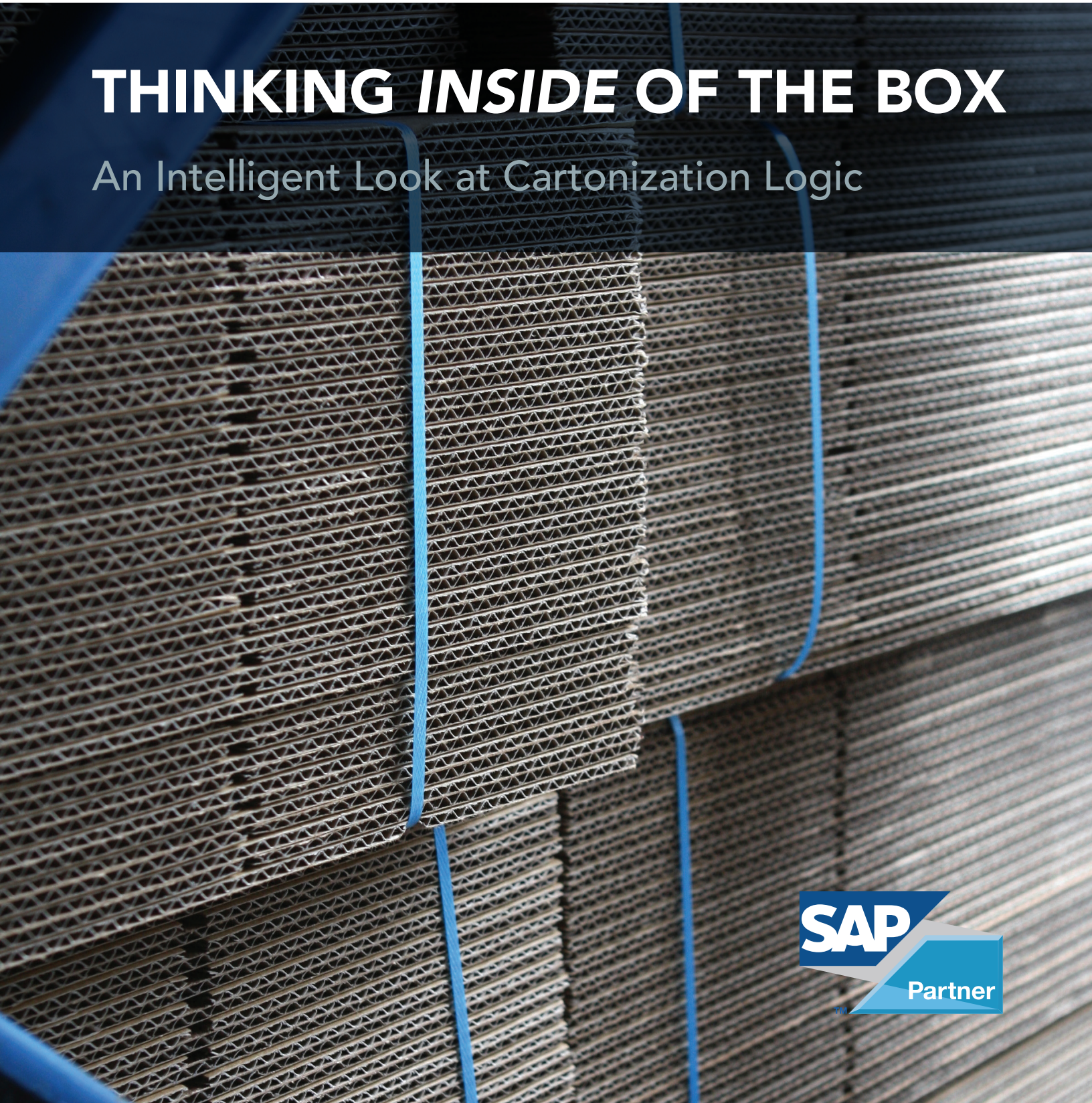
SCT software

THINKING *INSIDE* OF THE BOX

An Intelligent Look at Cartonization Logic



SAP Partner

INTRODUCTION

Shipping today is marked by a range of complexities. From the rise in shipping costs to the ongoing quest to maximize efficiency, shippers have no shortage of challenges. However, even the most complex of these challenges can be affected by a single, unified solution: cartonization.

