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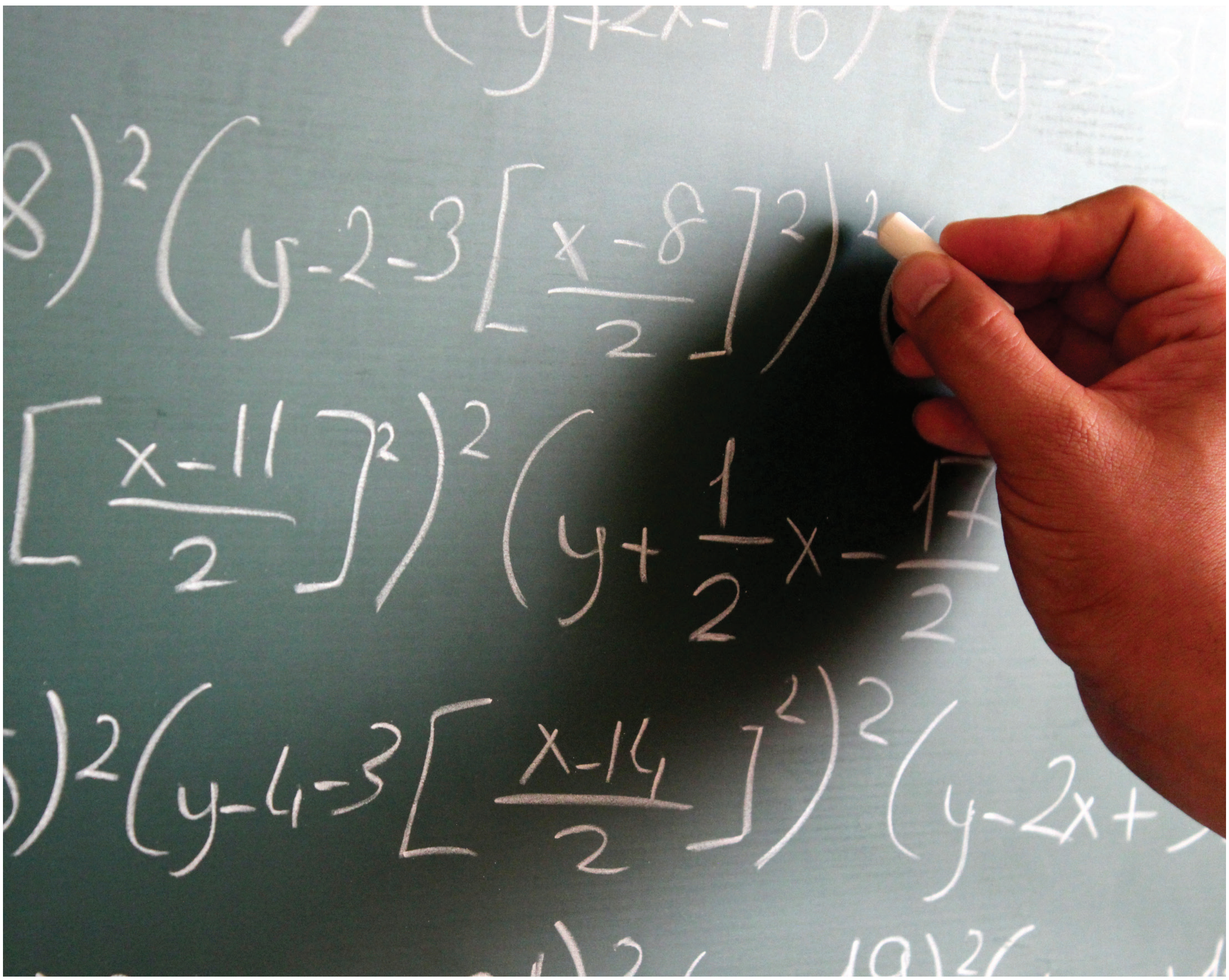
Member of the KUKA Group

DO THE MATH

Using Modeling to Optimize Distribution Center Automation



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INTRODUCTION

The engineers who design distribution centers (DCs) and the architects who design churches and synagogues have more in common than you might think.

In Christian congregations, attendance mushrooms for services on Christmas and Easter. The largest attendance at Jewish synagogues occurs on Rosh Hashanah and Yom Kippur. If architects based their plans on these peaks, these organizations would invest in square footage, seating and equipment that went unused most of the year.

