Beating Murphy's Law
on Warehouse Automation Projects

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TABLE OF CONTENTS

TABLE OF CONTENTS **2**

MURPHY'S LAW DEFINED **3**

WHY ARE WAREHOUSE AUTOMATION PROJECTS SO HARD TO GET RIGHT? **5**

WAYS TO BEAT MURPHY'S LAW **10**

LEARNING FROM MURPHY'S CURVE 11

PHASE 1: PROJECT CONCEPTING 12

PHASE 2: DESIGN ENGINEERING 20

IN CONCLUSION **29**

ADDITIONAL RESOURCES **30**

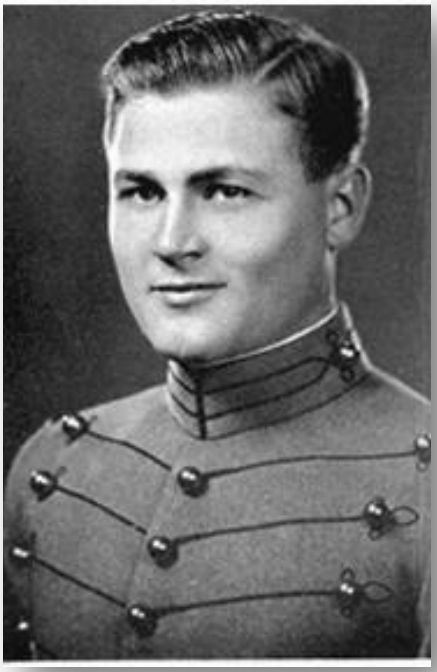
ABOUT THE AUTHOR **31**

HOW CAN COMMONWEALTH HELP? **32**

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MURPHY'S LAW DEFINED

Murphy's Law – the principal that "anything that can go wrong, will go wrong" – is likely familiar to anyone who's ever tried to hang a set of Christmas lights, bake a cake, or take the kids on a trip to Disney. Even in rudimentary endeavors, unforeseen events seem to occur with troubling frequency, and sometimes pile up at such a fast rate that the whole enterprise is threatened with failure.



EDWARD ALOYSIUS MURPHY
Image source: Wikipedia

Many readers might be surprised to know that Murphy is not just a proverbial figure; he was, in fact, a real person. Edward Aloysius Murphy (1918 – 1990) was a U.S. Air Force engineer who reportedly coined his namesake phrase while performing rocketry experiments in the 1940's. Aerospace is a field which is brutally unforgiving of things going wrong, a fact that was not lost on Edward Aloysius Murphy. In this amusing passage from Wikipedia, we are told that:

> *"Murphy himself was reportedly unhappy with the commonplace interpretation of his law, which is seen as capturing the essential 'cussedness' of inanimate objects… Murphy was said by his son to have regarded the many jocular versions of the law as 'ridiculous, trivial and erroneous'. His attempts to have the law taken more seriously were unsuccessful."*

For supply chain managers, the impact of Murphy's Law is probably at the mid-point of the severity meter, somewhere between having the Christmas tree fail to light up and having a rocket explode on the launch pad. Nevertheless, businesses have succeeded or failed based on the effectiveness of critical supply chain initiatives, and careers can be made or destroyed in the process. One of the highest profile supply chain failures occurred when Target Canada filed for bankruptcy protection in 2015 after numerous things 'went wrong' with their supply chain software systems, among other things.

FURTHER READING

Joe Castaldo of Canadian Business wrote a fascinating piece of investigative journalism chronicling in great detail the specific operational decisions which led to Target Canada's bankruptcy: http://www.canadianbusiness.com/the-last-days-of-target-canada/

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Even if a business doesn't become insolvent, a supply chain project gone bad can have extremely serious consequences for the business involved, including:

- **Service disruptions**
- **Cost overruns from using unplanned project resources**
- **Delays: both of the current project and other company initiatives**
- **Inventory inaccuracies**

The specific focus of this paper will be to examine ways to beat Murphy's Law on warehouse automation projects, which primarily includes implementing automated material handling systems.

"ANYTHING THAT CAN GO WRONG, *WILL* GO WRONG."



WHY ARE WAREHOUSE AUTOMATION PROJECTS SO HARD TO GET RIGHT?

Readers who have spent most of their careers in the field of supply chain operations can likely think of many examples of warehouse automation projects that "went sideways" – perhaps ones they were personally involved in, or ones they heard about anecdotally. Whether or not warehouse automation projects are really "harder" than projects in other fields is a subject for debate, but there often appears to be a tendency by executives to underestimate the complexity of these projects compared to other corporate initiatives. It's not uncommon to hear phrases like:

> *"We just finished implementing a new ERP/relocating our corporate offices/opening a new store…that went ok.*
>
> ***How hard can a warehouse project be?"***

Assuming that a warehouse project will be no more complicated than some other recent corporate initiative can create a mindset that may challenge the project before it even begins.

In fact, there are numerus reasons why warehouse automation projects can be exceptionally challenging to execute:

1. THERE'S NEVER "ONE THROAT TO CHOKE"

Even when working with a material handling systems integrator that is selling and implementing the entire system, the actual equipment involved in a warehouse automation project is nearly always manufactured by multiple different companies. For example, a multi-level conveyor-based pick module may utilize separate manufacturers for the conveyor, supporting rack structure, and devices like case sealers, printer-applicators, and scales.

While a single integrator may be responsible for ensuring that all of the equipment works together properly, a manufacturing problem or delay by any of the upstream suppliers can affect the timetable of the entire project and is sometimes out of the integrator's direct control. **The sheer number of different manufacturers involved increases the likelihood that at least one of them will experience an unexpected issue that impacts the project.** Many of the upstream vendors may only be supplying a small portion of the components, and therefore may not take the project as seriously as downstream vendors, who have a much larger financial stake in the outcome.

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2. NO ONE SOFTWARE SYSTEM DOES IT ALL WELL

On large and complex material handling systems, the flow of data can be very complicated. The following is a common way in which the outbound order flow may work in a typical distribution center.

1. Sales orders are entered and scheduled, and inventory is soft-allocated against those orders.
2. On the day an order is picked, a hard bin-level inventory allocation takes place for each item to be picked, and the workflow for the day is planned and organized so that it can be executed in the most efficient way.
3. As orders are fulfilled, picking tasks are directed and confirmed via mobile devices and barcode scanning. Cartons are routed through conveyor systems, which take numerous inputs from photo eyes, bar code readers, and RFID readers. The conveyor systems make decisions based on this information, sending output signals to diverters, mergers, sorters, printers, scales, and other devices.
4. Then, appropriate confirmations occur so that the customer can be notified of the status of their order and properly billed.