Shipping cartons may seem trivial, but for shippers, they have costly implications. Selecting the wrong carton or a sub-optimal configuration can dramatically impact shipping and material costs, and directly affect your bottom line. By leveraging cartonization logic, shippers can automate and optimize carton selections and configurations while boosting profitability. Explore this whitepaper for an intelligent look at cartonization, presented by SCT Software.

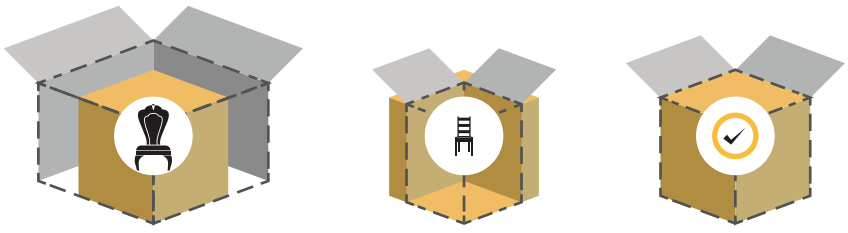
DEFINING CARTONIZATION:
PURPOSE, TECHNOLOGY, PROCESS

At the highest level, cartonization is the process of determining the number and size of optimal shipping cartons for a given collection of items. While this may sound simple, add an infinite array of items and a limited selection of boxes and you're facing a substantially more complex task.

Some would say that cartonization means identifying the smallest box to meet your needs, but that isn't necessarily enough. In a less myopic view, cartonization considers the variables of carton size and number, product size, number and fragility, shipping charges, product incompatibilities and a host of other business constraints to determine the optimal grouping that maximizes efficiency for shipping or storage.

The Purpose

Why does carton selection matter? Consider a basic example from childhood folklore: Goldilocks and the Three Bears. Goldilocks represents the product or products being shipped, and the chairs represent the cartons. For shippers, it comes down to identifying the carton configuration that is 'just right' for the job.



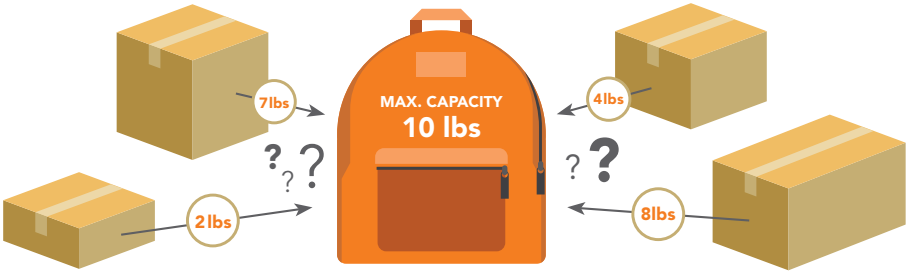
If you select a carton that is too large, you may need to add wasteful and costly dunnage like peanuts, air pouches or bubble wrap to fill the container. If you select a carton that is too small, you may need to use multiple cartons for an order, increasing costs for shipping and materials. Either way, you're encountering unnecessary costs. For most packing and shipping operations, even a small reduction in the cost per order can deliver significant savings directly to the bottom line.

The Technology & Logic

So cartonization is important. But how does cartonization logic work? Let's take a look at the technology and logic.

In theory, for every shipment, there is an optimal carton size that results in the most space occupied and the lowest possible void fill. Void fill refers to space not occupied by product. This can be accomplished by configuring item position and placement to ship items as tightly as possible. Cartonization is a lot like a large-scale game of Tetris, with big bottom-line benefits.

At the heart of cartonization lies the 'knapsack problem', a problem that has been closely examined by mathematicians for more than a century. Also termed 'combinational optimization', the knapsack problem says that given a finite set of items, each with their own volume and value, and a knapsack or container with a finite size, there is an optimal configuration of items that maximizes value.



Cartonization logic technology varies widely, but generally speaking, every solution consists of the following components.

ITEM DATA

Item data describes the item to be shipped and can include a diverse range of variables including volume, dimensions, weight, fragility and more.

CARTON DATA

Carton data describes the carton selection, including the number and dimensions of each available carton.

THE ALGORITHM

The algorithm is the brain of cartonization logic, cross-analyzing item data, carton data and additional business rules regarding shipping and dunnage to make a recommendation for the optimal carton and configuration.