To right-size their designs, smart architects analyze average weekly attendance and factor in extra space based on careful estimates of how many people will join the congregation. This ensures that everyone who attends services during 50 weeks of the year can be accommodated. During the two weeks of peak attendance, extra services can be scheduled or special arrangements can be made for overflow seating.

This same principle applies to warehouses and the material handling equipment (MHE) they house: plans must be made for peak capacities but designing for those capacities can result in unused resources during much of the year.

> Mathematical modeling — more complex in warehouse design than in sizing a church or synagogue — helps find the balance between peak and normal activities to right-size the distribution center and its material handling equipment.

It's important to follow best practices to ensure that all the equipment, software, and distribution processes — including manual, semi-automated and automated — work together as a unified system to anticipate and respond to peaks and lulls in workflow. By analyzing the goals of the material handling process and aligning them to industry guidelines, a properly designed warehouse will improve customer service, reduce inventory, shorten delivery time, and lower overall handling costs in manufacturing, distribution and transportation.

The mathematical model, based on current and historical data, enables business leaders and their design consultants to envision how the DC should work, and documents that the MHE and software selected provide an efficient and cost-effective solution.

ENSURING THE DC WORKS AS PLANNED

To ensure the design for MHE and software will meet order demand and business goals, it's necessary to evaluate DC processes, people, tools and technology. This should include:

- Understanding a "day in the life" in the distribution processes. How does product move through the distribution center? Where is data being collected and how is it being used?
- Collaborating with the people that any change will affect, from managers to pickers, to incorporate their business needs and everyday processing requirements.
- Aligning processes and people to resolve any issues exposed during the first two steps.

Mathematical modeling can then be employed to identify the product platforms, software enhancements and process improvements that are the best fit for a particular distribution center, preventing over-engineering or under-engineering the warehouse design.

Over-engineering burdens the business in terms of cost, size, complexity, benefit-to-value ratio and more. It can turn a potentially successful automation project into a financial and operational loss. An under-engineered solution may appear attractive in terms of capital cost, but will ultimately limit the flexibility of the warehouse to adapt to changing business dynamics and customer requirements. The cost of retrofits and additional square footage required to accommodate change will negate any upfront savings realized.

Modeling avoids the disruptions and costs associated with incorrectly designed or configured material handling solutions; it's simply easier to do the math than it is to unbolt conveyor or storage racks.

GATHER DATA THAT REVEALS DC ACTIVITY

Creating the mathematical models requires working through a detailed review to gather and analyze information about what actually goes on inside a distribution center. The first step is to collect data from relevant business platforms including warehouse management software (WMS), enterprise resource planning (ERP), warehouse execution software (WES), and homegrown software.

Specifically, the review should include information about:

- Inbound receipts to the distribution center
- Product characteristics (item master detail), e.g., serial tracking, lot control
- Outbound order data, such as daily throughput, order profile
- Packing, value add and shipping requirements and processes

Next, gain an understanding of how the DC operates and its business needs by answering the following questions:

- What scenarios does the customer experience every day?
- Which SKUs move quickly and which SKUs move slowly?
- How do seasonal demands affect operations and what adjustments are needed as a result?
- How is demand expected to grow?
- What SKUs, days, processes and seasons are outliers that would increase the scale of automation solution beyond what makes economic sense during normal operations?
- How are business requirements expected to change during the next three to five years?
- How much automation is enough to support these scenarios?

- Can we solve 80 percent of needs with 20 percent of the cost of automation?
- What is the return on investment?

Validating the accuracy of the data collected and summarized, along with future throughput projections, and business assumptions and rules that will drive the design, requires a thorough review with all stakeholders. This review is necessary to identify faulty assumptions and incorrect or incomplete data. It's essential that the business and the warehouse design consultant agree on the numbers before evaluating the feasibility of design concepts.

10 MATERIAL HANDLING BEST PRACTICES

When designing a DC, refer to best practices to ensure that all the equipment and processes work together as a unified system. Best practices recommended by the Material Handling Institute (MHI) include:

1. Planning: Define strategic performance objectives and functional specifications of the proposed system and supporting technologies at the outset of the design. The plan should be developed in a team approach, with input from consultants, suppliers and end users, as well as from management, engineering, information systems, finance and operations.

