LEVERAGING DATA SCIENCE FOR "DECISION INTELLIGENCE" IN THE DC

Advanced Machine-learning Algorithms and Data-driven Optimization Techniques Are Orchestrating Automation and Empowering Warehouse Execution

Honeywell Intelligrated

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INTRODUCTION

E-commerce order fulfillment demands have introduced unprecedented complexities in distribution centers (DCs) and fulfillment environments. As delivery windows shrink and product varieties (SKUs) multiply, fulfillment speeds and order volumes are accelerating beyond the capabilities of even the most sophisticated DCs.

While many online retailers are transitioning to advanced automation and robotics, traditional strategies of planning fulfillment waves days (or even hours) in advance are no longer viable. Order priorities can vary widely and change in an instant, and DC operators need the flexibility and agility to adapt continuously to fluctuations in demand and resource availability.

Increased process automation is becoming a necessity, but the integration of multiple automated systems and workflows can result in even more complexity. System interdependencies often are overlooked or underestimated, and a decision made in one system can create a cascading effect of unintended consequences in others, resulting in process inefficiencies at best — or productivity bottlenecks due to frequent manual interventions and reactive troubleshooting in worst case scenarios. The progressive uptake in automation also has led to the proliferation of data from nearly every corner of the DC.

This paper will explore how data science techniques — such as machine-learning algorithms, advanced data-driven optimization techniques and artificial intelligence — can leverage this abundance of data for insights into the interplay between automation systems. Combined with sophisticated warehouse execution system (WES) software, these tools can enable dynamic, real-time "decision intelligence" to achieve optimal execution strategies and business results in complex fulfillment environments.

What is decision intelligence?
Decision intelligence is achieved through the combination of machine-learning algorithms, advanced data-driven optimization techniques and artificial intelligence within the framework of a sophisticated warehouse execution system software. Together, these tools enable dynamic, real-time and automated decision-making capabilities to orchestrate the most optimal execution strategies and achieve maximum business results in complex fulfillment environments.

TRANSFORMING RAW DATA INTO PREDICTIVE INSIGHTS

1

From machine controls, sensors, automation systems and fulfillment processes, a continuous data flow is generated from nearly every corner of a warehouse or DC operation — potentially as much as 1,000 data points per second. This data presents a new opportunity for e-commerce retailers to gain real-time visibility into their DC operations and enhance the decision-making process to achieve optimal fulfillment results.



Transforming this raw data into actionable insights will require the use of sophisticated WES software with decision intelligence. In a connected, industrial internet of things (IIoT) infrastructure, these tools aggregate data inputs from every automation system, sensor, scanner, decision point, workstation, staff member and product flow to determine the optimum sequence of events needed to meet fulfillment targets and maintain DC workflow balance.

One of the main challenges that e-retailers face is being constantly distracted by disruptions in their day-to-day operations: responding and reacting to changes in demand and workload imbalances, thus shifting their attention from one section of the warehouse to the next. Not only do these disruptions and reactive interventions consume excessive amounts of managerial-level attention, they also lead to idle and underutilized systems and labor resources. Decision intelligence offers the potential to break this reactive cycle, take back control of warehouse operations, and make the shift to proactive intelligence to:

- Accurately predict the workload and anticipate future states of warehouse automation
- Provide dynamic real-time optimal execution strategies to maximize performance
- Automate workflow and workload balancing to avoid bottlenecks and congestion

With advanced decision intelligence capabilities — through machine-learning and data-driven optimization techniques — built into WES software, the potential impacts of specific decisions or scenarios can be automatically anticipated. For example, in determining the ideal sequence of orders to be picked, decision intelligence runs a variety of possible scenarios and highlights how these actions would create a cascade of effects on other systems and resources throughout the fulfillment ecosystem.

