

- 45% errors: Item omitted - operator omits the item from the order even though the item is in stock within the warehouse. This can be caused by batch processes whereby inventory information is not updated at the same time as the transactional event occurs in the warehouse; or because of poor quality inventory information resulting from errors related to paper-based processes. This can also be due to lack of operator discipline.
- 30% errors: Wrong Item - operator erroneously picks the wrong item; 90% of these mistakes arise because the operator is at the wrong location or because multiple items are commingled in the same pick location (which is one of the worst warehouse operating practices that continues to take place in thousands of operations even to this day).
- 23% errors: Miscount of quantity - this happens when the operator reads the correct quantity but makes a mistake counting the pieces to be picked. This can happen in operations where large quantities of units on an order line are being picked from split case or full case pick slots. This is very common in warehouses that fulfill customer orders and warehouse branch transfers from the same distribution center (The branch transfers order in case quantities and the customers order units/eaches and there is only one pick slot set up for the item). This also frequently occurs when large quantities of a product are ordered say for a price drop or an event.
- 2% errors: Quantity misread or transposed - operator picks the right item in the wrong quantity (usually short) because the pick list is erroneously read resulting in a quantity mispick. Often times, poor pick list formatting; or faded printer ink on the pick list; or poor warehouse lighting can contribute to this situation.

**Benchmarking Order Accuracy**

Whenever I ask a company how they measure distribution center order accuracy, I have to chuckle because there really is no consistent measurement system out there. Below are four order accuracy measurement statistics and quite frankly all four of these should be measured in any distribution operation that has a checking function.

1. **Gross error rate in units** :
    - Order calls for 5 units of item A and operator picks 3 units of item A; therefore 2 units under = 2 errors
    - Order calls for 5 units of item A and operator picks 8 units of item A; therefore 3 units over = 3 errors
    - Order calls for 5 units of item A and operator picks 5 units of item B; therefore 5 units over of item B + 5 units under for item A = 10 errors
2. **Net error rate in units**
    - Order calls for 5 units of item A and operator picks 3 units of item A; therefore 2 units under = 2 errors
    - Order calls for 5 units of item A and operator picks 8 units of item A; therefore 3 units over = 3 errors
    - Order calls for 5 units of item A and operator picks 5 units of item B; therefore 5 units mis-picked = 5 errors
3. **Net financial error rate**
    - Order is for $100 and $105 worth of merchandise is picked; therefore the error rate is $5 out of $100 ordered = 5.0%
4. **Mark-outs**
    - Order has 10 items (i.e. order lines) and only 9 order lines are shipped *as requested* by the customer; therefore there is 1 order line that has insufficient quantity shipped which is termed as a markout. This would result in 1 erroneous order line out of 10 lines shipped.

For the purpose of this article, we will be using the gross error rate measurement when we discuss the accuracy levels obtained from each technology such that all accuracy figures can be compared on an apples-to-apples basis. The gross error rate is the least commonly used measurement methodology because it is the most punitive and most distribution managers are less interested in using a statistic that reflects poorly on the operation. For this reason, most companies use the mark-out methodology (or some variant) which is the least punitive accuracy measurement.