The knapsack problem says that given a finite set of items, each with their own volume and value, and a knapsack or container with a finite size, **there is an optimal configuration of items that maximizes value.**

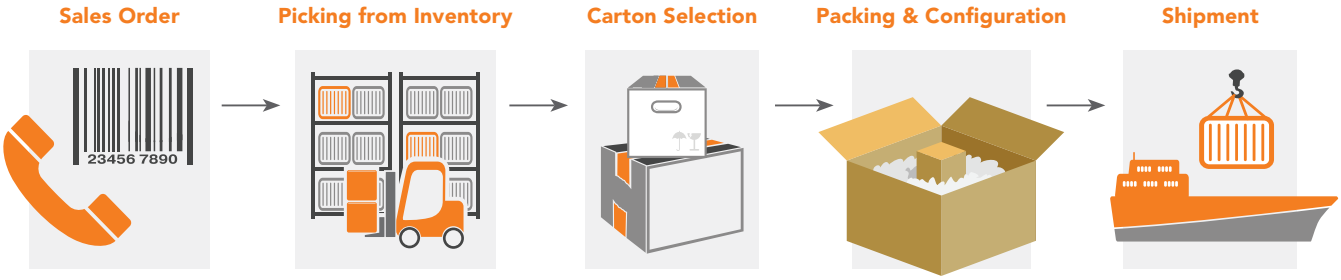
THE OUTPUT

When the algorithm is finished its work, cartonization logic is not yet complete. What follows is a detailed directive for pick and pack operations, illustrating how to put the optimal configuration into practice.

It is important to note that a foundation of accurate master data is the starting point for cartonization logic. Without reliable data characteristics for items and containers, the cartonization algorithm has nothing to optimize.

The Process

Now you know how cartonization logic works, but how can you make it work for you? How does cartonization fit into the shipping process? In order to completely optimize carton selection and configuration, initiatives must be tightly integrated with the entire pick, pack and ship process. See a diagram of their integration below.



PICKING FROM INVENTORY

Inventory data characteristics must be systematically defined for each item, with detailed specifications for volume, dimension, fragility, weight, dunnage requirements and a variety of other characteristics. As items are picked from the inventory, these characteristics come along with them.

CARTON SELECTION

A defined selection of cartons has data characteristics of its own, including size and weight capacity for each item in the selection. Using cartonization logic, item characteristics and carton characteristics are analyzed and an optimal carton is identified.

PACKING & CONFIGURATION

Along with an optimized carton selection, the cartonization solution produces a detailed directive for the optimal carton configuration, which packing personnel utilize to configure and prepare packages for shipment.

Why Cartonization? A Look at the Business Drivers

Today's shipping environment has shippers hard-pressed to improve efficiency and remain profitable amidst the rising cost, complexity and competitiveness of business. In today's context, cartonization is not only beneficial, it is imperative to keeping shipping costs under control and maximizing profit. Let's take a look at some of the business drivers that have made cartonization logic a requirement for shipping operations.

In today's context, cartonization is not only beneficial, it is **imperative to keeping shipping costs under control and maximizing profit.**

The Rising Cost of Doing Business

In 2013, Amazon spent roughly $6.64 billion on shipping alone.[1] The truth is, free shipping isn't free, and consumers have come to expect free shipping from their retailers. With consumer expectations and the cost of doing business at an all-time high, shippers must find strategic ways to mitigate the rising costs of shipping and materials.

In 2013, Amazon spent roughly **$6.64 billion on shipping alone.**[1]

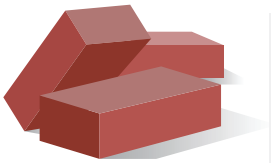
DIM SHIPPING COSTS

New carrier policies from UPS and FedEx have transitioned to Dimensional Weight Pricing (DIM) for all ground packages, marking a paradigm shift for shipping cost and arguably the greatest price increase in the history of shipping—at least since fuel surcharges were instituted in the 1980s. Under DIM pricing, ground packages must pay for load space occupied or weight, whichever is greater. As a result, shippers can expect to sustain shipping cost impacts of roughly 17 percent.[2]

To calculate Dimensional weight, divide package volume (L x W x H) by the Dimensional factor (DIM factor). The DIM factor refers to the density of each package in pounds per cubic foot and varies from carrier to carrier. Generally speaking, the higher the DIM factor, the greater the potential for added shipping costs. For a demonstration of how DIM pricing works, consult the example below.