2. Standardization: All material handling equipment, controls and software should be standardized and able to perform a range of tasks in a variety of operating conditions.

3. Work: Material handling processes should be simplified by reducing, combining, shortening or eliminating unnecessary movement that will impede productivity. Examples include using gravity to assist in material movement and employing straight-line movement as much as possible.

4. Ergonomics: Work and working conditions should be adapted to support the abilities of a worker and reduce repetitive and strenuous effort.

5. Unit loads: Work should be designed to move several individual items together as a single load (as opposed to moving many items one at a time) and as unit loads such as containers, pallets or totes.

6. Space utilization: To maximize efficient use of space within a warehouse, keep work areas organized and free of clutter. Maximize density in storage areas (without compromising accessibility and flexibility) and utilize overhead space.

7. System: Material movement and storage should be coordinated from receiving, inspection, storage, production, assembly, packaging, unitizing and order selection to shipping, transportation and the handling of returns.

8. Environment: Energy use and potential environmental impact should be considered when designing the system, with reusability and recycling processes implemented when possible, as well as safe practices established for handling hazardous materials.

9. Automation: Deploy automated MHE to improve operational efficiency, responsiveness, consistency and predictability wherever there's an appropriate business case.

10. Life cycle cost: Analyze life cycle costs of all MHE. These costs include capital investment, installation, setup, programming, training, system testing, operation, maintenance and repair, reuse value and ultimate disposal.

Source: MHI
http://www.mhi.org/fundamentals/material-handling

FINDING CORRELATIONS

In the second step, the goal is to identify what products, order types and processes should be automated and how much automation is required to effectively and efficiently handle orders. Keep the focus on safety while driving to the most-economical return on investment in MHE and software. Here's how to do it:

- Identify the highest throughput SKUs in the warehouse with a Pareto Principle (80/20 rule) analysis
- Find which days and activities generate the most activity (Figure 1)
- Classify events by their relevance, occurence and how extreme
- Identify high-impact, extremely high-throughput SKUs which can be treated differently
- Identify SKUs with high probability to be ordered with other SKUs
- Identify high-velocity, high-frequency SKUs (Figure 2)
- Identify low-velocity, low-frequency SKUs (Figure 2)

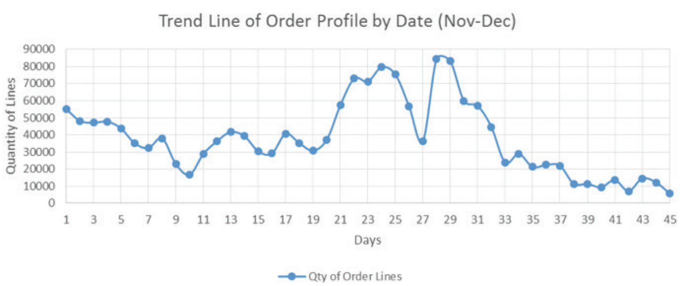

Figure 1: An analysis of order activity by day helps identify the frequency and severity of peaks that must be accounted for, but not necessarily designed to.

Learning the velocity and frequency of SKUs informs decision making about what to automate. Some products are always in demand with such high throughput that the continuous replenishment needed to maintain sufficient inventory may preclude them from some automated systems. For example, in the velocity curve shown in Figure 2, eight percent of SKUs account for 40 percent of throughput.

In another recent engagement, Swisslog worked with an online grocer to identify the fastest moving SKUs and handled these products outside of the automated system to reduce the costs of the automated system. The fast-moving products were slotted closer to the shipping dock, with an assisted lift.

Slower-moving products that are predictable and seasonal items produced for sale during a limited period also likely are not good candidates for automation. Some products, think golf clubs or hockey sticks, are too large to store in most automated systems and need to be handled separately from the normal workflow.

This analysis will find correlations among the data, but not causation for warehouse situations. Nevertheless, each correlated metric is an opportunity to fine-tune the potential automation solution and cost-justify major hardware and/or software changes in design.