Due to the extreme diversity of these tasks (some involving external communications with customers, some involving accounting functions, some involving interfaces with mobile computers and machine-level controls), there is rarely, if ever, a single software system capable of effectively managing all of these tasks. In most cases, these functions must be handled by separate ERP systems, Warehouse Management Software (WMS) systems, Warehouse Control Software (WCS) systems, parcel manifesting systems, and perhaps others. These systems all must have interfaces written to connect to each other, and these interfaces must be configured, tested, and deployed to work in concert. This degree of complexity is ripe for Murphy's Law to manifest itself.

3. MECHANICAL FLEXIBILITY LIMITATIONS

If software systems have unexpected bugs, they can sometimes be corrected rapidly during implementation.

However, if mechanical equipment like conveyors or automated storage and retrieval systems have not been properly designed to accommodate the specific operation in question, re-manufacturing equipment can be extremely time-consuming. As a result, the company must live with sub-optimal performance until the design problem can be fixed. In some cases, correcting the underlying design issues will be so costly that the company simply keeps the less efficient design in place and accepts a higher operating expense than was budgeted for the project.

4. INBOUND VERSUS OUTBOUND

During the design process, much time and energy of the team is focused on designing the outbound distribution processes: picking, packing, and shipping. To some degree this is appropriate, as the outbound processes are usually the most labor-intense and time sensitive parts of the operation. However, this focus often takes attention away from the inbound processes of receiving, put-away, and bin replenishment, which are ultimately just as vital to the successful operation of the system. Balancing the right level of attention to both inbound and outbound flow can often be a challenge under the high pressure of the design process.

5. THERE ARE NO "STANDARD SYSTEMS"

Distribution centers differ greatly from one to the next, even within the same industry. Product handling characteristics differ, sales channels and order profiles may vary, and volumes may be greater or lesser from one site to the next. Companies often have varying philosophies on the use of automation, customer service requirements can differ, and organizations can have diverse approaches to accounting for inventory carrying costs. As a result, every automated material handling system must be designed starting with a blank sheet of paper and no prior assumptions. It is often the tendency of design engineers to assume that a distribution center will function similarly to those they have encountered in the past, and to make subtle assumptions which may be invalid and can have a big impact on the design of the system.



6. THE DETAILS ARE TEDIOUS

With storage and handling equipment, tedious details can make or break a system. Realistically, every single item that is stored in the system must have a dimensional and velocity analysis performed on it to determine the optimal storage medium and slotting plan for it. Many times, at the start of the project, the dimensional and other data may not exist to perform this level of analysis. A company may perform an initial conceptual design based upon more general data, which can be sufficient for the early project objectives (such as gaining executive approval and selecting vendors). The company may plan to gather the more detailed data as the project unfolds and have it ready in time to perform final engineering a few months later. Too often though, the project focus shifts to other more urgent matters, and the all-important master data update either never happens, or is rushed and results in hidden icebergs in the form of data errors. Shortcutting the data modeling process can appear to save time in the design cycle but can result in severe storage and throughput issues during implementation.



7. LACK OF STAFF EXPERIENCE

Implementing automated material handling systems is a highly specialized discipline. Many companies may not have any staff members who have participated in these kinds of projects in the past. This lack of subject matter expertise can cause the team to underestimate the difficulty of the initiative and fail to ask the right questions when evaluating vendors and partners. It can place the company in a position of over-dependence on vendor experts whose interests may not be fully aligned with those of the company purchasing the system.

8. EVERY DAY IS A SNOWFLAKE

In the past, when retail stores acted as a buffer between the distribution center and raw consumer demand, it was somewhat easier to plan workflow in advance and level-load resources over a period of time. For example, an apparel manufacturer might receive retail orders several weeks before they

must be picked and shipped, allowing the work to be spread out and each day's work to be planned a day or more in advance for maximum efficiency in the fulfillment process. Now, with the rise of e-commerce, the same distribution center must often pick, pack, and ship orders the same day that an order is placed, leaving little time for workflow planning and labor scheduling.

Most distribution centers must fulfill a wide range of order profiles that are drawn from different SKU sets, have varying numbers of lines, varying handling characteristics, varying requirements for value-added services, and different levels of urgency. The volumes of each order profile, which must be fulfilled on a given day, dictate the execution tactics that must be used. Each day is different from the one before in ways that won't be known until the day arrives, meaning that automated systems must be highly flexible and adaptive.

9. FLOW ANALYSIS IS COMPLICATED

Many automated warehousing systems involve conveying a wide range of items at a high rate of speed through complex travel paths that include rapid diverting, routing, sorting, merging, and accumulating. It can be very difficult to analyze these complex patterns of flow using conventional tools like spreadsheets, especially given the "every day is a snowflake" dynamic noted earlier. Failing to properly analyze flow can lead to system bottlenecks, backups, and labor imbalances in the operation.

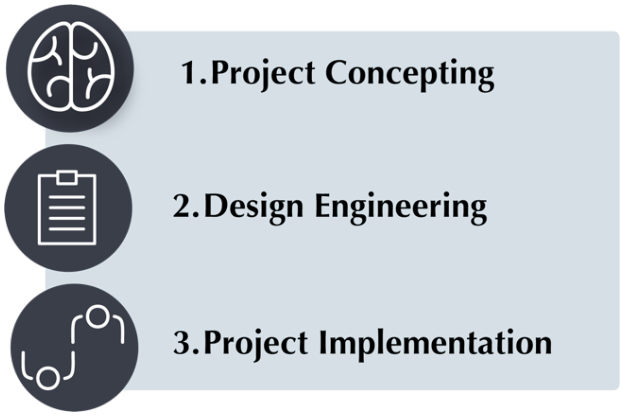
10. NOT EVERYONE CAN DRIVE A FERRARI

To build on the previous point, even if the design and installation of the automated system go exactly as planned, operating the system on a day-to-day basis can present real challenges. Daily, and often hourly, decisions must be made about which orders to release to the system and in what groups. Labor must be allocated to different areas of the operation based the day's order volumes and profiles and must be dynamically re-allocated throughout the day to prevent imbalances from developing.

Careful attention must be given to replenishing forward pick areas to ensure that pickers are not waiting for product to arrive. The company must be able to build groups of orders which can be released to the material handling system together in ways that will allow those orders to flow smoothly through the mechanical and human aspects of the order fulfillment system. In the same way that you wouldn't hand a new driver 16-year-old the keys to a Ferrari, it is unrealistic to expect that a warehouse team, whose only basis of experience is operating in a non-automated facility, will suddenly be able to use a sophisticated material handling system effectively.

WAYS TO BEAT MURPHY'S LAW

Despite these challenges however, it *is* possible to beat Murphy's Law during warehouse automation projects as numerous companies have discovered. Projects can typically be divided into three key phases:



Many companies have focused on ways that they can best control "the unknown" during the implementation phase, only to discover that the best opportunities to minimize the impact of Murphy's Law existed many months before in earlier project phases.

