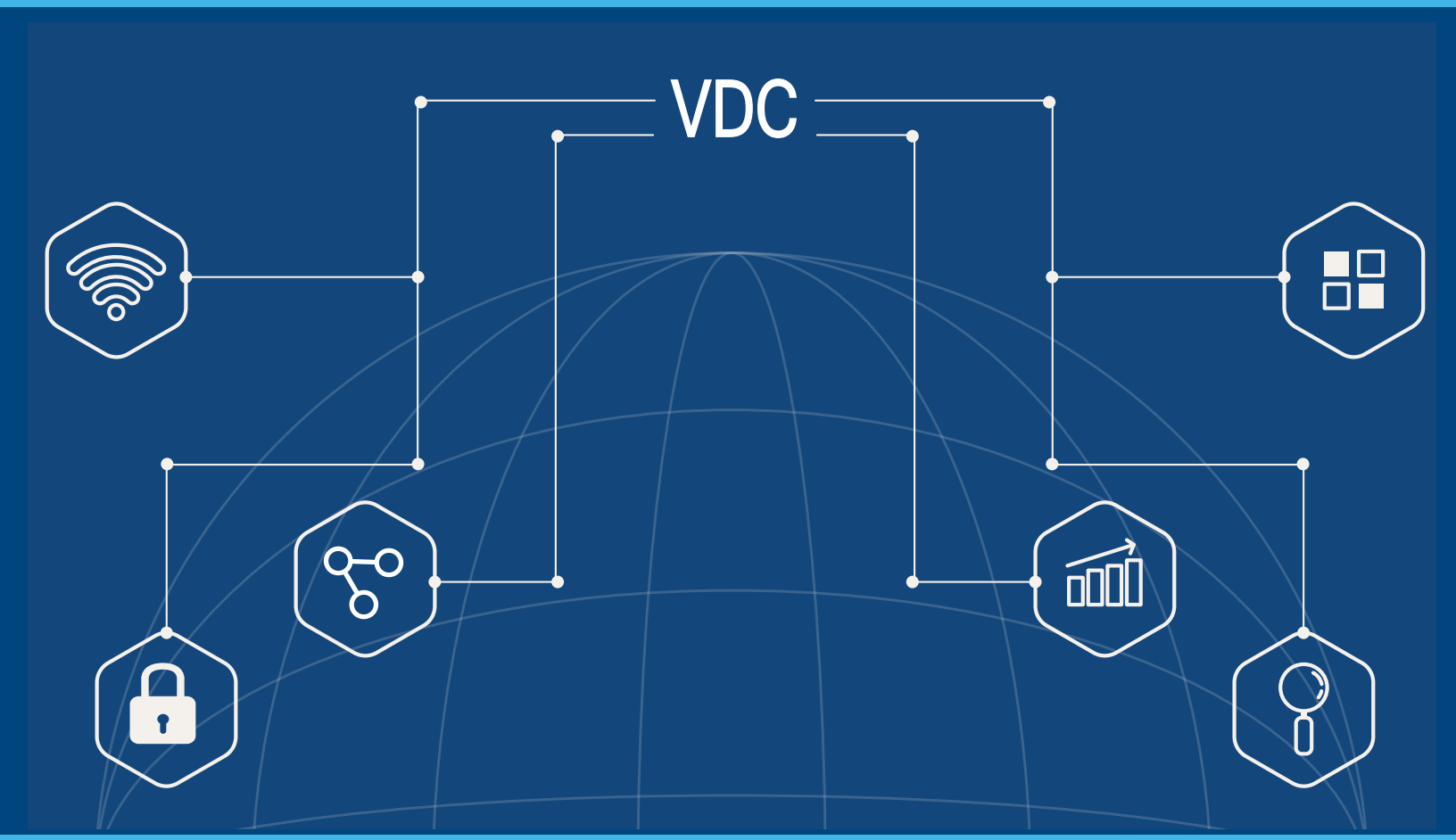
Analyzing the Business Impact of Inefficient Motion in Warehousing

More Walking = More Errors & Fatigue = More Attrition; Is There a Way to Cut Back?



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NEWCASTLE SYSTEMS

VDC Research

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Overview

Customers today expect the perfect order with the fastest possible delivery 100% of the time, placing tremendous pressure on product companies and their distribution/warehousing channels. The obligation to have the *right barcode label* on the *right product* with the *right documentation*, which is *dispatched from the right warehouse* at the *right time* and *delivered to the right location* without *triggering returns* and being *complete* is unprecedented. VDC surveyed 160 warehouse operators and technology investment decision makers on their key investment and operational priorities and leading workflow-related challenges as part of a study for **Newcastle Systems**, a leading mobile powered workstation vendor. Fewer than 20% of respondents experience on-time shipments of orders from their warehouse locations at least 97% of the time. This is a staggering statistic that also results in high operational costs, sub-optimized supply chains with unreliable delivery performance and schedules, and unhappy customers. Warehouse operators are struggling to not only fulfill these expectations but also retain an ever-fluid workforce that is increasingly burdened with the requirement to *do the job faster* despite scaled back resources due to the pandemic, manage greater capacity, and consistently improve accuracy and speed of order fulfillment.

There is a massive disparity in the warehouse performance metrics of ecommerce giants compared with those of small- and medium-sized businesses; the latter are struggling to remain competitive with key order fulfillment benchmarks. VDC believes that while the top 1% of organizations have successfully driven down error rates to less than 1%, majority of the businesses struggle with improving labeling accuracy, order fulfillment statistics, and overall efficiencies. Warehouse workflows are not fully optimized and they are being forced to operate with 85%-95% of their pre-pandemic workforce according to VDC's research. 40% of respondents indicated that the number one challenge facing them is poor warehouse workforce planning including labor allocation/hiring, task management, and worker productivity. Strategic technology investments will be crucial to increasing accuracy, improving speeds, and lowering overall workforce fatigue. Our research to identify and measure warehouse workflow-related inefficiencies points to the growing efforts to cut down extraneous costs by eliminating unnecessary movement in order to reduce error incidence. **Grant Industries**, an organization that VDC profiled as part of this study, stated that "*even with a decrease in the number of workers in warehouses due to pandemic-related rules of social distancing, we did not experience any dip in operational performance, helped by investments in mobile powered workstations.*"

The Post-Pandemic Warehouse

The COVID-19 pandemic resulted in a surge of online demand for all types of products, resulting in an accelerated growth of e-commerce channels, even as global supply chains experienced massive disruptions, particularly from the standpoint of available labor. The need to address customer requirements for increased fulfillment speed, improved accuracy, and managing greater capacity is higher than ever before with explosive growth in ecommerce sales volumes since early 2020, and is placing immense pressure on supply chains and warehouses. It has had a tremendous impact on how warehouse operators fulfill and manage unpredictable demand, not only with rising investments in automation technologies but also with a highly trained workforce that has access to relevant information where and when required. VDC's in-depth interview with a Fortune 300 retailer shows that applications such as "*validating receipts; sorting massive volumes of incoming shipment by PO/color/size; and, ensuring received goods are appropriately categorized/earmarked for further movement within the warehouse*" will continue to require significant manual labor and are not processes earmarked for automation. While several such applications can be addressed through mobile computing and printing devices, there are specific workflows that require workers to have access to large displays and/or industrial-grade printers capable of handling large print volumes.