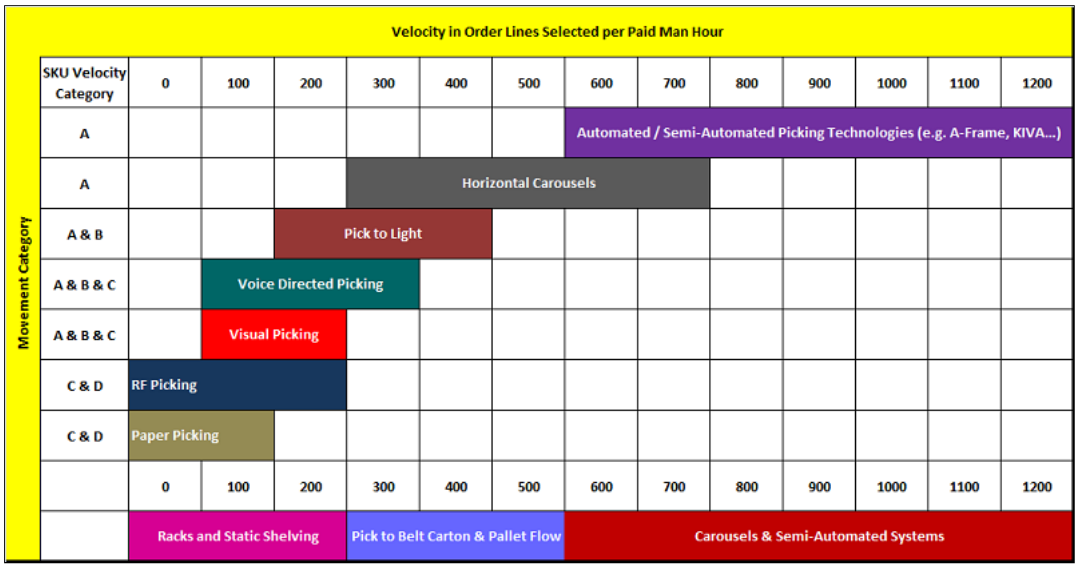
**Overview of the Most Applied Distribution Order Picking Technologies**

The following provides a brief overview of the most commonly used order picking technologies in today's warehouses:

- **Radio Frequency Scanning Devices** - The most widely deployed order picking technology by a wide margin. RF handhelds have been in widespread use in warehouses since the early 1980's when radio transmitters and bar code scanners were integrated into portable handheld units to enable real time data collection when operators perform tasks in the warehouse. With warehouse management systems providing computer directed task management, the use of RF handhelds and truck-mounted devices exploded over the past 30 years. To this day, RF devices remain the most flexible technology because they can be used across all functional warehouse operations (i.e. not limited to order picking), and because they are capable of capturing product or customer-specific data (e.g. lot number, serial number, catch weight, etc.). In general, RF devices are also the least costly warehouse order picking technology to deploy. For industrial warehousing applications, leading vendors include: Motorola; Intermec; Psion Teklogix; LXE; and Honeywell (Hand Held Products).
- **Visual Logistics** - A relatively new twist on an old theme which has been applied to both RF handhelds and pick to light technologies by different vendors. In the case of RF handhelds, rather than displaying text-based messages to operators to instruct them, the handheld displays graphical images combined with text instructions. The images are used to enhance the instructions and to improve accuracy (e.g. image of the product, the unit of measure, the bin location, the packaging instructions, etc.). In the case of pick to light, the display unit positioned at the header of the flow rack/shelf displays an image of the SKU to help the operator pick the correct item and unit of measure. Leading vendors in the visual technologies application include TECSYS (RF Handhelds) and ASAP Automation (Pick to Light).
- **Pick to Light** - Consists of light displays that are typically installed per each fixed pick location in shelving units, case flow racks and storage racks. Order picking tasks are downloaded to a subsystem that lights up the display units one at a time as operators pick each order line. The light display identifies the pick location where the task is to be performed and the header display unit indicates the pick quantity and carton/tote to put the product into. The operator typically pushes a button on the light display unit to confirm the pick task. Pick to light systems can also be installed on mobile carts for cluster picking multiple orders in a single trip through the warehouse. Pick to light can also be used for reverse picking for flow through operations where goods are received and then put into locations that represent customer orders. This latter approach is often used in retail distribution centers for product lines such as apparel. The fundamental advantage to pick to light is that it is a visual technology which supports high speed order picking rates and world class accuracy levels. Leading vendors include: Dematic; Intelligrated; Lightning Pick technologies; Knapp; Kingway Material Handling Corp.; System Logistics; KardexRemstar; Innovative Picking Technologies; ASAP Automation; and Working Machines Corp.
- **Voice Directed Picking** - Operators wear headsets with microphones and communicate orally with a software system in real time to receive and confirm picking tasks. The synthetic computer voice instructs the operator to go to a pick location and the operator confirms the location by speaking the random check digits that appear on a label positioned at each pick location (i.e. the label typically has a random 2 or 3 byte check digit). The system then instructs the operator to pick the designated quantity along with any other instructions that are required to complete the work task. Voice directed technology has been used in industrial applications since the 1980's but really only found a home in warehouse operations after Walmart installed the Vocollect Talkman into their Clarksville, Arkansas distribution center in 1996. The fundamental advantage of voice directed picking is that it enables "hands-free" (and to a certain extent "eyes-free") picking technology which means that the operator's only focus is finding the right location and picking the right quantity. The benefit of being hands-free is that the operator has both hands free to lift heavy products without the time loss associated with having to manipulate and holster a handheld RF device. Voice technology really took off in the grocery distribution industry where cold storage environments require that operators wear gloves to keep their hands warm hence making it difficult and unproductive to use RF handhelds. Today, voice directed picking is a mature and proven technology that has been widely deployed across many industry verticals. Leading vendors include: Vocollect; Voxware; Lucas Systems; and as well, most RF vendors have layered some flavor of voice recognition software onto their RF handheld units.