This paper will focus on how companies can beat Murphy's Law in the phases of (1) Project Concepting and (2) Design Engineering.

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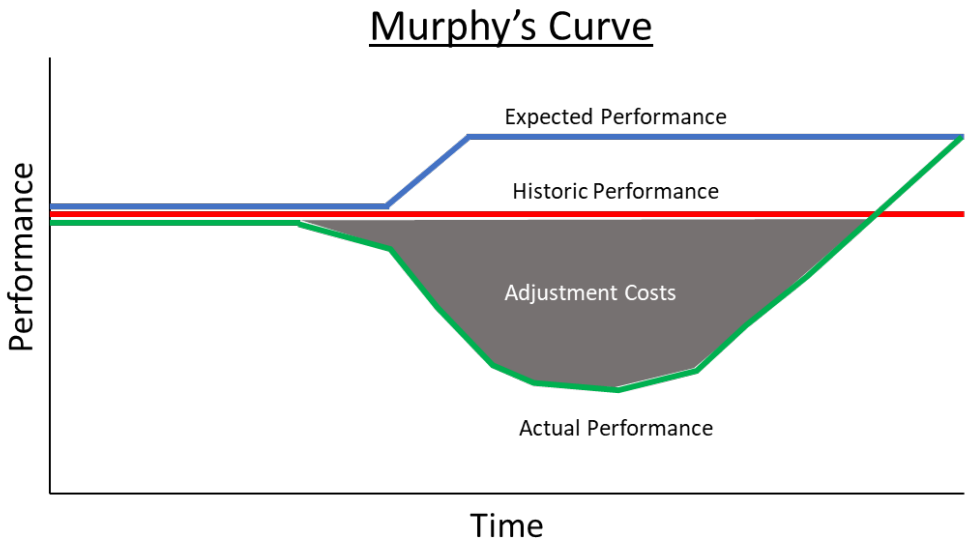
LEARNING FROM MURPHY'S CURVE

Ensuring a project survives Murphy's Law begins with understanding "Murphy's Curve", a key concept. In 1991, a seminal work was published in MIT's *Sloane Management Review* called "Beating Murphy's Law," authored by W. Bruce Chew, Dorothy Leonard-Barton and Roger E. Bohn. The article described a principal that the authors termed "Murphy's Curve" (figure x), which illustrates the gap that often exists between expected results and actual results on projects. Murphy's Curve highlights a key observation:

Unrealistic expectations doom many projects to failure before they begin.

The reality is that even with successful projects, there is almost always a period of decreased performance which begins before the go-live. It can last for an extended period while the operations staff adjusts to the new processes and technology and while bugs are worked out of the system. With a well-planned and well-run project, this adjustment period is short, and performance begins to improve over time, eventually surpassing the pre-deployment levels and achieving the gains that were the rationale for the project. However, many companies gloss over this reality and expect that after deploying new technology they will see an immediate and sustained performance improvement. The variation between expected and actual results can be significant, as figure x indicates.

FIGURE X: MURPHY'S CURVE



Source: Beating Murphy's Law; MIT Sloane Management Review, April 15, 1991; W. Bruce Chew, Dorothy Leonard-Barton and Roger E. Bohn

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Beating Murphy's Law begins with an acknowledgement that Murphy's Curve can, and will, be present in every operations improvement project to some degree. The following section will explore ways to lessen the impact of Murphy's Curve in the Project Concepting Phase.

PHASE 1: PROJECT CONCEPTING

As discussed earlier, the seeds of success or failure during implementation are usually sown during the Project Concepting phase. This crucial phase can often begin a year or two before the new system goes live, and frequently involves some of the following steps:

- Identifying the problem
- Evaluating a broad range of possible solutions
- Choosing a design concept
- Estimating the business case and return on investment if the solution is deployed
- Obtaining executive approval for the project

This section describes ways that companies can get ahead of Murphy's Law early in the project and better position themselves for a deployment that meets or exceeds expectations.

DON'T ASK THE BARBER IF YOU NEED A HAIRCUT

Why is Murphy's Curve such a surprise to so many companies? In other words, why do organizations embark on projects with such unrealistic expectations for achieving rapid performance gains? The reasons likely differ in each case, but being "over-sold" on a return-on-investment (ROI) projection by less-than-objective sources is often at the heart of the matter. Executives reviewing a business case for a capital project would do well to ask themselves whether those preparing the figures have any incentives to present an overly optimistic picture, either intentionally or unintentionally. It may be that the underlying business case was developed by an equipment provider who stands to benefit if the technology is adopted, and who may choose to ignore the potential Murphy's Curve of temporary productivity losses.



In another scenario, the business case may have been developed by company employees who may be desperate for the relief they believe the technology will provide, but too inexperienced to understand the trough of productivity that will inevitably occur before the benefits are realized. In either case, very few

companies appear to account for "Murphy's Curve" in any meaningful way during the project concepting phase. While some may acknowledge that there may be a learning curve associated with new technology, most seem to believe that the curve will be short, and performance will never be worse than the present (pre-go-live) levels. Very few companies actually build-in an increase in operating expenses to the project budget to account for Murphy's Curve. As a result, executives embark on the initiative with an inaccurate view of what could unfold.

PERFORM A RISK ASSESSMENT

A good first step towards accounting for Murphy's Curve is to perform a risk assessment on each of the potential solution scenarios being considered. Often**, the technology that holds the greatest promise of cost savings can also involve the greatest risk of failure**. Certain forms of warehouse automation may be very unforgiving of minor design flaws or changing business conditions, while other technologies may be more flexible and adaptable to these forms of change. Other technologies may seem promising but may be relatively new and untested in the marketplace. Companies seeking aggressive cost savings can often be blind to the risks inherent in some technologies. A thorough risk assessment can be an effective way to highlight these risks and impact the choice of design and technology early in the project.

To perform a risk assessment, start by identifying the specific risks which are present on the project. Examples of risks to account for include:

- **Risk of short-term operating cost increases at startup (Murphy's Curve)**
- **Risk of sustained operating cost increases due to design flaws that cannot easily be corrected**
- **Risk of short-term service level reductions at startup**
- **Risk of sustained service level inefficiencies due to design flaws that cannot easily be corrected**
- **Risk of system interface/integration issues**
- **Risk of software bugs or flaws**
- **Risk of project cost overruns**
- **Risk of delayed implementation**
- **Risk that the solution is not flexible or scalable enough to meet future business needs**

Next, assign each risk a weight factor based upon your company's tolerance for risk in this area. For example, the company may be relatively unconcerned with the risk of cost overruns compared to

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the risk of the project not going live on time, prior to a peak demand period. These two risks should be weighted differently.