Exhibit 1: What are the primary challenges faced by warehouse operators?

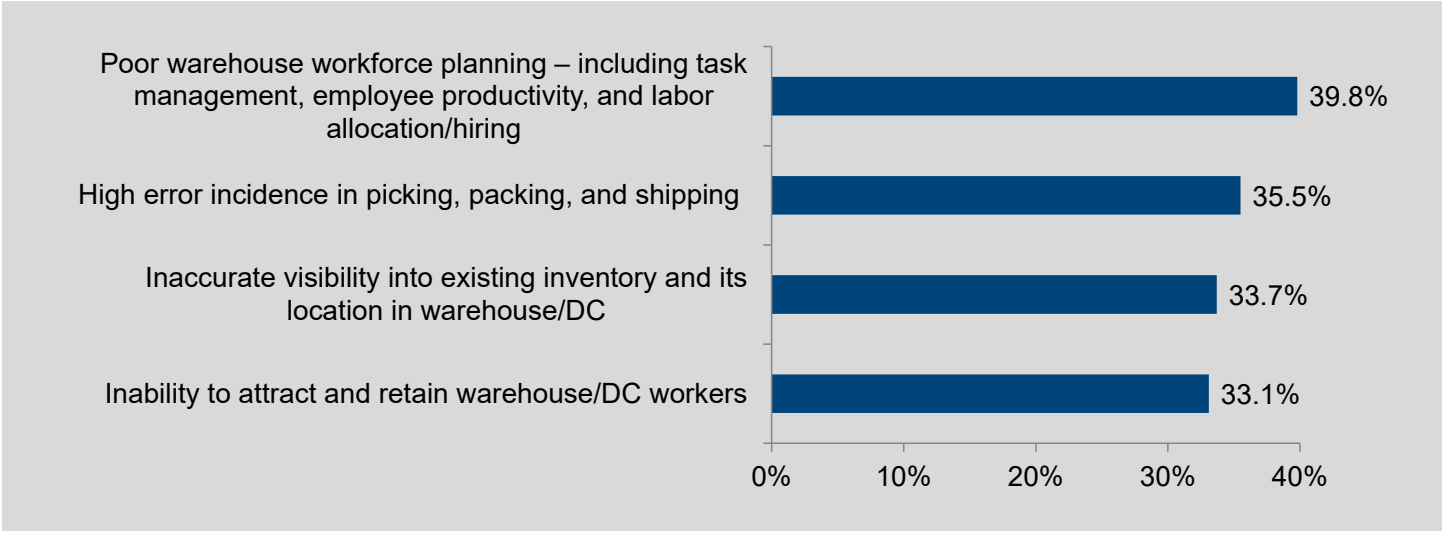
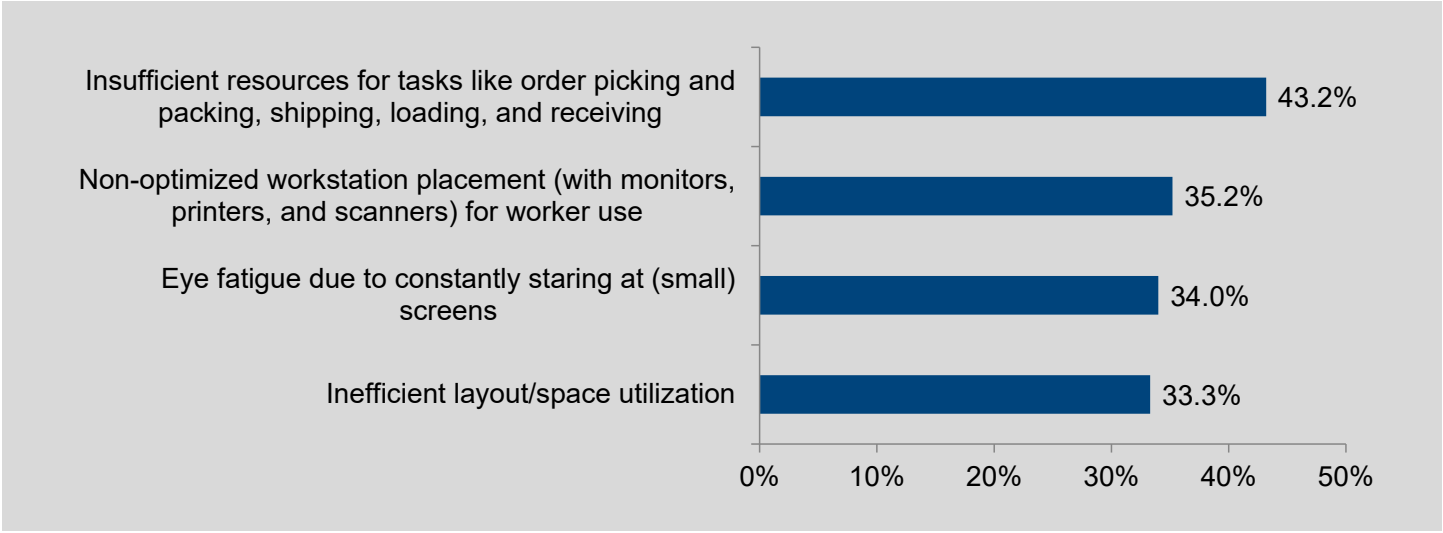


Exhibit 2: What are the primary challenges faced by warehouse workers?



Warehouse operators are scrambling to better utilize and retain available resources, including their workforce. Finding the right people is critical to improving and optimizing warehouse productivity; however, hiring and, more importantly, retaining a qualified workforce is a significant challenge given this industry's "*disposable worker business model*". One-third of respondents highlighted their inability to attract and retain warehouse workers. Leading AIDC channel organization, *Peak Technologies*, mentioned that "*warehouse environments are currently struggling with an older workforce*" and are becoming unable to hire younger workers. Managers are faced with a significant hiring crunch, which has prompted them to closely evaluate technology investments and monitor operational costs (including that associated with "*inefficient motion*"). Relatively low hourly pay-rates and intense workloads discourage the younger workforce from signing up for repetitive jobs. Enormous strain on operations is resulting in increased errors—high error incidence in picking, packing, and shipping (36%)—and inefficient operations. Warehouse workers themselves are also increasingly faced with challenges like insufficient resource allocation (43%), non-optimized workstation placement (35%), and eye fatigue due to constantly staring at small screens (34%), all of which contribute to attrition rates that are higher than in any other industry. Monthly attrition rates exceed 10% for nearly half the survey respondents, which significantly increases operational expenditures when the cost to hire and train each warehouse worker is to the tune of $5,000-$10,000.