Balloon

Actual Weight: **0.1 lbs**
Dimensional Weight: **3 lbs**
Billable Weight: 3 lbs



Brick

Actual Weight: **3 lbs**
Dimensional Weight: **3 lbs**
Billable Weight: 3 lbs

Cartonization logic evaluates the contents of each order to determine the optimized carton configuration prior to pick and pack. With cartonization, shippers can select the smallest box size possible while still keeping products safe during shipping, and even reducing the number of cartons used. Advanced cartonization logic cuts to the heart of DIM shipping, mitigating the additional charges and achieving true shipping optimization.

CARTON COSTS

Shipping isn't the only cost that is on the rise. On average, the cost of paper is expected to increase at a rate of 2.1 percent per year in the next three years. Meanwhile, wood pulp is expected to increase at a rate of 3.0 percent per year and molded fiber is expected to increase at a rate of 4.2 percent per year.[3] This price climb is due in part to the growth in demand for paper and corrugated boxes as shipping materials for digital retailers.

For most shipping operations, even a small increase in a cost per box can cut significantly into the bottom line. By reducing the number of cartons per order, and therefore, reducing the number of total cartons required, cartonization logic can unlock significant savings for shippers. And that's just the carton.

DUNNAGE COSTS

There are more material costs incurred in the shipping process than the cost of cartons. Shippers also incur significant expense from a variety of dunnage materials including shipping paper, Styrofoam peanuts and air pillows. On the whole, the shipping industry is marked by widespread overuse of these materials, with room to reduce excess dunnage and therefore, eliminate extraneous costs. Cartonization logic focuses on minimizing the amount of void fill or unoccupied space per package, and therefore, the amount of dunnage required.

Driving Business Efficiency

In addition to rising costs, the modern day shipper faces a variety of intense pressures from competitors and customers alike. In response to these pressures, shippers must find ways to dramatically build new efficiencies in time, labor requirements and material resources. With cartonization, shipping operations can automate the optimization process and unlock new levels of efficiency. Let's examine some of the drivers that have elevated the pressure to be efficient.

SMALLER ORDER SIZES

Over the past several years, retail giants have seen an increase in e-commerce activity and therefore, B2C shipments. As a result, average shipment size has been on the decline, with many shipments consisting of multiple smaller items and lower density packages. Given this trend toward smaller, lower-density parcels, shippers are forced to optimize item combinations in a single package, boosting the efficiency of space utilization and minimizing the shipping cost incurred per order.

Advanced cartonization logic cuts to the heart of DIM shipping, **mitigating the additional charges and achieving true shipping optimization.**

By reducing the number of cartons per order, and therefore, reducing the number of total cartons required, **cartonization logic can unlock significant savings for shippers.**

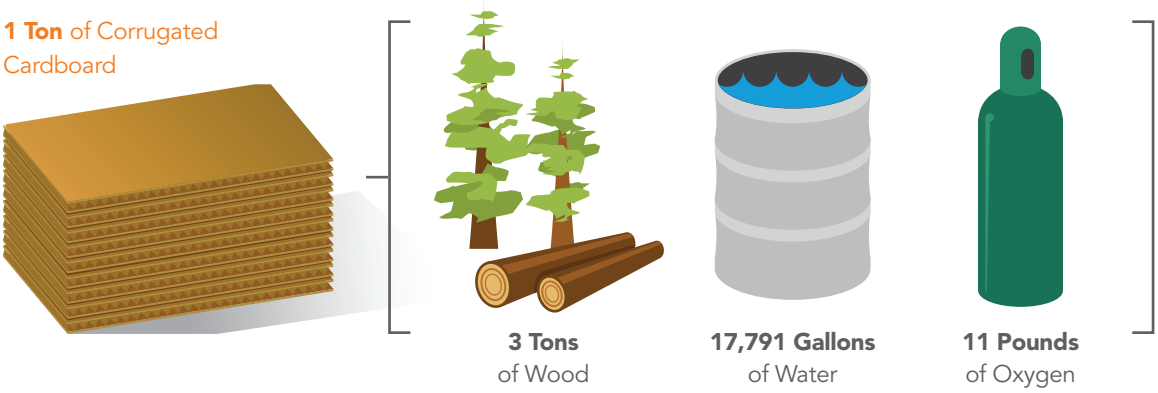
Cartonization logic focuses on minimizing the amount of void fill or unoccupied space per package, and therefore, the amount of dunnage required.