THE POWER OF DATA SCIENCE IN THE DC

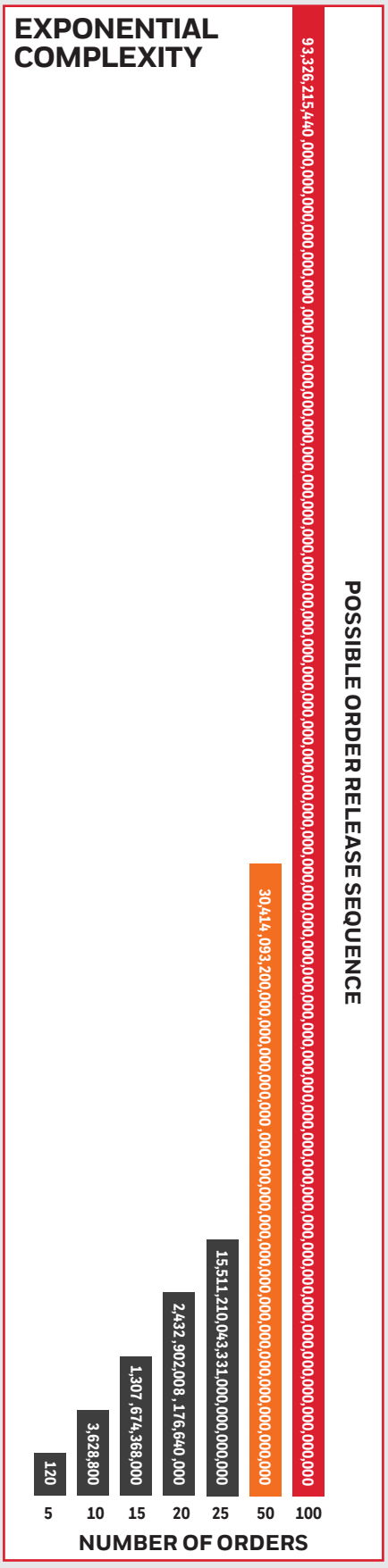
One way to contextualize the role of data science in the DC is to compare it to a game of chess. To excel in a chess match, players need to think not only through several moves in advance, but also perform this exercise with multiple scenarios. Each move or scenario dictates a series of new possibilities and sequence of events that creates a cascade effect leading to a potential outcome. The more moves and scenarios a chess player considers, the more likely they are to discover the optimal course of action needed to win the game.

The same is true when applying decision intelligence to warehouse automation and fulfillment scenarios. As we increase fulfillment complexities with the number of automation systems, workstations, processes, orders and SKUs, the possible permutations expand exponentially — and from a human capabilities perspective, become nearly impossible to manage and decipher.

Enter modern WES software decision intelligence that's designed to parse through myriad decision and data points to optimize DC execution and achieve specific fulfillment outcomes. This ability to select the optimal fulfillment path among millions of possible scenarios becomes a force multiplier for effective warehouse execution — and ultimately, fulfillment success. What's more, imagine being able to make these decisions at literally any point of the fulfillment cycle, not only the day before or at the start of a shift, but mid-shift and in real time in response to ever-changing customer demands and supply chain requirements.

Sophisticated WES software with decision intelligence provides the following transformative benefits to DC operations:

- Real-time visibility into order status, inventory allocation and fulfillment operations, including a comprehensive dashboard of all warehouse activities
- Dynamic, automated decision-making based on order priorities, workload, labor availability and automation system status
- Improved accuracy rates, on-time delivery targets and process rigor
- Accurate predictions and proactive decisions to avoid congestion and provide optimal balance of all warehouse activities impacting order fulfillment


EXPONENTIAL COMPLEXITY
120
3,628,800
1,307,674,368,000
2,432,902,008,176,640,000
15,511,210,043,331,000,000,000,000
30,414,093,200,000,000,000,000

MACHINE-LEARNING SCENARIO: SMART ORDER RELEASE

2

When you consider that the average cost to fulfill an order is roughly 70 percent of that order's value, online retailers need every advantage to drive down fulfillment costs and grow their profit margins[1]. By applying decision intelligence to order priorities and optimal order release sequencing — rather than using traditional "first-in, first-out" wave strategies — DC operators can streamline operations and reclaim their profits.

In this scenario, a machine-learning algorithm looks at current orders in the queue and selects from a variety of order release sequences to determine which one will yield the most efficient and productive results. This calculation evaluates various dynamic factors of the fulfillment ecosystem, such as: the number of orders, the time to complete tasks, picking, travel and dwell times, inventory locations, conveyor status, and put wall availability for order consolidation.

By sequencing orders and releasing them based on the most optimal scenario, DC operations can significantly reduce unnecessary and inefficient over-processing and achieve substantial financial benefits. And algorithms are designed to find an optimal scenario fast, regardless of the number of orders, although there are exponentially many permutations. What's more, these self-learning algorithms are smart enough to detect familiar patterns in datasets, essentially giving them a head start and reducing the amount of calculations needed.