Exhibit 3: What are your organization's primary reasons for investing in/evaluating warehouse technology solutions?

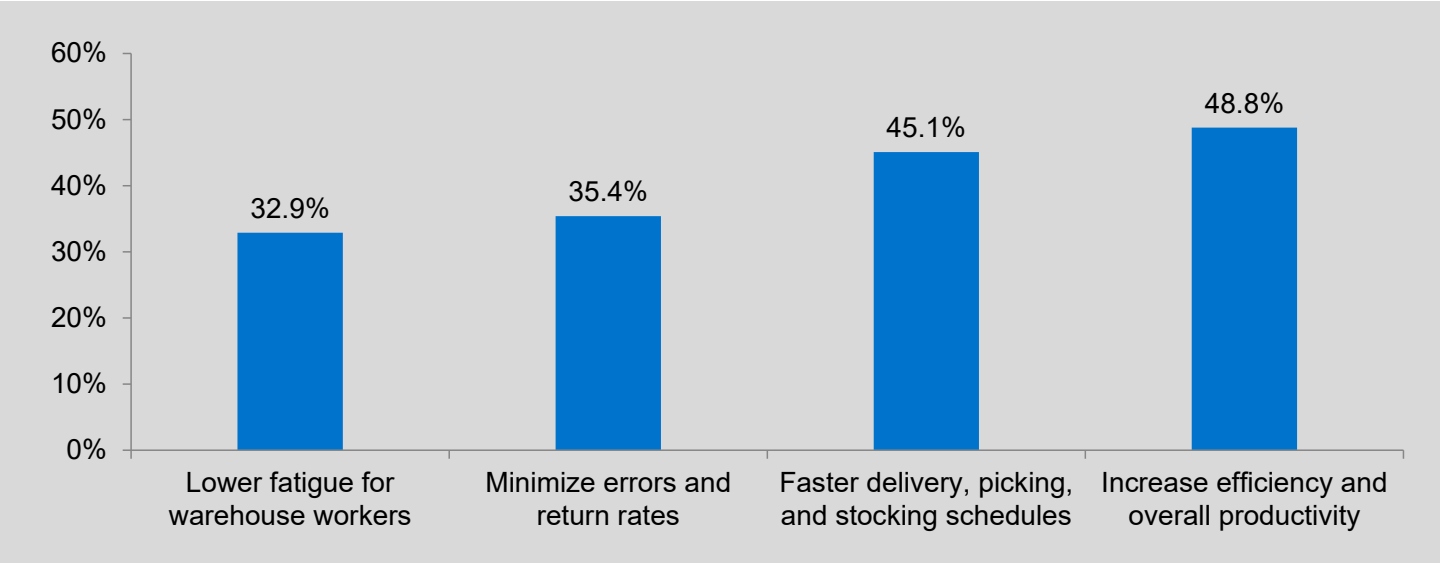
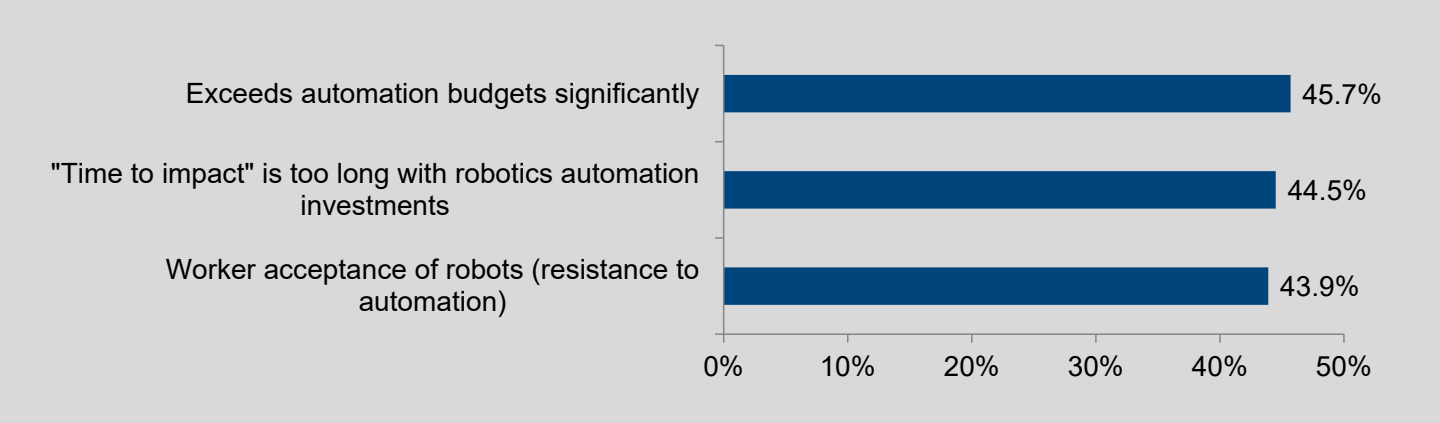


Exhibit 4: What are the leading warehouse technology adoption barriers?



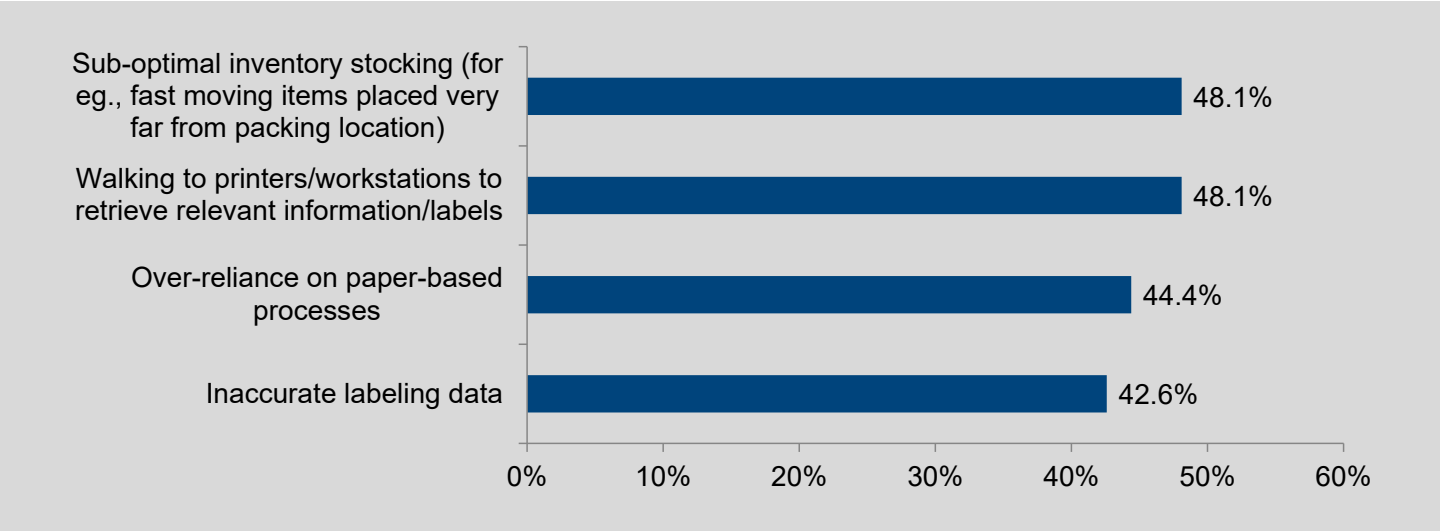
Sixty-percent of decision makers surveyed expect their warehouse sizes to trend up significantly over the next 3 years, which will accelerate the need to find cost savings from warehousing operations in order to accommodate a significant surge in scale and function. 95% of these respondents are already tasked with identifying potential sources of cost savings within warehousing environments with nearly half indicating that the savings needs to exceed more than 15% of current costs. They are increasingly considering technology investments to increase efficiency and overall productivity (49%); increase speed of delivery, picking, and stocking (45%); minimize errors and return rates (35%); and, lower fatigue for warehouse workers (32%). At the same time, VDC's research shows that there is a certain level of hesitancy for the more expensive solutions given upfront investment costs and prolonged ROI timeframes. Warehouse operators highlighted that they are particularly sensitive to these investments not exceeding their prescribed budgets (46%) and are keen on solutions that have a low time-to-impact (45%).