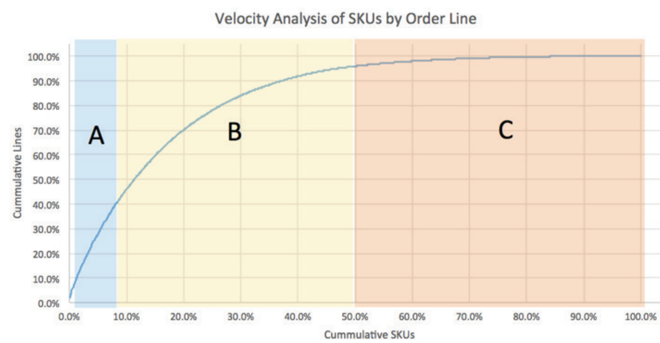

Figure 2 : The velocity analysis shows that eight percent of SKUs account for 40 percent of order lines and 50 percent of SKUs account for almost 90 percent of order lines. This analysis helps inform decisions about where to focus automation to achieve the highest return on investment.

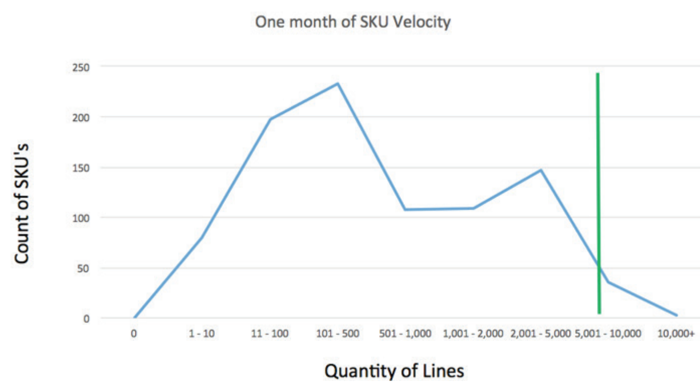

Figure 3: The extreme level of activity for the limited number of SKUs to the right of the green line makes them candidates for handling outside of the automated system.

This analysis can produce unexpected results. Swisslog was recently asked to automate picking of paint pails and gallon cases within a DC. During the data analysis it was determined that handling the fastest moving SKUs, including caulk, tee-shirts and the highest throughput paint SKUs, outside of the primary automation produced the desired results with a smaller investment in automation.

USING DATA TO INFORM DESIGN

The third step in a detailed warehouse analysis involves creating process and material flow diagrams, identifying the needs of subsystems, bottlenecks and integration points between the subsystems.

To do the analysis, ways to weight classes of SKUs and their characteristics need to be created. Also, sub-classes such as flow rate, can be identified to track as key process metrics along with what has to be fulfilled and the cost of not fulfilling. It's also important to avoid "rubberbanding" — in which material handling equipment is stretched to, and sometimes beyond, its capacity.

Swisslog avoids rubberbanding by introducing elasticity into the system by engineering to a daily peak demand plus some percentage, usually 20-25 percent, aligned to the natural hourly swings in throughput and the forecasted three- to five-year growth projections. In one recent engagement, the customer specified a demand rate of 75 cases per minute. However, Swisslog, after analyzing the data, demonstrated that a demand rage of 100 cases per minute was required to ensure the elasticity needed to support minute-by-minute variability in the workflow.

A THOROUGH THROUGHPUT ANALYSIS

The throughput analysis needs to determine:

- What are the inputs and outputs of warehouse subsystems?
- How will peak throughput vary daily and during the day?
- What are potential scenarios and unplanned influences on the system (product damage, out of stock SKUs, and returned inventory)?

This analysis calculates the required activities through the entire DC and through each function and system being considered for future deployment. Daily average and peak metrics, such as orders, lines, units and handling units, enable the MHE system and all related sub-systems to be designed to support future fulfillment demands.

In addition to capacity to support future growth, a well-designed MHE system will provide "catch-up" capacity to enable the system and the DC to recover from minor work interruptions or downtime incurred during the work day.

SUMMARY: MATHEMATICAL MODELING BUILDS BUSINESS CONFIDENCE

Mathematical modeling is used to create realistic, data-supported warehouse designs that build confidence in MHE system expectations and sizing recommendations.

Mathematical modeling requires collecting data from business platforms, developing a detailed understanding of warehouse processes, and analyzing data to identify the sweet spot for automation in terms of products to be automated and system capacity. It can increase planning time, but the result is reliable, provable conclusions about how the system will perform that informs cost-effective design and minimizes the need for future retrofits and expansion while solidifying the business case for automation.

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