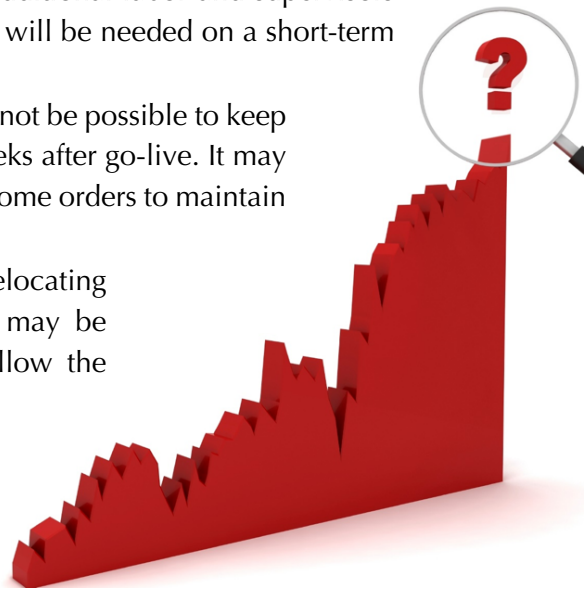
Lastly, give each potential solution scenario a numeric rating for each of the risk areas (a low score represents low risk, a high score represents high risk). Multiply this rating by the weighting factor to achieve a weighted risk score for each solution scenario. It may be discovered that certain solutions that offer the highest potential for labor savings may also have the highest risk of cost or schedule overruns. As a result, the company may choose a solution that is less automated, but less risky, or may choose to proceed with the riskier technology and build in contingency factors for cost and time overruns.

EXPECT THE UNEXPECTED (AND BUDGET FOR IT!)

A key tactic to avoid disappointing project results is to explain the concept of Murphy's curve to the executive team and financially account for the inevitable drop in productivity during implementation. Plan for Murphy's Curve. Build it into the project ROI model through a solid risk mitigation plan.

Some key cost increases which often occur during the Murphy's Curve period at project startup include:

- ***Temporary labor costs:*** Often more labor will be required in the weeks (or months) following the technology deployment. Workers must become acclimated to the new processes and technology, and productivity rates will almost certainly suffer at first. Additionally, managers must get used to different ways of releasing work into the new system to be able to balance labor and workflow across the operation. It is rare to get this right the first time, even with sophisticated warehouse control software (WCS) systems. Additional labor and supervisors will likely be required, and perhaps even an additional shift will be needed on a short-term basis.
- ***Expedited shipping costs:*** Even with additional labor, it may not be possible to keep up with outbound order volumes in the first few days or weeks after go-live. It may be necessary to subsidize the cost of expedited shipping on some orders to maintain customer service levels.
- ***Additional inventory carrying costs:*** If the project involves relocating the distribution center from one site to another, then it may be necessary to purchase additional inventory in order to allow the facilities to operate in parallel for a brief period.



- ***Unknown costs – contingency factors:*** Additional costs for labor, shipping, and inventory represent only the "known" areas where overruns can be expected. Each project inevitably contains unexpected, "unknown" costs that present themselves once the project begins. These unknown events are what often come to mind when the phrase "Murphy's Law" is used – anything that can go wrong often does go wrong. A few real-life examples of unplanned-for events plaguing warehouse automation projects include:
    - A company that was expanding its distribution center discovered that the incorrect sprinkler heads were used when the building was constructed many years before and was forced by the local fire marshal to upgrade the entire sprinkler system in both the existing and new portions of the building.
    - A company that was constructing a new distribution center encountered a period of unseasonably bad weather, which severely delayed the foundation work and set the entire project behind.
    - A company that was installing new pallet racking in California was unable to find a certified slab drawing of the building they had moved into and was forced to have core samples taken for the seismic analysis after weeks of searching for the drawings.

In each of the above (true) examples, the problems that befell the project were difficult to anticipate, but resulted in both time and cost overruns. Adding a certain percentage of contingency time and cost to the project budget is the only way to ensure that the budget can withstand some of these unexpected manifestations of Murphy's Law.

The above costs should be estimated as accurately as possible and included as project costs in the accounting model. While doing so will almost certainly increase the payback period for the technology, failing to account for these factors will result in a return-on-investment projection that is incorrect. If the project will not meet the corporate ROI guidelines once the additional costs from Murphy's Curve have been factored in, then perhaps the rationale for the doing the project in the first place should be reconsidered. Don't fall prey to thinking that the current project will be the exception to the rule. **Remember, the productivity drop from Murphy's Curve occurs *even if everything goes according to plan*.** There is an inevitable adjustment period as operators and managers get used to using new technology, which will result in loss of efficiency even in the best of deployments.

MANAGE THE CALENDAR

Many companies set themselves up for failure early on by committing to an unmovable deadline for completing the project. The most common reasons for this are:

- ***Facility exits:*** The timeline is based around a date when the company must exit an existing facility
- ***Seasonality:*** The timeline is based on the need to have the system operational in time for a peak period (often around the Christmas holiday season).
- ***3PL contract expiration:*** The timeline is based on transitioning away from a third-party logistics provider on a certain date.

The deadline may be set far enough in advance that the company believes it is easily attainable. Then, Murphy's Law begins to play out, and the timeline is extended by unforeseen circumstances. Faced with the seemingly unmovable deadline, the company then marches inexorably towards a go-live date that becomes more and more risky with each passing day. Executives issue ultimatums. Project managers are offered carrots or threatened with sticks based on achieving the timetable. Key stakeholders feel increasing pressure to "launch the boat" while workers are still patching up holes in the hull.

All of these pressures often cause the project leaders to decide to move forward with the go-live, even though all the indications are that the technology is not yet fully tested and ready, sometimes with catastrophic results. Executives may fear the impact of a delayed launch, but are blind to the far greater consequences of a premature, failed launch (remember, it's too late to bring the boat back to the shipyard after it's sunk to the bottom of the harbor!).



It's too late to bring the boat back to the shipyard after it's sunk to the bottom of the harbor.

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So, what can be done to resist this pressure for a premature go-live?