1. https://www.efulfillmentservice.com/wp-content/uploads/2017/09/State-of-Ecommerce-Order-Fulfillment-Shipping.pdf

REAL-WORLD SIMULATION

Based on assumptions of a typical e-commerce operation, simulation environments can compare traditional warehouse execution methods — with no data science or decision-making capabilities — to data-driven optimization techniques that automate the entire operation via intelligent sequencing of orders. Even with conservative estimates of KPI improvements, the results indicate the potential for substantial annual financial gains.

In this scenario, smart order sequencing delivers annual financial benefits of more than $1.6 million in revenue.

SMART RELEASE | FACILITY ANNUAL FINANCIAL BENEFITS

▲ $1.62M direct savings

SOFTWARE-ENABLED **VALUE**

Increase Throughput, Reduce Order-fulfillment Time, Reduce Congestion, Robust Adaptive Decision-making, System Efficiency Improvement, Real-time Scheduling, Lean Work Load Sequence, Late Shipment Reduction, Labor Productivity & System Utilization Improvement

INCREASED THROUGHPUT

Balanced Workload

- Reduced Congestion
- Lean WIP
- Capacity Management

ON-TIME SHIPMENT

Responsive Fulfillment

- Dynamic Order Release Based on Priority
- Shorter Lead Time
- Reduced Recirculation Instances Through Balanced Workload

IMPROVED UTILIZATION

Revenue Increase Sources

- Less Work Reallocation
- Less Idling Time
- Fewer Number of Touches
- Reduced Overtime
- Increased Productivity

Assumptions: 6,000 CPH; 2 shifts of 200 workers each; 17.75 loaded wage; 40 hr/52 week/year; fulfillment cost $2.5/order; tardiness penalty $2

3

THE BROAD APPLICABILITY AND POWER OF DECISION INTELLIGENCE

E-commerce fulfillment centers are filled with an array of material handling equipment, automated high-speed systems, robotics and manual workstations — all of which serve specific purposes within the fulfillment process and are interdependent on each other. A disruption or malfunction in any one of these critical components can cause cascading impacts throughout an operation. To maintain holistic process efficiency and fulfillment productivity, every machine, process and person must be precisely orchestrated together in one harmonious symphony of activities.

Without visibility to each of these systems, the complexity of their interactions with each other and their impacts on the entire fulfillment ecosystem are often underestimated and misunderstood. To consistently achieve daily throughput targets, meet customer service level agreements and maximize profitability, DC operators need advanced warehouse automation software. A next-generation WES with advanced data optimization and machine-learning algorithms — or decision intelligence — can provide visibility into every facet of warehouse operation.

Today's powerful software platforms can collect and analyze data from every connected system and process to enable intelligent decision-making within the following critical order fulfillment functions:

Routing — Carton, tote and item routing based on a license plate number (LPN) are foundational DC functionalities, often within the purview of warehouse control system (WCS) capabilities. A sophisticated WES with decision intelligence impacts larger business flows by tracking the contents within each tote — not just its LPN — to inform real-time, dynamic routing decisions based on the next-best destination. At every routing decision point, these intelligent software platforms can act within milliseconds to route SKUs or orders to improve the accuracy and productivity of the operation and adapt to dynamic order priorities.

Order prioritization and release — Many e-retailers are balancing a variety of delivery windows and customer SLAs continually, as well as fulfilling a combination of both store and direct-to-consumer orders. A modern WES weighs every factor to determine the most optimal release timing, fulfillment process, picking order and execution path. As aforementioned, decision intelligence accurately can predict order processing time, track

system capacity, and provide optimal release sequencing to ensure on-time shipment and maximum profitability — all while continuously balancing the workload throughout the entire fulfillment system.

In e-commerce fulfillment environments where order priorities are constantly in flux, machine learning enables flexible, dynamic order reprioritization. For example, a WES quickly can locate an item that has already been picked for a lower-priority order, re-route it from the sortation system, and re-assign it to a higher-priority order — without impacting the shipment time of the original order.

Labor management — A WES with machine learning can evaluate individual picking rates and tasks in the queue to forecast and predict labor requirements and optimize fulfillment workflows accordingly. Armed with this intelligence, DC managers proactively can allocate the optimum number of resources to workstations and pick zones based on the anticipated or real-time workloads.