THE DEMAND FOR IMMEDIACY

Meanwhile, as more and more shopping takes place online, today's consumer seeks in-store immediacy with e-commerce convenience. This places enormous pressure on shippers, requiring that they streamline the pick-and-pack process and speed up their pace of fulfillment. By identifying items based on carton requirements, cartonization empowers shippers to direct like orders to where they can be efficiently packaged, dramatically improving throughput and turnaround.

SUSTAINABILITY INITIATIVES

Corporate sustainability initiatives have also increased the importance of making more efficient use of dunnage materials and cartons. **Producing one ton of corrugated cardboard uses approximately three tons of wood, 17,791 gallons of water and 11 pounds of oxygen.**[4] Assuming approximately 20,000 medium-sized cardboard boxes make a ton,[5] Amazon's largest volume day in 2012 would represent 780 tons of cardboard, approximately 2,340 tons of wood, 13.8 million gallons of water and 8,580 pounds of oxygen.[6] Even a small reduction of dunnage, carton size or number of cartons used can have dramatic implications on a company's environmental footprint.



COMPREHENSIVE CARTONIZATION LOGIC:
VOLUME, DIMENSION AND ORIENTATION

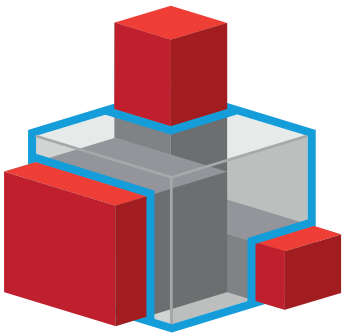
Not all cartonization logic solutions are created equal. Now that we understand what cartonization is, and why it is needed, it's time to examine what sets one cartonization algorithm apart from another. What should you be looking for in a cartonization solution to achieve comprehensive shipping optimization? Let's take a look at the alternatives.

Volume

The bare minimum for cartonization logic is the volume based calculation or fluid fill method. This method calculates the volume of an order using the volume for each individual item. While this method can improve carton configurations, it fails to identify essential information regarding product dimensions, assuming that all volume is 'fluid'.

Because of this critical shortcoming, the fluid fill method often relies on a lower maximum authorized fill rate of 80 percent, for example, resulting in an actual fill rate of around 60 percent.[7] Without this maximum authorized fill rate, the risk of overfilling cartons would be high. Why? Let's look at an example.

A Demonstration of Fluid Fill

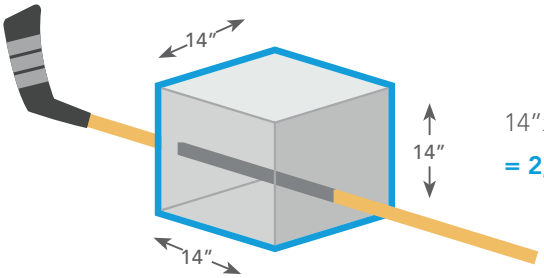


Considerations:

- Total Volume

The fluid fill method is most troublesome when item shapes are irregular. **For example, a hockey stick may have an estimated volume of 2,500 cubic inches assuming that its shape is regular. Under the fluid fill method, a box of 14 x 14 x 14 inches should fit the stick.** In reality, it's easy to see that the stick's dimensions prevent this from happening. That brings us to the next level of cartonization logic: Volume and Dimension.

Fluid Fill and the Oddity of Shape

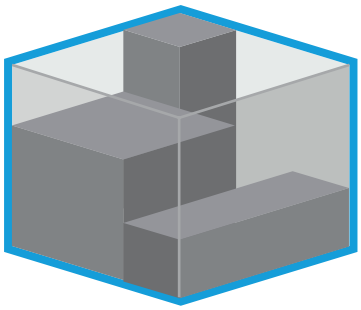


14"x 14"x 14"
= 2,500 Cubic Inches

Volume & Dimension

The next level of cartonization logic considers dimension in addition to volume. Let's call this the dimensional fill method. Instead of relying on volume alone to recommend carton configurations, this method adds dimension as another layer in order to prevent the previously illustrated limitations from occurring. Consider an adaptation of the prior example.