35% of warehouse workers surveyed cited non-optimized workstation placement for worker use (with monitors, printers, and scanners) to be one of the primary challenges.

Warehouse Operators Focused on Technology Investments That Will Generate Substantial Savings

Since the pandemic, regular season has been as busy as, if not busier than, what has historically been associated with peak capacity at warehouses and fulfillment centers. 85% of respondents expect their monthly fulfillment volumes to exceed 5000 orders in the next 3 years, which will only place tremendous pressure on warehouse workers who are already grappling with the need to do more. Operational costs will increase exponentially if adjustments are not made to existing processes and workflows. The pressures of competing against Amazon, which can ship most items in 2 days if not the same day, is making it increasingly important for organizations to get more products out of the door quicker. VDC had detailed conversations with AIDC channel organizations, Barcodes Inc. and Peak Technologies, where they highlighted efforts to enable customers "*to improve worker efficiency and experience*", and to make tools available at their disposal for alleviating cost-related pressures. These solution partners ask critical questions of their customers around time spent in redundant activities and measures taken to make associates more productive while also lowering overall error incidence.

Exhibit 5: What are the leading factors contributing to inefficiencies across your organization's warehouse tasks/workflows?

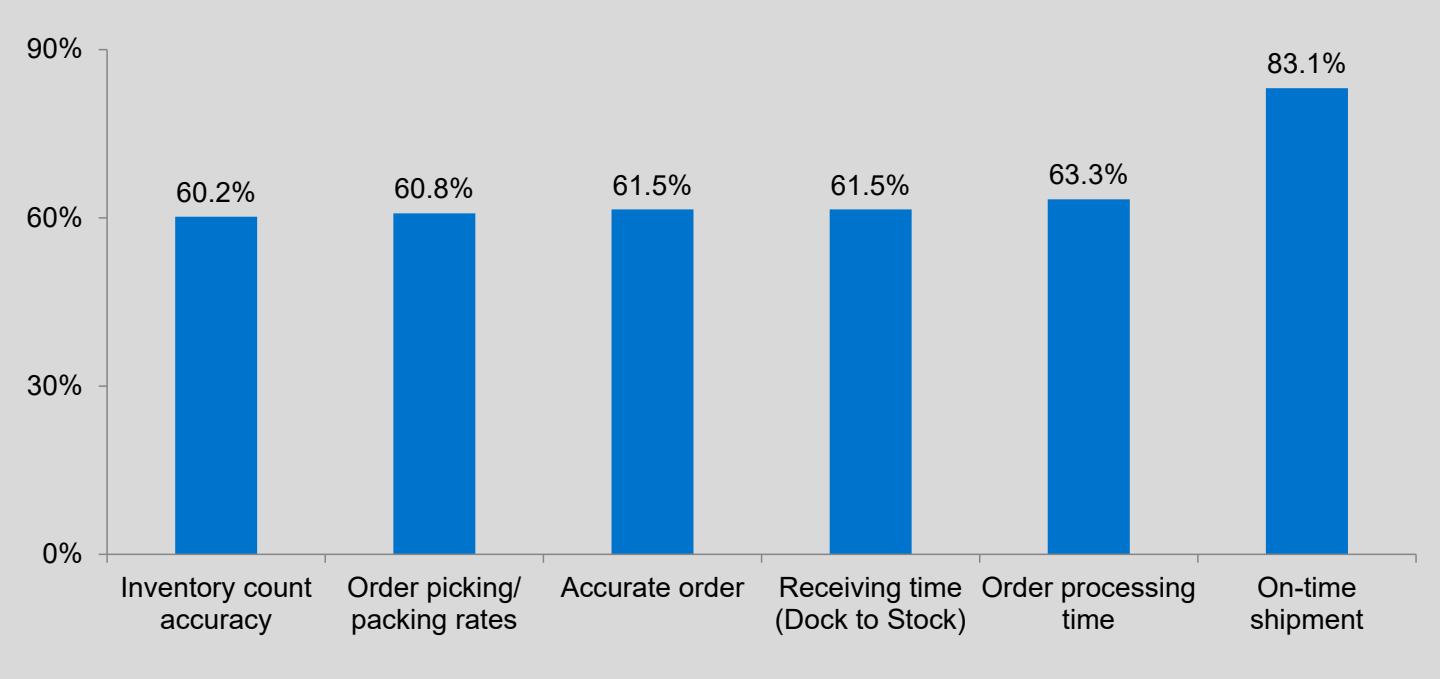


Warehouse managers who participated in VDC's survey cited the following as the five most important productivity metrics that they track—on-time shipment, order processing time, receiving time (dock-to-stock), accurate order, and order picking/packing rates. Order picking/packing, shipping, and receiving were highlighted as the most inefficient processes by 20%-30% of respondents with the primary factors contributing to inefficiencies across these workflows being—walking to workstations to retrieve relevant information (48%); sub-optimal inventory stocking (48%); over-reliance on paper-based processes (44%); and labeling errors (43%). Measures taken to substantially improve overall productivity for the key metrics will tie back to lowering errors across each of the warehouse workflows. Exposure to the possibility of errors is only increasing given the demands placed on supply chains and warehouse operators. While automation (including labeling) is certainly part of the solution, it is also becoming important to equip associates with the right tools required at the point-of-activity (like shipping and receiving docks) to make relevant data/information immediately accessible. Half the respondents currently track the average distance walked per worker per shift, which can range from 3-to-7 miles for 80% of respondents for 2 primary reasons—huge warehouses necessitate a lot of walking to get to points-of-activity (40%), and retrieving printed output from static workstations to complete tasks (36%). VDC believes that powered carts can potentially enable workers to work more efficiently as they now have access to the full suite of WCS/WMS, printers, and scanners

Fewer than **20%** of respondents experience on-time order shipments AND delivery to the right location from their warehouses at least **97%** of the time.