- ***Estimate the timetable accurately:*** To begin with, project planners should research the actual time it will take to complete the project.
- ***Don't ignore design and vendor selection time:*** Companies often under-estimate the time it will take to fully design the system and conduct a thorough vendor selection process (these two steps alone can take six months or more on complex material handling systems).
- ***Approvals always take longer than expected*:** Executive approvals for capital-intense warehouse automation projects are rarely obtained in a matter of days, even at small companies with streamlined decision-making processes. Obtaining capital request approvals, negotiating details of contracts, and performing legal reviews can take weeks or months- not days. This process is often repeated multiple times: once for the overall project budget approval and again each time large vendor contracts are to be executed. Time for this should be built into the timetable from the beginning.
- ***Manufacturing lead times can change*:** In busier economic periods, manufacturing lead times can be much longer than in slower times. Don't assume that vendors can manufacture equipment as quickly as they may have done during the last project you worked on. Get updated manufacturing time estimates prior to presenting any project timetable to the management team.
- ***Add contingency time:*** Remember, it is usually difficult or impossible to anticipate when Murphy's Law will strike. Add contingency time to the project schedule, even if the weather seems good and it looks like clear sailing ahead.
- ***Have a backup plan to extend the deadline:*** In most of the scenarios cited above (facility exits, peak periods, 3PL contract expirations), the deadline is often not truly "unmovable". Lease extensions can be negotiated, penalty clauses can be enacted and paid, overflow facilities and temporary labor can be hired to survive peak periods, and 3PL contracts can be renegotiated. While all of these alternatives can be costly, they may be vastly less expensive than having a failed project with product unable to ship. Additionally, if the backup plan is developed early enough, it may be possible to negotiate more favorable terms than if the discussions are held at the last minute under emergency circumstances.

SPECIAL CONSIDERATIONS FOR SMALL COMPANIES

Approvals take time, even at small companies:

- Don't assume that project approvals will be as easy as getting the business owner to sign on the proverbial dotted line.
- Smaller companies often have more capital limitations and may need to take on debt to finance a project. Bank approvals can be time consuming.
- Smaller business owners may have less robust internal resources and may be more inclined to get a "second opinion" from an external source.
- Smaller companies may be more risk averse. This can slow down the process, as business owners need more time to get comfortable with the project risks.

DON'T LAUNCH THE SHIP IN A HURRICANE

Many companies make the mistake of going live with a new project either during - or immediately before - a peak demand period. For companies in the retail or consumer goods sector, each year can bring greater seasonal surges as consumers increasingly align buying habits around "Black Friday" or "Cyber Monday" promotions during the year-end holidays. These events can mean demand surges of more than ten times normal volumes. While companies may view the new system as vital to helping the company survive the next busy season, deploying poorly tested technology at the height of the busy season is a recipe for a shipwreck.



*To avoid this, companies should plan to deploy new warehouse automation as far **in advance of the peak period** as possible and **have a contingency plan in place** if the project is delayed (as noted previously).*

It may be possible to rent additional space where orders can be manually picked for a period of time during the busy season, using temporary workers. This option may not be inexpensive, but it is likely preferable to being forced to go-live with an unready system.

Ultimately, the company should make an honest "go/no go" decision well in advance of the busy season and have a "Plan B" to delay the go-live until after the busy season, if needed.

IMPLEMENT IN PHASES

Depending on the nature of the design, it may be possible to implement project in phases, rather than all at once. This is especially true if the project involves relocation to a new distribution center. If there is more space available than is necessary on day-one, it may be possible to relocate the operation to the new building and initially begin filling orders using manual processes. Then, once the company has settled into the new site and new employees have been trained and are proficient, the more automated phases of the technology can be installed. Another way to deploy in phases involves installing all of the new technology but using more basic pick methodologies at first until the technology stabilizes and workers get familiar with new processes. For example, workers might

initially only pick one order at a time before later transitioning into a more complex cluster picking process.

In either example, while some of the full benefits of the new technology may be slightly delayed, the risk of the organization choking on too much change, too fast, is greatly reduced.

VALUE EXPERIENCE

While it may be impossible to forecast everything that could go wrong on a project, experienced project leaders, who have implemented similar technology numerous times before, can usually do a better job of anticipating the likely problem areas than can individuals who are working on their first project of this kind. Veterans are far less likely to minimize the risks of going live too soon and can often temper the desire to finish "on time" with the need for the system to work properly.



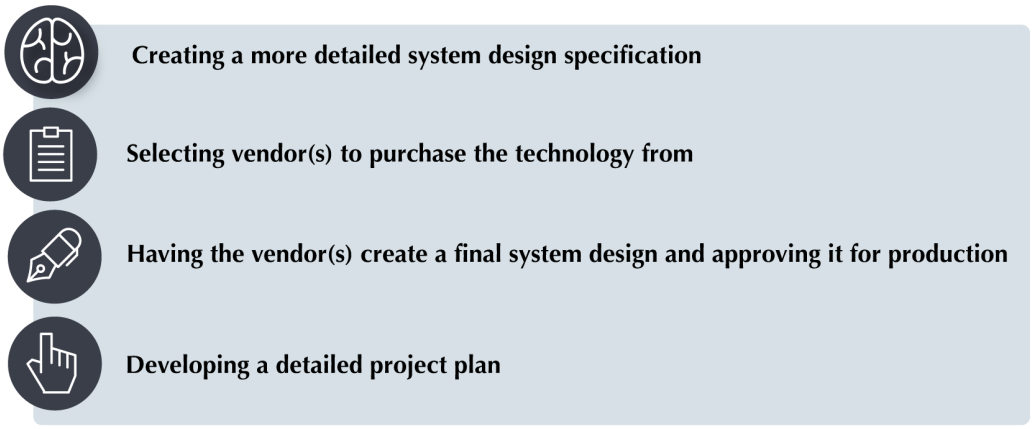
The value of having a project leader who has implemented similar technology many times in the past cannot be overstated.

It may be possible to hire such a resource as a company employee and have that individual then transition to an operational role once the project is over. Some companies have found that it is more practical to use an external consultant in this role. Many consultants have transitioned from one warehouse automation project to the next over a period of two to three decades, giving them vastly more project experience than an operations leader who may have only gone through the warehouse automation cycle a few times. **Automation consultants can bring targeted experience to the project during a defined period without having to stay on the payroll once the system is running and stabilized.**

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PHASE 2: DESIGN ENGINEERING

The Design Engineering phase typically begins after the project budget has been approved and ends when a final design from specific vendor(s) has been created and approved. Key steps that generally take place during this phase include:



This section discusses ways that companies can continue the best practices from the Project Concepting phase and further increase their chances of beating Murphy's Law.

SELECT PARTNERS WISELY

The best designs and project plans can still fail in the hands of the wrong. Companies do well to conduct a thorough vendor selection process to ensure that the companies they partner with are those best equipped to meet their needs.

Some key mistakes companies often make when it comes to vendor selection include:

- ***Love at first sight:*** Some companies irrationally latch on to certain technologies, which they may have seen at trade shows or site tours, believing it must be the right choice for their company absent of any objective evidence. Many of the forms of warehouse automation in use today can be impressive to observe and have in fact transformed many operations for the better. But, as pointed out in earlier sections, each distribution center is a unique "snowflake" with specific requirements that differ from other sites. Technology that works well in one distribution center may be the wrong choice for another facility – even one in

the same industry. There is no substitute for an objective design process based on empirical data modeling and broad perspective on the solutions that actually work in the real world.