**Labor Productivity Comparison**

The chart below depicts how each order picking technologies relates to order picking labor productivity rates. The chart below was originally put together by Dematic and I changed it to reflect my experience in working with companies. The chart does a good job of establishing a framework for comparing the productivity rates one can realistically expect to achieve from each type of order picking technology.

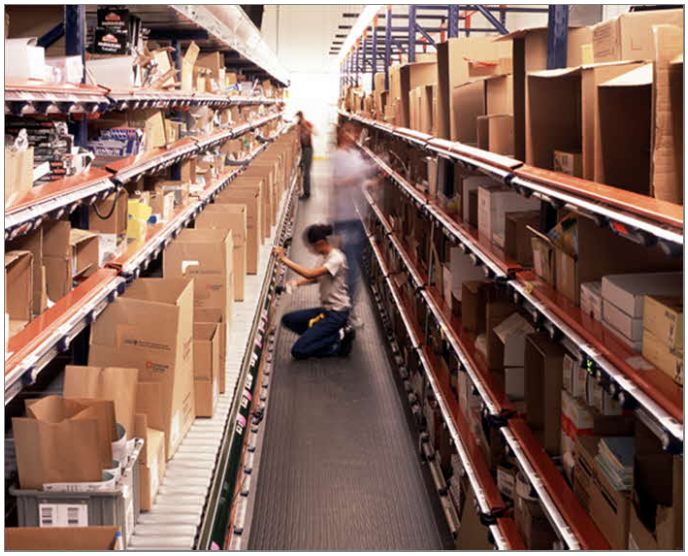



What this chart depicts is where each order picking technology best fits in terms of the SKUs it is applied towards and the material handling systems most commonly used. For example, most pick to light applications can be expected to support pick rates of between 100 to 400 order lines per worked man-hour and pick to light is most typically applied to case flow rack or pallet flow rack pick slots. I have worked with some companies that use pick to light and achieve 100 lines per hour pick rates and others that achieve 350 lines/hour. There are many valid reasons for the significant difference in productivity rates from one operation to the next and this discussion goes beyond the scope of this article.

The intent of this chart is to depict that in general, order picking rates for RF handheld picking are typically lower than voice directed picking with pick to light and carousel pick rates being on the higher end of the spectrum. Of course, it is difficult to generalize on this topic since for example I have worked with many carousel installations that are very unproductive and others that are blistering fast. For example, H.E.B. operates multiple carousels in their low velocity Grocery/HBC/GM distribution center in San Marcos,TX and the fastest of the carousel workstations has operators working at upwards of 650 lines per hour without people breaking into a sweat. To put that into perspective, that means the operator picks a new item every 5.5 seconds! I've seen other places where the carousel pick rate is 75 lines per hour. The bottom line is that carousels can be a painfully slow or lightning fast depending on the industrial engineering and thought that goes into the setup of the operation.