According to data published by the National Safety Council, a nonprofit safety advocate, "*74% of employers underestimate the prevalence of fatigue in the workforce.*" VDC believes that unnecessary movement and inefficient motion within the warehouse not only add to the hours of work but also contribute to worker fatigue and, therefore, mislabeling and errors. Half the respondents believe they can actively enhance worker productivity by enabling them to take the laptop, printer, and scanner to the point-of-activity. Technology options with relatively low upfront costs will increasingly appeal to a broad base of organizations with distributed warehousing operations. Organizations like CTDI and Grant Industries profiled for this white paper have highlighted the need to alleviate fatigue and stress levels associated with warehouse workflows via such strategic solution investments.

Exhibit 6: What are the most important productivity metrics and/or KPIs that you currently AND plan to track at your warehouse location(s)?



Evolution of Printer Deployment and Use in the Warehouse

Printing significant volumes of barcode labels is a critical requirement in most warehouses. Large facilities currently print, on average, 4000 labels/day according to our research and expect labeling volumes to grow exponentially over the next 3 years, even doubling in several cases, as operations scale and ecommerce volumes expand. Printer investments are distributed across both mobile and stationary form factors, with the latter being primarily used to support high-volume and large label-size (like 4"x6" shipping labels) requirements. Given their strategic importance for various warehouse workflows—particularly inventory stocking, receiving, and shipping—operators have positioned these devices across different locations in large warehouse spaces, often supporting on-demand printing.

However, warehouse managers feel compelled to have their associates for these workflows undertake batch printing since the workstations, and therefore printers, are not easily accessible from the point-of-activity. Warehouse managers that VDC spoke to as part of this research mentioned that "workers need to spend hours at staging locations at the center of the warehouse for data entry and label printing applications". They typically create and print labels in dedicated office spaces, leading to significant increase in errors and placing undue stress on associates to move back and forth from the point-of-labeling. According to VDC's survey results, average labeling error rates stand at just over 3% due to factors including—incorrect data on labels due to workers having to walk to-and-from printers and workstations (51%); inconsistent labeling processes across the workforce (48%); and, manual spot-checking at receiving, shipping, staging, and loading (44%). More than half the survey respondents indicated that their workers need to walk more than 3 times/day to specific printers during an 8-hour shift to gain access to documents and labels required to support various warehouse workflows.

*Exhibit 7: Cost of labeling errors = Average labeling error rates * Average number of labels printed per day in large warehouses * 365 * Approximate cost per fulfillment error (Approximate labeling error rate – 3%)*

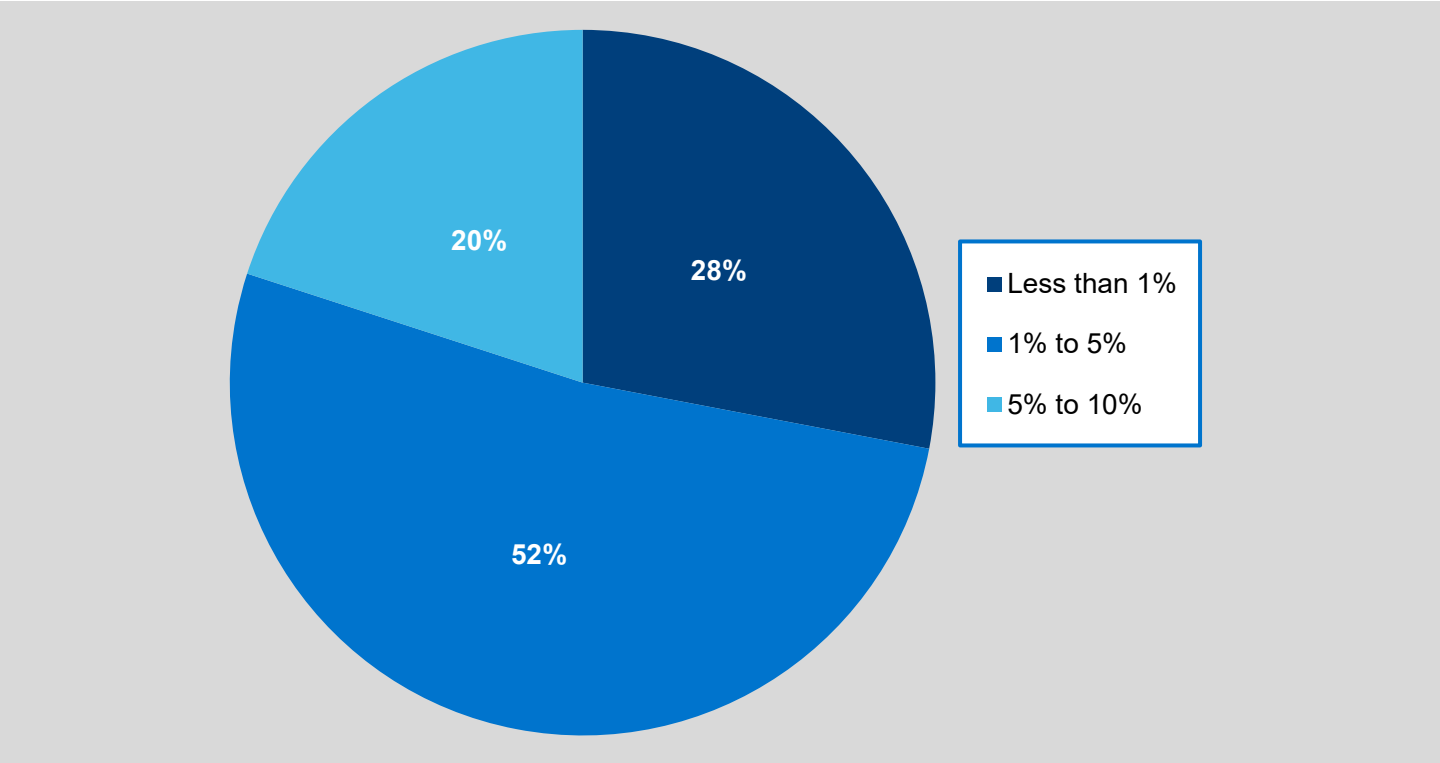
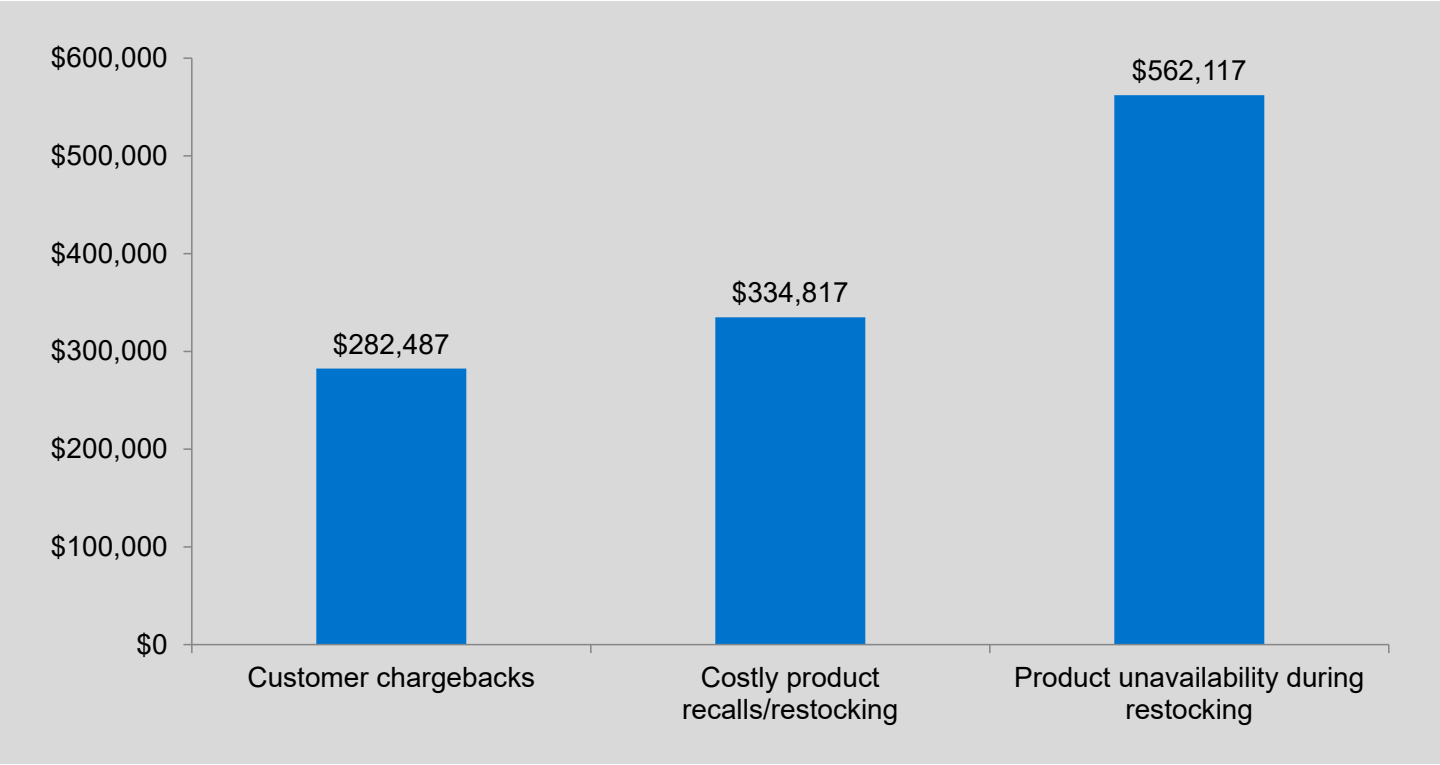