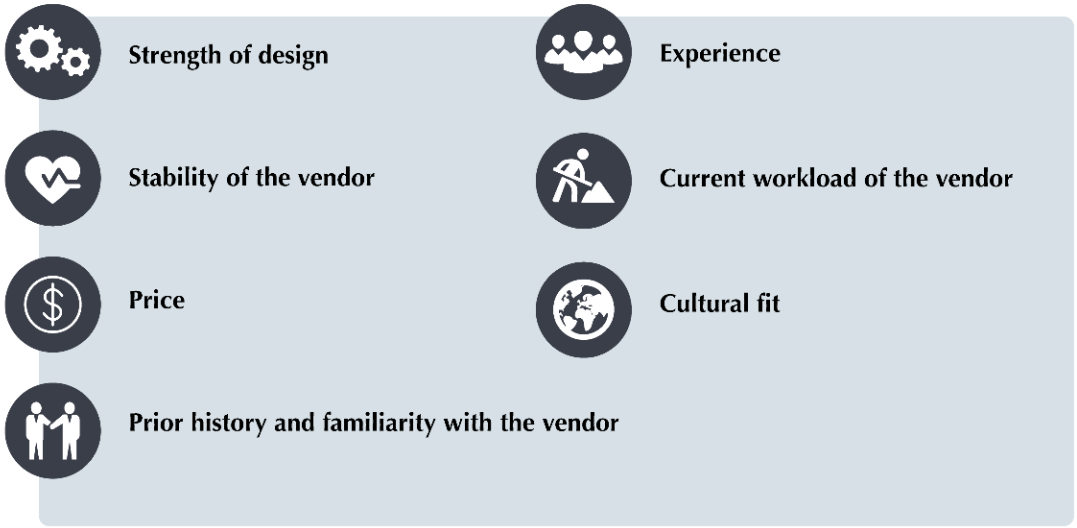
- ***The lowest price wins:*** Companies are right to seek competitive pricing from their vendor partners, but many make the mistake of prioritizing price above all else. This may be a valid strategy for less automated solutions, such as static storage equipment and vehicle-based picking systems, where the products in question have become commoditized. In these cases, product designs are often fairly standard and minimal custom-engineering must take place. Simpler equipment can often be well-described in detailed functional specifications, and if bidders adhere to these specifications, then a strong case can be made that the lowest-price vendor should be awarded the contract. However, for more complex systems, the lowest price vendor may not always be the best choice. When systems are highly complex and difficult to fully describe in a written specification, then there is often a large potential for vendors to cut corners in ways that are not initially evident.

  Additionally, the success of complex automated systems often lies in the ability of the vendor to understand the unique operational requirements and engineer a custom solution for the client.

  Often, the low-price bidder may not have invested as heavily in their engineering staff or quoted the same number of man-hours as other bidders who have taken a more thorough approach. Many times, by over-emphasizing price as a decision criterion, companies unwittingly pressure even responsible vendors to cut corners and omit key design features, which may prove critical to the success of the system. Often, a low price that seems too good to be true can mean the vendor has under-staffed the project, and the customer can be forced to take on a larger share of project implementation responsibilities than they are able to easily handle. Key implementation responsibilities may be forced on the customer's internal staff, who may or may not be prepared to play these enhanced roles. Companies should instead take a balanced view where system price is one of several design criteria, and not necessarily the most important one.

- ***The familiar company wins:*** Many companies make the mistake of using a vendor that may be familiar to them, but not well qualified to undertake the present project. Certainly, there is value to working with partners who have a solid, proven track record of executing on past projects. However, companies do well to ask themselves whether they have taken an honest look at the "familiar" company's qualifications and track record of designing and implementing the specific technology in question, for the current initiative.

Companies implementing warehouse automation should instead take a well-rounded approach and conduct a thorough request for proposal (RFP) process that evaluates the following criteria:



SPEND "SMART MONEY" TO MITIGATE RISK

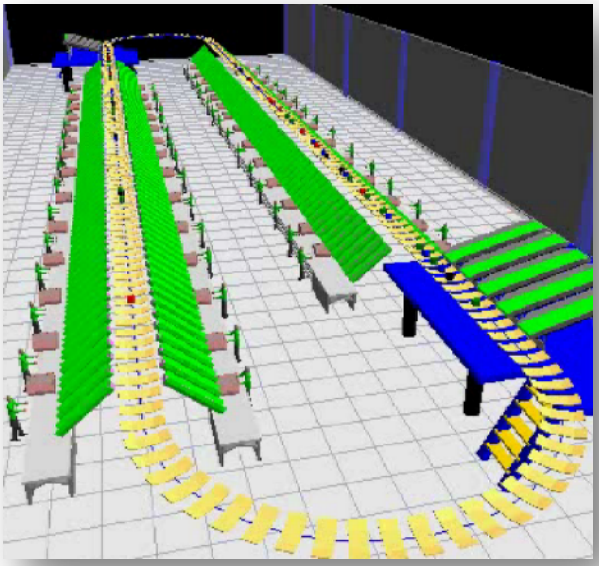
While Murphy's Curve cannot be entirely eliminated, having the "right" design to begin with can be a major step towards ensuring that the curve is shallow and short. In most cases, the system design is only truly finalized once a vendor is chosen, and that vendor performs their internal detailed design engineering process. When this design is complete, the company purchasing the system is presented with a set of drawings and design specifications to approve for production. So how does the purchaser know that the vendor's design is "right"?

Reviewing the design parameters and rationale is a good first step toward understanding the system's capabilities and the vendors line of reasoning when developing the design. In simpler systems, reviewing these data models in spreadsheets may be sufficient to ensure that the design will meet the operational needs. However, in more complex systems, it may not be possible to thoroughly model all of the ways in which the system will operate using even the most sophisticated of spreadsheets.

For these more complex designs, companies do well to consider investing in two key technologies which can help ensure that the design is truly optimized around their business needs: simulation technology and slotting software.