Storage allocation — In dynamic automated storage and retrieval systems (AS/RS), machine-learning algorithms provide the decision intelligence to maximize storage utilization and enable smart slotting while ensuring optimal retrieval time frames per item. This advanced logic can determine optimal storage location dynamically for items of various sizes while weighing the trade-off between space utilization and retrieval times based on an item's relative demand.

Just-in-time, goods-to-operator (GTO) put wall and allocation — When an influx of orders consists of multiple items, both automated and traditional picking processes must be sequenced properly to coordinate efficient order consolidation precisely — either at a GTO station or a put wall. With ever-changing order fulfillment priorities and dynamic workloads, it's no longer efficient simply to pre-assign orders and/or SKUs to designated GTO stations and put walls.

Machine learning provides the decision intelligence to monitor the workloads at all GTO stations continually and predict the times it will take for individual items to be picked for multiple orders — often sourced from a variety of pick processes throughout the DC. This information allows the software to coordinate the pick timing of items dynamically with their respective orders, and then allocate them to the most optimal GTO stations.

Similarly, for put wall order consolidation, machine-learning algorithms evaluate each picking task needed for active orders and then calculate the times it will take for items to arrive at the available put wall locations. By evaluating multiple fulfillment scenarios, the system generates the best picking and order release sequences to coordinate the arrival of orders and their items at the most optimal put wall stations.



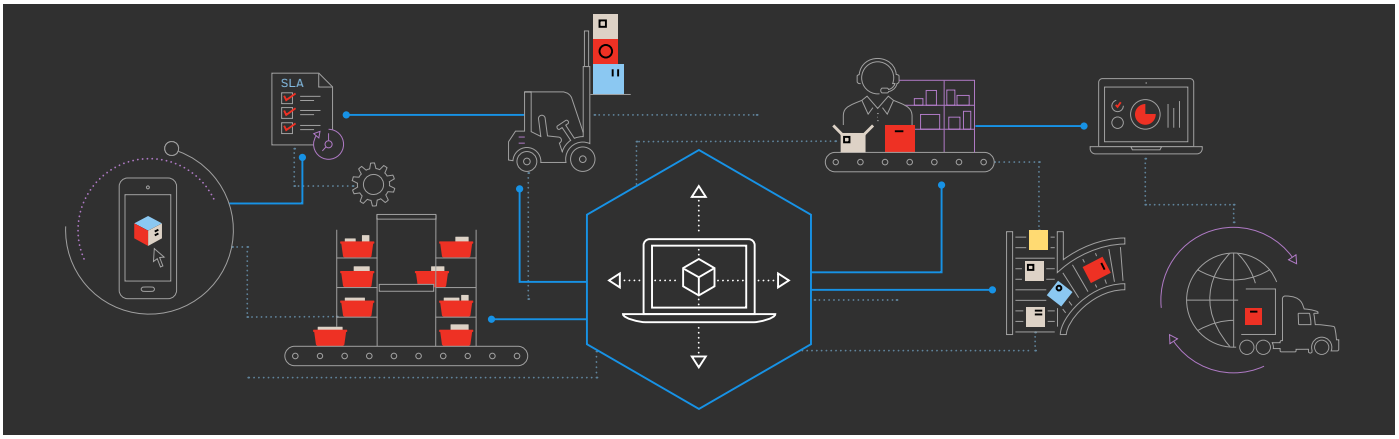


EMPOWER YOUR DC WITH DECISION INTELLIGENCE

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Matching the pace and complexity of e-commerce requires new approaches that enable real-time, decision-making precision and much tighter control over dynamic DC fulfillment ecosystems. The Momentum™ software suite from Honeywell Intelligrated is engineered to do just that. Equipped with robust WES capabilities, modular functionality and a powerful Decision Intelligence machine-learning engine, we're helping leading e-retailers accelerate their digital transformations and empower fulfillment performance execution.

With Momentum software, you can combine advanced automation, robotics, AS/RS, voice, labor management, machine control, real-time asset monitoring and a wide variety of order fulfillment technologies — all within a connected infrastructure seamlessly — to gain visibility and take control over every facet of your fulfillment operations. Our agile, extensible and state-of-the art software architecture is designed to allow you to scale up quickly to meet your current and future requirements.



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LDSWP | 06/20
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