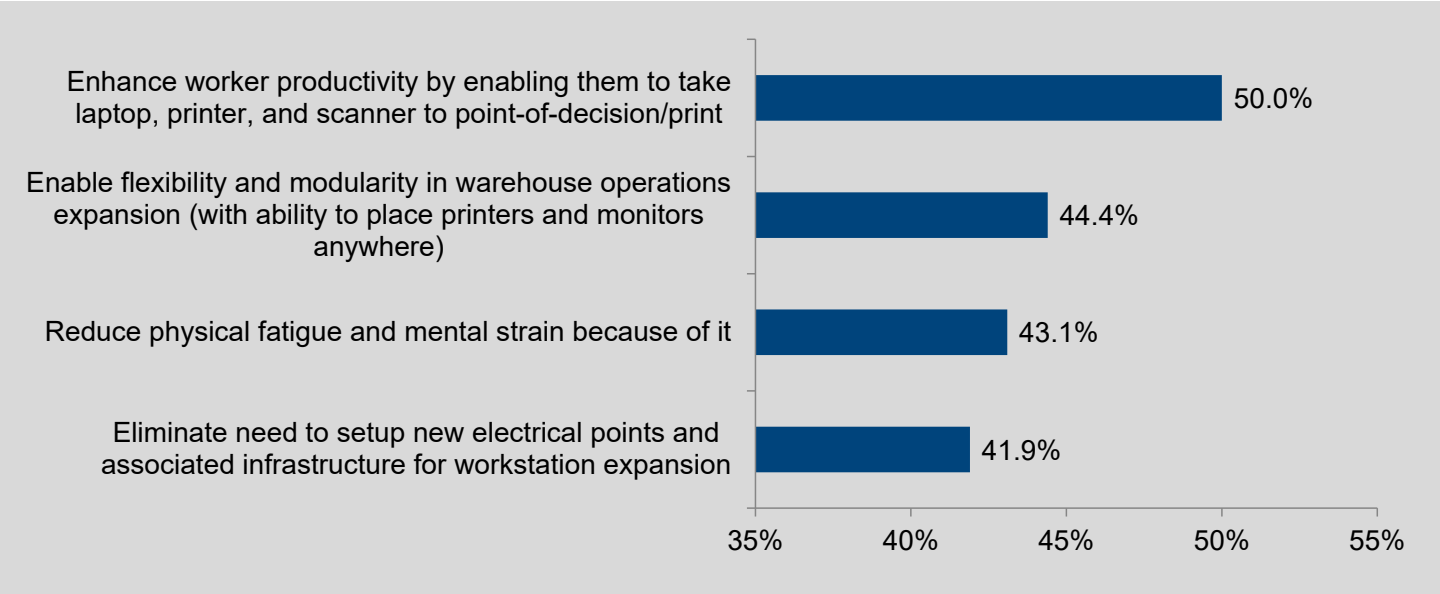
Exhibit 8: Approximate annual costs associated with order fulfillment errors—for product recalls/ restocking, customer chargebacks, and product unavailable during restocking - $1 Million (Cost per labeling error – $25)



Our research shows that batch printing processes are a significant source of label application errors while also resulting in unnecessary worker movement as they walk to-and-from printers on static workstations. Eighty-percent of organizations with current or planned investments in mobile powered workstations expect lower error incidence by writing off batch printing. These powered carts potentially highlight the next stage in printer deployments within the warehouse by providing access to printed output (labeling and/or shipment-related documentation) directly at the points-of-operation, eliminating the need to retrieve the same from distributed locations. As previously stated, this is especially relevant for the following workflows—inventory/stock count, receiving, and shipping. **Grant Industries** indicated that they "*have also been able to eliminate the need for batch printing and having to go back and forth between workstations—label printing is now a dynamic on-demand process.*" The organization has also seen an increase in the number of printers across each of its facilities since its investments in powered carts to support worker operations.

What Makes Mobile Powered Carts an Attractive Investment Option?