Realistic productivity rates for each order picking technology follow:

- RF handheld pick rates can range between 50 to 190 order lines/hour. Productivity will be hampered if the operator has to manipulate and holster a heavy handheld unit with every pick task rather than using a back of the hand scanning unit. Also, excessive scanning requirements (e.g. location and item and put-to carton ID label) will slow people down. If bar codes are missing and operators have to manually enter data then this also reduces productivity.
- Visual Logistics pick rates are generally slightly higher with a range of 60 to 220 lines per hour. This technology is similar to RF scanning in terms of its use but the visual images help to reduce travel time and product identification efforts because the operator has access to visual information.
- Pick to light order pick rates generally run between 110 and 350 lines per hour with some people capable of picking up to 400 lines per hour. Productivity can be negatively affected by having the operator pick and pack concurrently whereby 2/3 of the time is spent trying to pack the product into a shipping carton. Also, having the operator work on more than 2 cartons or totes at a time hurts pick rates because the put portion of the pick task involves more than 2 entities. Some people set up operations where the operators work a train of 12 cartons concurrently and this is a sure-fire way to reduce productivity *and* accuracy levels. Lastly, if too many shipping cartons are staged on the conveyor system then this can really slow people down as well ( See image below for how not to do it).



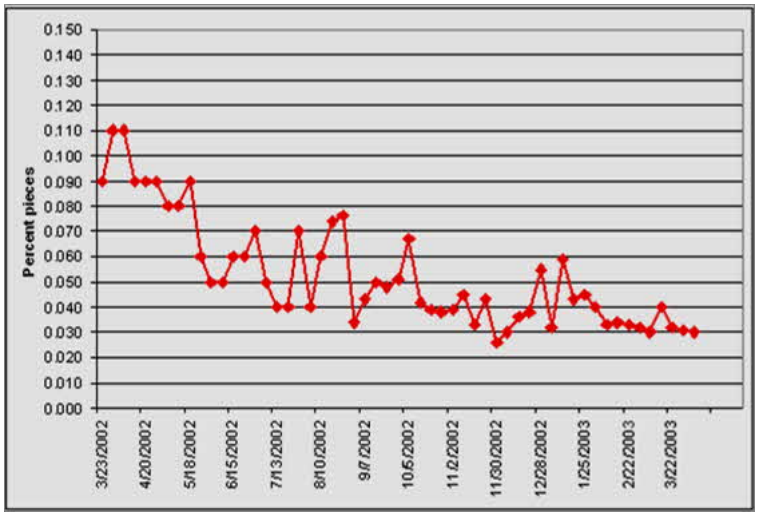
- Voice directed pick rates generally run between 175 to 275 order lines per hour though most applications that I have seen run at closer to 230 lines per hour on the high end. Clearly this is faster than RF picking (typically by as much as 25 - 35%) because of the hands-free aspect of the technology. In my opinion, voice directed picking is not as fast as pick to light because there is less time required for the human brain to visualize lights as versus having to receive and communicate oral commands as is the case with voice directed picking. Having said this, the vendors of voice technology systems will hotly contest this opinion so suffice to say that there are different schools of thought on this subject. Voice picking rates will be reduced if the operator has to conduct too much dialogue with each transaction, if the check digits at the bin location are too long ( 2-3 bytes should suffice), if data capture is required, or if poor slotting is in place.

**Order Picking Accuracy**

It is important to note that order picking technologies have morphed over the years such that today we have RF handhelds with voice recognition; pick to light combined with voice, visual technology combined with pick to light and RF, etc. When we discuss productivity and accuracy rates we do so in the context of the standalone technology by itself and not being combined with other technologies - in order to keep the discussion straight forward.

In general, based on the data coming in from the field, voice directed picking applications seem to be scoring the highest rates of accuracy of the order picking technologies reviewed in this article. There are some interesting innovations underway that are challenging this statement which I will elaborate on shortly. Again, the accuracy figures below are based on the gross error methodology discussed above.