SYSTEM SIMULATION

Simulation software differs from other forms of data modeling in some significant ways. Simulation software allows actual material handling equipment to be built with defined performance parameters and logic models, which simulate the decisions that are made by the controls software as various inputs are received. Graphical layouts are created which show what the equipment looks like in 3D renderings. Both mechanical as well as human work rates can be defined and modeled. A material handling system can be virtually "built", and the software can simulate the picking, packing, and shipping of actual sales orders both by human and mechanized processes. Some of the key questions that simulation software can often answer include:



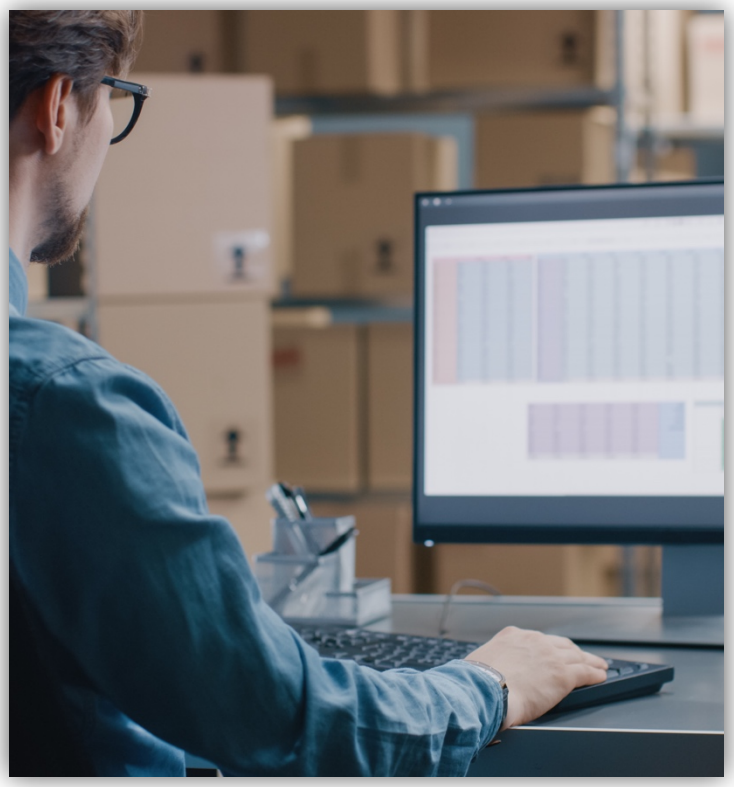
- How will the system respond if last Wednesday's sales orders were processed through it?
- How would the system respond if the orders from the busiest day last year were processed through it?
- What bottlenecks exist in the system?
- What would happen if a key component in the system failed?
- What if we grouped orders in batches like this? How quickly can the system process them?
- If we don't have the labor perfectly balanced across zones, what level of labor imbalance will make the system choke?
- What happens if the shipping area falls behind for "x" minutes? At what point does the system back up and shut down the picking area?
- Will it be possible to replenish the system quickly enough without interfering with picking?
- What if the average lines per order drops from three to two? How will this impact the system throughput?

In complex material handling systems, simulations can identify design flaws in ways that no other modeling tools can. Unfortunately, simulations can be very costly and time-consuming to build. Many companies choose not to have a simulation performed in an effort to save money or preserve the project timetable. However, buyers would do well to consider the time and cost of rectifying a design flaw after a system has been built and installed.

Sometimes companies choose to have their material handling equipment provider perform a simulation of the system. However, purchasers should consider that equipment providers are not always the best source for this form of critical design validation. It can often be more effective to have an independent, third party perform the simulation, if for no other reason than to review the design with a "fresh set of eyes". Many independent consulting firms can perform material handling simulations free from any desire to sell equipment, or any pride of authorship in the design, which could inadvertently bias the results.

SLOTTING SOFTWARE

Another key design area that can cause problems with material handling system implementations is that of bin slotting: determining the optimal location for each SKU in the system. There are two basic approaches which can be taken to bin slotting: (a) using spreadsheet-based tools, and (b) using commercially developed, specialized slotting software. Each approach can be effective in certain situations.



Spreadsheet tools can often be used to perform very accurate bin sizing. This step is crucial as the final storage mediums are designed, and shelf spacings are set during implementation. Improper bin sizing can result in bins which are too large (creating wasted space and excessive travel), or too small (creating product overflows and excessive replenishment labor). Incorrect bin sizing is usually caused by either (a) faulty master data, or (b) shortcomings in the calculation methodology. Errors in master data can often be caught by having individuals who are knowledgeable of the business review the data, investigate outlying data points with a critical eye, and look for results which do not intuitively seem right. Conversely, errors in calculation methodology can often be remedied by having individuals experienced in slotting processes create the slotting tool using proven methods.

Many companies have found it beneficial to utilize a commercial slotting software system. Commercial slotting tools surpass the capabilities of spreadsheets in a number of ways:

- Pre-coded calculations and rules that have been battle-tested in numerous applications
- Ability to perform more complex slotting using multiple criteria, including:
    - Sales velocity
    - SKU affinity
    - Family groupings
    - Segregation rules
- Ability to interface directly with a WMS system to trigger product moves and manage directed put-away

While commercial slotting tools are not inexpensive, they can often prove to be a wise investment. In the chaos of a system implementation, it can be difficult to rapidly correct slotting mistakes on the fly; far better to avoid making them to begin with by investing in a rigorous slotting program from day one.

DON'T FORGET INBOUND PROCESSES

As pointed out in a preceding section, the outbound processes of picking, packing, and shipping often receive a disproportionate degree of attention during the design process, to the exclusion of inbound processes like receiving, put-away, and bin replenishment. Companies often reason that because failure to ship product can put them out of business quickly, all resources must be focused on this area, and that somehow the replenishment process will "figure itself out".

While it is true that problems with outbound processes can negatively impact the operation in immediate and direct ways (orders don't ship), inbound problems may be slower to manifest themselves, but every bit as serious to the operation. Many material handling systems appear to go live successfully at first, with just "a few minor problems" putting away product and



Matrix content from Stephen Covey's
Seven Habits of Highly Successful People

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replenishing the forward pick areas. However, as these "minor problems" build up, they can eventually cripple an operation over time as each day, more and more pickers arrive at bins that do not have enough product to fill their orders. More and more labor must be dedicated to getting product in the right pick faces, or inefficiently performing picks from reserve locations. Often, when trying to quickly stock bins to get product out the door, workers may take short-cuts and make product moves without taking the time to record them in the WMS system. This creates another insidious problem as inventory accuracy begins to drop, making the WMS incrementally less able to effectively trigger replenishment tasks. The impact of inbound flow problems is less immediate, but just as consequential as outbound problems.

This inattention to inbound processes is a classic case of failing to focus on areas of the design that are "important, but not urgent," known as the "Quadrant 2" tasks, a term coined by author Stephen Covey in *The Seven Habits of Highly Effective People*. If "important, but not urgent" areas are ignored long enough, they become critically urgent and can potentially sink a project.

The remedy to this situation is to insist on rigorous design and discussion around the receiving, put-away, replenishment, and slotting processes at all design meetings.

THE RULES FOR SYSTEM-DIRECTED PUT-AWAY MUST BE THOROUGHLY DEFINED

- How will the WMS or WCS know if newly arrived product will be able to fit in the desired bin location?
- Will bins that already contain product be "topped-off", or should new product always be put in empty bins only?
- If newly-arrived product is put-away in overstock locations as a rule, what should happen if the forward pick location is empty? Should new products be put there, first?
- How will the WMS system manage these rules and execute this strategy?