Exhibit 9: What are the primary influencers for your organization's existing/proposed investments in mobile powered workstations?



The cost of losing workers is stifling, which makes it important for organizations to invest in solutions that adequately addresses their requirements for measurable AND substantial productivity gains—in terms of labor cost-related savings, uptick in orders fulfilled per day, reduction in workforce fatigue, and drop in labeling errors/inaccuracies. Nearly all of VDC's survey respondents indicated interest in mobile powered workstations that can help workers take the relevant tools—like laptops (with at least 1 full-screen monitor), printers, and scanners—wherever they go within the warehouse. These carts can typically last a full day's shift before requiring a battery recharge, thereby minimizing downtimes. Research participants indicated that they expect to see the most significant efficiency improvements in the following warehouse workflows—inventory/stock count, receiving, and shipping—as a direct result of investments in mobile powered carts. Organizations including CTDI and Grant Industries with existing investments in these carts are pleased with their ROI timeframes that are less than 6 months. **CTDI** believes that investments in powered carts have been directly responsible for its workers "*saving time and improving their operational throughput*."

Newcastle Systems' key AIDC solution partners, Barcodes, Inc. and Peak Technologies, have seen quantifiable benefits like "*more shipping and more picking*" by mobilizing their customers' warehouse workforce with these carts that can power printers, scanners, PCs, laptops, and monitors on-the-go. They believe that these workstations offer the tools required to bring the worker to the actual work itself while also "*presenting a modern working environment that makes workers more productive*". It is also important for these solution providers to be able to communicate time-to-impact expectations to its customer base that spends time evaluating various investment options that can drive up worker efficiencies and overall productivity.

> *Investing in Newcastle Systems' mobile powered workstations can help alleviate warehouse worker fatigue and improve the overall experience. Cutting down the number of miles that these workers need to walk will directly impact their quality of work life.*
>
> - Raul Cepeda, Vice President Product Management & Strategic Alliances at Barcodes, Inc.

Warehousing operators evaluate investments in these carts across their ability to improve the following parameters—lower operational costs, lower error incidence, increase in revenues and productivity, elevated worker safety and security, and positive influence on brand name and reputation, especially to attract new workforce. These powered carts enable warehouse operators to get more work done and drive-up productivity, also helping add output lines/workstations based on changing requirements. Shippers and expediters constantly open and close warehouses based on ebb and flow of customers, which makes it imperative to offer built-in flexibility to operations and technology investments. For instance, Peak Technologies has had some of its retail customers close down stores since the start of the COVID pandemic and convert them into ecommerce distribution points and fulfillment centers. They have chosen to invest in powered workstations that can be moved around the warehouse space as necessary "without having to drop electric lines at specific points and making any significant infrastructure investments in terms of setting up new static workstations".

> *Newcastle Systems' powered carts help bring the warehouse closer to the actual work itself. Warehouse operators can be flexible and scalable by taking a modular approach to how they build and extend workstations.*
>
> - Jeff Walters, Regional Vice President at Peak Technologies

About Newcastle Systems

Leading Mobile Powered Workstation Vendor

Company Overview

Newcastle Systems is a mobile powered workstation vendor helping its industrial and warehousing customers improve overall operational metrics, including productivity and workflow efficiencies. It designs and sells carts that function as all-in-one mobile stations, carrying monitors, printers, scanners, and other equipment required by warehouse operators (and others) in order to maximize worker productivity. The company aims to support its clients in their efforts to reduce labor costs while eliminating footsteps and reducing overall workforce fatigue.

Target Markets and Applications

Newcastle Systems' products especially appeal to application environments across 3PL, industrial distribution, manufacturing, and retail. Its customers primarily use these mobile powered carts to support label printing applications across various workflows such as inventory/stock count, receiving, and shipping, aiming to improve its customers' dock-to-stock times and on-time shipments. The company prides itself on its integrated power capabilities and light-weight swappable battery packs. Printers (thermal and/or non-thermal) and other devices can be plugged in to the AC outlet on the battery-powered cart, which are then used to support a variety of logistics, warehousing, and packaging applications.

Customers interviewed and profiled for this white paper are exceptionally satisfied with Newcastle's willingness to adapt its products to their unique application requirements and specifications, including the development of lithium iron phosphate batteries that make the cart much lighter to navigate through large warehouses—an important criterion to lower overall worker fatigue. They have also seen a direct and significant impact on order fulfillment and productivity because of investments in mobile powered workstations. The vendor helps its customers and partners evaluate key efficiency and productivity metrics across primary functional departments such as inventory management, receiving, and shipping that see the most use for these powered workstations. CTDI, a Newcastle customer, believes that the workstations have helped it "significantly enhance overall productivity levels across all their associates responsible for picking, packing, shipping, and inventory control". Operators can lower fatigue and stress levels associated with warehouse processes due to scaled back walking time and the availability of detailed information and insights when and where required.

Customer Case Studies

CTDI is a full-service engineering, logistics, and repair organization for the communications industry—including major OEMs, telecom operators, and cable service providers; the company counts service providers like Comcast, Nortell, and Verizon among its global customer base. It provides a dynamic business model to customers across the following divisions – STB/CPE, Mobile and Consumer Electronics, Network Services, and Product/Supply. CTDI has more than 19,000 employees spread across 100 facilities worldwide with corporate headquarters located in West Chester, PA.

Relationship with Newcastle Systems

CTDI's warehouses manage and distribute huge pieces of equipment that its customers like Comcast and Verizon use regularly. These facilities are large and typically span over 700,000 sqft. The company had an inherent requirement for tools and technologies that would help ease worker shifts and drive-up overall process efficiencies. The team evaluated Newcastle Systems' mobile powered workstations in 2016 and considered them to be "*a viable investment option*". It currently has 52 mobile workstations in 1 facility, which are used 24x7 across several shifts; other facilities have also started making considerable investments in similar powered cart solutions. Most powered cart configurations include a laptop computer, monitor, printer (barcode label and/or full-page), and scanner. Upfront investment costs for Newcastle's products made it an easy decision, especially given the number of devices to which workers now have immediate access, saving time and improving operational throughput.

CTDI uses various Newcastle workstations to meet its warehouse requirements. The NB380 can support one printer laptop, and scanner each while the NB480 is powered by 2 batteries and can support more devices, based on workers' requirements. CTDI will also accelerate its investments in Newcastle's Lithium-based batteries that are designed to last about 8 years and are not heavy like the Sealed Lead Acid (SLA) alternatives.

Worker Efficiency Improvements

CTDI believes that Newcastle's workstations have helped it significantly enhance overall productivity levels across all their associates responsible for picking, packing, shipping, and inventory control. Warehouse workers are now able to take workstations with them, which has a direct, and significant, impact on efficiencies and time spent walking. The company believes its associates no longer have to run back and forth between the point-of-work and workstations; they are able to "*solve issues right then and there*". Newcastle's mobile-powered workstations also help CTDI alleviate fatigue and stress levels associated with warehouse processes. "*Without it, work would be terrible*" Is a common refrain. Worker frustration is kept at bay as they have access to the necessary tools when and where they need them.