- RF picking accuracy rates generally run between 5 to 7 errors per 1000 units picked which translates between 99.3 to 99.5% accuracy. The cause of errors relate to several factors such as bar codes being missing or damaged, operator scanning the right first product but then subsequently picking the remainder of quantity in correctly, mis-counts, etc.
- Visual logistics accuracy rates are generally slightly better than RF accuracy pick rates because the use of images helps operators to see product images which reduces the chance of picking the wrong unit of measure during the pick process. In split case operations, a common mistake happens when the operator picks the right product in the wrong unit of measure (e.g. inner packs versus eaches).
- Pick to Light accuracy rates generally run between 3 to 5 gross errors per 1000 units picked which translates into 99.5 to 99.7%. Errors are caused by picking too many orders together in one cluster such that the pick task is correctly performed but the operator deposits the goods into the wrong tote/carton. Also, having a pick to light display shared across 2 pick locations to save capital expenditure requirements is a big no-no which is something that one major retailer learned years ago.
- Voice directed pick rates generally run from 0.3 to 3 gross errors per 1000 units picked which translates into 99.7 to 99.97% accuracy. Most common cause of error is quantity mispicks, particularly for large quantity order lines. Other causes for errors relate to how the check digits are positioned relative to the slot location. Some companies actually place the label on the inside of the rack upright to conceal it from operators who “look ahead”. The intent is to prevent the operator from seeing the check digit label from a distance of 10 - 20’ from the pick slot because the operator reads off the check digit well ahead of arriving at the pick location which increases the probability of reading the correct check digit but then picking from an incorrect neighboring pick slot. The chart below shows one company’s experience with implementing voice technology in a 2-phased approach and how they reached 0.3 gross errors per 1000 units picked within 12 months of initial go-live.




Lastly, there is an interesting new application out there that combines infrared technology with pick to light and it's been made available by a company called **Speastech**. The cute thing about this application is that the operator does not have to use his or her hands to push any light display buttons to confirm the pick task because each time the operator's hand enters into the pick bin location the invisible infrared lights detects if the operator's hand has entered into the correct location. The company claims to have a customer that has made zero errors in 7 million pick tasks which is a pretty incredible statistic. This technology looks like it will find a good home in distribution operations for smaller higher value items such as jewelry; parts distribution and kanban type applications. The best way to understand what this technology is doing is to take a look at a video that can be found **here**.

**Capital Expenditure Requirements**

Always a key consideration, the capital expenditure requirements for each order picking technology varies by the number of operators in the case of RF Scanning, Visual Logistics and Voice Directed Picking or by the number of pick locations in the case of Pick to Light. For the sake of this article, we have created a sample distribution center sized at 100,000 square feet with 25 operators and 2,500 SKUs.

**RF Scanning / Visual Logistics**

- Assume a fixed cost for site survey, installation, training, cabling, project management, support plans, etc. and 3 access points to cover a 100,000 sq. ft. facility to be in the order of $US 45,000
- Assume that each operator has a rugged handheld terminal device with extra battery, charger, holster & accessories at a list cost of $US 2500 per unit x 25 units = $62,500
- **Total system cost for a 25 user application is about $108,000**

**Pick to Light**

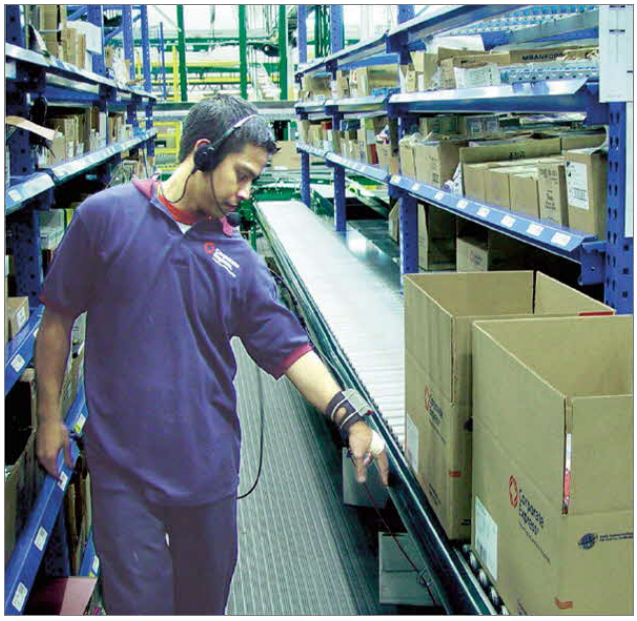
- Assume $US 50,000 - $100,000 for fixed project overhead to pay for system installation, engineering, software integration, computers, scanners, services, training, freight, etc.
- Assume between $100 to $130 per pick location which assumes one LED light display per location and 1 header display per flow rack. Therefore $100 - 130 x 2500 locations = $250,000 - $325,000
- **Total system cost ranges between $300,000 - $425,000**