ATTENTION SHOULD ALSO BE GIVEN TO BIN REPLENISHMENT

- What will be the replenishment triggers?
- Will minimum and maximum stocking levels be defined for each product in each forward pick bin?
- How precise will these rules be?
- What happens if a SKU is re-slotted in a different forward-pick storage medium?
- How will the min/max quantities be calculated?
- What will be the specific trigger for min/max bin replenishment?

- Will the trigger occur as soon as an allocated product depletes a bin below the minimum level?
- Can bins be proactively replenished prior to product being allocated and waved to orders?
- Will pickers only be sent to bins when it is known that there is sufficient product to fill the demand (to avoid a random, first come/first served allocation in short stock situations)?
- What will happen if a replenishment takes place before the bin is depleted and the newly arrived product will not fit in the bin? Where will the product be placed? Can a certain percentage of bins be intentionally left empty to accommodate these situations?
- How much labor will be required to replenish bins each day?
- How much additional labor will be required to get through the "Murphy's Curve" period of reduced productivity?
- Has this labor been obtained and trained?
- How will replenishment tasks be measured and managed-to, each day?

SLOTTING RULES AND DATA INTEGRITY ARE ALSO KEY TOPICS TO ADDRESS

- What rules will used to slot the forward pick locations?
- Will slotting be based upon sales velocity, SKU affinity, segregation, family groupings, or other criteria?
- What system will manage these rules and suggest the optimal bin location for each SKU?
- How will this information be relayed to the WMS or WCS during put-away and replenishment tasks?
- What will be done to remediate data errors as they are encountered?
- If a replenishment worker is unable to fit all the product in the bin as expected, is there a defined resolution path where the situation can be investigated, and can corrections be made to master data expeditiously?

By giving thorough attention to these and other issues during the Design Engineering period, companies can help ensure a harmonious flow of materials in the distribution center in both inbound and outbound directions.

OVER-TRAIN

When it comes to operator training, there's no such thing as too much. It can be inconvenient and costly to take operators away from their duties to train them on new processes, but it is important to remember that training *will* happen – it will either be in a controlled fashion, ahead of the deployment, or chaotically in the heat of the go-live.

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Project leaders and engineers may find it easy to under-estimate the degree to which new processes and technology must be clearly laid out to the those who must actually use them. The key project stakeholders may have been living and breathing these changes for over a year prior to deployment, as new processes are designed, built, and tested. However, the system operators are frequently only exposed to the new processes in the immediate lead-up to the implementation. It may take them longer than expected to embrace the new ways of working, and they may not readily admit when they do not understand aspects of the new workflows. Murphy's Curve cannot be eliminated, but relentlessly training, testing, and re-training can make it as shallow and short as possible.

AGREE ON THE DEFINITION OF "SUCCESS"

The old metaphor of "the operation was a success, but the patient died" is an apt analogy to describe how the definition of "success" may be different for the doctor than for the patient. The same principal can apply to warehouse automation projects. For companies installing new technology, their definition of successful project likely involves enterprise-level measures such as whether the company was able to ship orders faster, at a lower cost, and without interruption during the implementation. It may surprise these companies to learn that the vendor partners they are working with may not define success the same way. To an automation vendor, "success" may simply mean that the technology was able to perform a series of operations on a checklist after it was turned on. Like the physician in the earlier example, the technology vendor may be oblivious to the fact that the operation can still "die" even if the individual system components perform according to a specification.

Getting all project stakeholders aligned around a single definition of success early in the initiative can impress on all participants that they need to think in terms of how the technology will be able to improve the operation. When design engineers take off the blinders and begin connecting the functioning of the technology with the ways in which it is to be used, they can potentially suggest design improvements or be more alert to design flaws early in the project, to the benefit of all involved.



IN CONCLUSION

As noted at the outset, Murphy's Law will affect all warehouse automation projects. But with proper planning, companies can minimize its impact and ensure that the project still meets its original design objectives. By having patience and discipline in the early phases of the project, organizations can lay the groundwork for effective implementations which are remembered long afterwards – not for the temporary impact of Murphy's Law, but for the transformative effect on their supply chains.



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ADDITIONAL RESOURCES

White Paper: *Six Tips to Avoid a Failed WMS Implementation*

White Paper: *Five Ways to Meet the Challenges of E-Commerce Distribution*

White Paper: *Six Ways to Postpone – or Eliminate - Your Distribution Center Expansion*

White Paper: *The Picking Playbook*

White Paper: *The Packing Playbook*

White Paper: *Distribution Center Design Series – Part I: Developing a Storage Design Tool*

White Paper: *Distribution Center Design Series – Part II: Developing a Throughput Design Tool and Determining a Pick Strategy*

White Paper: *How to Choose the Right WMS - Part I: Distribution Center Process Optimization*

White Paper: *The Ultimate WMS Preparation Guidebook*

White Paper: *Selecting the Right WMS*

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Mr. Hobkirk is the founder and President of Commonwealth Supply Chain Advisors. Over his career, he has helped hundreds of companies reduce their distribution labor costs, improve space utilization, and meet their customer service objectives. He has formed supply chain consulting organizations for two different systems integration firms and managed the supply chain execution practice at The Aberdeen Group, a leading technology analyst firm. Mr. Hobkirk has authored dozens of white papers on supply chain topics, and his opinions have been featured in publications such as DC Velocity, Modern Materials Handling, Supply Chain Management Review, The Journal of Commerce and The Wall Street Journal.



KEVIN THUET

Mr. Thuet is a Senior Supply Chain Professional and Consultant with over 28 years of experience in Manufacturing and Distribution Center Design. Over his career, he has designed over 400 facilities for companies such as: Nike, GAP, Ralph Lauren, Columbia Sportswear, Motorola, Walmart, USPS, Excel Beef, HP, Houghton Mifflin, Canon, Sony, Keystone Foods, SGS Thompson, Medtronic, Sigma Aldrich, and others. Mr. Thuet has been awarded 2 US Patents on Automated Material Handling Equipment Designs. He has published over 30 articles on quality, manufacturing, and distribution in national publications, in addition to receiving the Who's Who for professional management three years in a row.

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HOW CAN COMMONWEALTH HELP?

Commonwealth Supply Chain Advisors is a leading supply chain consulting firm that helps companies of all sizes optimize their supply chain networks, design distribution centers, and select and implement Warehouse Management Software (WMS). Commonwealth has offices in Boston and Cincinnati. Every year since 2013, Commonwealth has been named a "Top 100" supply chain partner by Supply Chain Brain publication. Commonwealth's insights are widely respected and regularly published in journals such as Supply Chain Management Review, Supply Chain Quarterly, and The Wall Street Journal. For more information, visit www.commonwealth-sca.com



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