> *"CTDI's investments in Newcastle's mobile workstations have proved to be very beneficial. Instead of having workers move back and forth, we now enable them to take all necessary devices with them, which improves productivity and lowers time spent walking."*
>
> - Jose Balderas, Facilities Supervisor at CTDI

Grant Industries is a leading supplier to the beauty and personal care industry; the company is involved in the research, development, manufacturing, and marketing of specialty performance ingredients. Grant Industries operates two manufacturing facilities—one in Elmwood Park, NJ and the other in Beijing, China—and has four warehouses in the US. The company serves all major global cosmetic markets with products including elastomers, actives, peptides, and micronized powders among others used as part of foundations, lip products, sunscreens, lotions, etc.

Relationship with Newcastle Systems

Grant Industries was introduced to Newcastle Systems through its technology partner as it worked aggressively to upgrade its overall labeling and inventory systems. The company was creating and printing labels in warehouse offices, far removed from where they were needed. This contributed to a significant increase in errors and undue stress on warehouse workers who had to move back and forth from the point-of-labeling. Grant decided to automate its labeling process and also alleviate worker fatigue and stress due to constant walking by making strategic investments in mobile powered workstations. These carts are deployed across all four warehouses and carry thermal label printers or inkjet printers, depending on specific application requirements. Grant Industries' labeling process has now become more dynamic with its printers used for printing hazardous material signage, GHS information, pictograms, and even color labels.

Grant Industries initially made investments in standard mobile carts with no batteries on which its workers could place laptops; however, excluding the printers from the carts placed an unnecessary burden on warehouse workers to retrieve printed output (labels and documents). The company's acceptance of Newcastle's powered mobile workstations was almost immediate and turned out to be a "*game changing investment*" across warehouses, labs, and even production facilities. While the fundamental requirement for these workstations remains the same, Grant invests in different models to meet unique considerations within each. For instance, it uses workstations with a larger workspace for shipping applications; metal-based workstations with a smaller workspace for production applications; and those made from polyurethane or industrial plastic for all others.

Worker Efficiency Improvements

Grant Industries has experienced significant benefits from its investments in Newcastle's workstations. The ability to have the whole system—printer, laptop, monitor, and scanner—in one place is unmatched. Workers can now place up to 2 monitors on these workstations, which helps tremendously with "*lowering eye fatigue*". They have also been able to eliminate the need for batch printing and having to go back and forth between workstations—label printing is now a dynamic on-demand process. Grant has experienced the most significant uptick in ROI on these investments in its workers' productivity and overall efficiencies since COVID. Even with a decrease in the number of workers in warehouses due to pandemic-related rules of social distancing, the company did not experience any dip in operational performance, which was helped by investments in these powered workstations.

> *"We are 3 years in with our first investments and have been very impressed with how these workstations from Newcastle Systems handle wear-and-tear and survive in harsh environments. The batteries on these carts last 2 full days per charge, which is a tremendous benefit for workers in receiving and shipping. These carts have also helped our workers lower both mental strain and physical fatigue."*
>
> -Casey Heemskerk, Operations Manager at Grant Industries

Fortune 300 Discount Retail Customer

A Fortune 300 discount retailer counts itself among the earliest adopters of Newcastle Systems' mobile powered workstations. The company has nearly 2,000 locations across the United States and specializes in off-price selling of various fashion and beauty products. It capitalizes on customers' desire to shop at stores that offer compelling value through heavily discounted products via its global sourcing strategy. This retailer owns and operates six warehouses in the United States, each a minimum of one million square feel.

Relationship with Newcastle Systems

The retailer was one of Newcastle's earliest powered cart customers and has continued to scale up its adoption in these solutions. The company is exceptionally satisfied with Newcastle's willingness to adapt its products to the retailer's custom specifications, including the addition of Lithium Iron Phosphate swappable batteries that make the cart much lighter to navigate through large warehouses.

The retailer has currently invested in close to 350 carts across all its warehouses, particularly "*for supporting receiving-related workflows*". Except for a small number of carts used to support reprinting labels, label printers are not used with the powered carts. Leading applications supported by powered carts include "*validating receipts; sorting massive volumes of incoming shipment by PO/color/size; and, ensuring received goods are appropriately categorized/earmarked for further movement within the warehouse.*" While the retailer has existing and ongoing investments in robotics automation technologies, including Autonomous Mobile Robots (AMRs), it does not see these solutions displacing the need for manual labor for the types of processes supported by Newcastle's equipment.

The retailer believes that these carts help its workforce by giving them the full horsepower of all warehouse management systems right at the point-of-decision. This is particularly important as battery-powered workstations enable the retailer to bring the cart to the worker without having to deal with making infrastructure investments including dropping new electrical lines for operating various AIDC devices, laptops, and monitors.

> *"Newcastle Systems' carts are very well-constructed and are built to sustain continued usage. 95% of our warehouse workers stand on their feet all day; the lithium-powered workstations ease overall fatigue since they cut down on unnecessary movement. These carts make the full-suite of WCS and WMS available to the decision-maker at the point-of-activity."*
>
> - Senior Operations Director at Discount Retailer

About The Authors

Richa Gupta is a Consultant working for VDC's AutoID & Data Capture practice. She has been tracking the markets for a range of AIDC technologies at VDC since 2010, including, but not limited to, barcode scanners and printers, labeling solutions, machine vision solutions, and robotics automation. Over the years, she has undertaken market opportunity sizing and forecasting, competitive landscape analysis, and offered strategic marketing assistance, while also providing valuable thought leadership for this technology segment. Richa holds a degree in Computer Engineering and an MBA from India.

David Krebs has more than 10 years of experience covering the markets for enterprise and government mobility solutions, wireless data communication technologies, and automatic data-capture research and consulting. David focuses on identifying the key drivers and enablers in the adoption of mobile and wireless solutions among mobile workers in the extended enterprise. David's consulting and strategic advisory experience is far reaching and includes technology and market opportunity assessments, technology penetration and adoption enablers, partner profiling and development, new product development, and M&A due diligence support. David has extensive primary market research management and execution experience to support market sizing and forecasting, total cost of ownership (TCO), comparative product performance evaluation, competitive benchmarking, and end-user requirements analysis. David is a graduate of Boston University (BSBA).

About VDC Research

Founded in 1971, VDC Research provides in-depth insights to technology vendors, end users, and investors across the globe. As a market research and consulting firm, VDC's coverage of AutoID, enterprise mobility, industrial automation, and IoT and embedded technologies is among the most advanced in the industry, helping our clients make critical decisions with confidence. Offering syndicated reports and custom consultation, our methodologies consistently provide accurate forecasts and unmatched thought leadership for deeply technical markets. Located in Natick, Massachusetts, VDC prides itself on its close personal relationships with clients, delivering an attention to detail and a unique perspective that is second to none.