**Voice Directed Picking**

- Assume an 802.11b compliant RF network is required to cover 100,000 sq. ft. $US 40 - 50,000
- Assume $15 - 30,000 to pay for the hardware server, database, chargers, accessories, etc.
- Assume $20 - 50,000 per site to pay for professional services
- Assume between $4500 - $6000 per wireless mobile computer terminal bundled with software priced on a per user basis
- Total system cost for a 25 user application ranges between $188,000 - $280,000

**Order Picking Technology "Best Fit"**

Now we mentioned earlier that these order picking technologies are morphing and we now see companies using them together so that we can obtain the best of aspects of each technology. For example, in the photo below, the operator is guided to the right location by the voice terminal headset. He then confirms the location by speaking the check digit or by scanning the location's bar code using his back-of-the-hand scanner. The voice terminal then tells him the quantity to pick. Any required data collection is then scanned as part of the pick transaction and lastly the operator verbally confirms the completion of the task. This approach combines the benefits of RF scanning (data collection) with the benefits of voice technology ( hands-free order picking).



Perhaps the best way to describe the best fit for each of the picking technologies discussed in this article is through the following table where the more red stars implies a better fit.

| | RF Scanning | Visual Logistics | Pick to Light | Voice Technology |
|---|---|---|---|---|
| Productivity Speed | ★★ | ★★★ | ★★★★★ | ★★★★ |
| Accuracy | ★★★ | ★★★★★ | ★★★★ | ★★★★★ |
| Data Capture Capability | ★★★★★ | ★★★★★ | ★ | ★ |
| Flexible Multi-Functional Capability | ★★★★★ | ★★★★★ | ★★ | ★★ |
| Hands Free | ★ | ★ | ★★★★ | ★★★★★ |
| System Cost | ★★★★★ | ★★★★★ | ★★ | ★★★ |

The above chart is a picture that says a thousand words so hopefully this provides the reader with enough information to make a decent assessment of the technologies to consider relative to the characteristics of the distribution center operation.

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 provides logistics and distribution technology consulting services. Our services include: distribution network strategy; distribution center design; material handling and automation design; supply chain technology consulting; product sourcing; 3PL Outsourcing; and purchasing; transportation consulting; and operational assessments

***Below if Some Interesting Feedback on this White Paper***

> May, 2013.
>
> I have found your picking technology comparison article a very interesting read and largely correct in its assumptions however, I would disagree with a couple of your points. I have been selling voice directed picking for 11 years with three different companies – the last 4 years with Dematic. So I get to see a lot of order fulfillment operations too. One mistake many people seem to make is regarding the speed of paper-based picking which is a very fast and very inaccurate form of picking, people seem to think that by adding some RF scanning technology the result must be a faster pick, in my experience this is rarely the case. A paper picker with his pencil behind his ear and his pick sheet in his mouth will tell you (when he takes it out) that he too is working hands-free.
>
> When Selling RF scanning against paper it would be foolhardy to assume an increase in performance because of the technology used. The big gains from replacing paper with RF scanning are accuracy, visibility, dead-time savings (picking up the next order) and administration savings (no order administration or data processing). These are all valuable benefits but I would not be brave enough to give an assurance that the day's work would be finished earlier, I would strongly suspect it wouldn't be.
>
> One big benefit of introducing RF picking of any type is that there is an immediate gain of up to 10% initially just because the pickers now know their performance is being tracked irrespective of the process change and must therefore work at a

respectable speed. This increase cannot be attributed to superior technology, the same effect could be achieved simply by adding a couple of supervisors to the warehouse floor or a sensible bonus scheme.

In my view RF scanning is old technology that should be overstepped by adopting Voice, there are very few warehouse tasks that I have seen that cannot be improved with a voice terminal and scanner attached. The only doubt in my mind would be the receiving task, this can easily be carried out by Voice but with not much improvement in speed or accuracy.

Kind regards,
John Harper
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