A Demonstration of Dimensional Fill



Considerations:

- **Total Volume**
- **Minimum Dimensions**

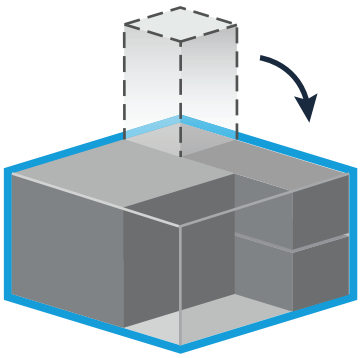
By considering the length, width and height amongst all three objects, the dimensional fill method arrives at a minimum carton size that will hold all items, then matches this minimum size with the closest standard carton equal to or larger than these dimensions. This eliminates the need for a generous maximum fill rate, and more accurately selects and configures cartons. In addition to dimension, the dimensional fill method will also consider maximum weight so as not to overload cartons.

While an improvement, the dimensional fill method assumes that item position is fixed and therefore, fails to consider all possible configurations. This results in excess void fill that must be occupied with wasteful dunnage.

Volume, Dimension, & Orientation

The third level of cartonization logic adds yet another variable to the mix: orientation. Let's call this the dynamic fill method. In addition to considering volume and dimension, the dynamic fill method considers all possible carton configurations by changing the orientation and configuration of products. Let's revisit the example once more.

A Demonstration of Dynamic Fill



Considerations:

- **Total Volume**
- **Minimum Dimensions**
- **Optimal Orientation**

By evaluating orientation in addition to volume and dimension, the dynamic fill method optimizes carton configurations, minimizing void fill and dunnage use, and reducing shipping costs. By optimizing the position of items in the carton, the example above is able to significantly reduce the recommended carton size.

In addition, the dynamic fill method enables shippers to calculate with great precision, down to the 100th of an inch, approaching nearly 100 percent fill factor. In addition to orientation, the dynamic fill method analyzes item ordering in the packing process, producing detailed specifications for optimized carton packing.

As the only level of cartonization logic to consider item placement, the dynamic fill method represents complete carton optimization, maximizing cost savings and efficiency.

As the only level of cartonization logic to consider item placement, the **dynamic fill method represents complete carton optimization, maximizing cost savings and efficiency.**

CSO™: OPTIMIZED PARCEL PACKING AND CARTONIZATION FOR SAP®

As an industry leader in logistics execution, SCT Software is driving widespread carton space optimization by augmenting SAP® capabilities with CSO™, a best of breed optimized parcel packing and cartonization solution designed to eliminate suboptimal packing configurations. Let's take a look at what sets CSO apart.

Built in SAP®

Strong accurate master data is an essential prerequisite for cartonization logic and a key obstacle to many organizations in fully optimizing carton configurations. CSO is built in SAP allowing seamless access of SAP master data to create accurate packing proposals and drive efficiency. With SAP as the foundation, CSO effectively *bests* the best practice, augmenting SAP's leading capabilities.

Fully Integrated into the Pick, Pack and Ship Processes

CSO considers multiple variables including business rules, carton sizes, inventory of packing materials, product dimension, material characteristics and more to systematically make recommendations and generate packing proposals that streamline the pick, pack and ship process. Proposals can then be used to automatically create handling units, allowing the user to directly pick-to-carton.

Designed for Control

CSO's cartonization logic algorithm uses a series of master data and configuration tables and allows the user to control the following parameters in addition to item volume, dimension and position:

- **Carton Fill Factor:** Maximum volume to be filled with items being shipped.
- **Material Incompatibilities:** Materials that cannot be packed together.
- **Product-Specific Dunnage/Void Fill Criteria:** Optimal materials to be used to pad and protect items.
- **Line Item Splitting, Banding & Pre-Packaged Units:** Items to be placed in different cartons or banded together.

Unlocks Business Value

CSO™ empowers SAP® customers to achieve complete carton optimization and maximize value by enabling them to do the following:

ENSURE THE MOST COST EFFECTIVE PACKING OF CARTONS

Mitigate reliance on guesswork or tribal knowledge and eliminate costly suboptimal configurations by streamlining the packing process and identifying the most cost-effective packing solution.

OPTIMIZE BOX CONFIGURATIONS

Evaluate the full range of available box sizes from the smallest to largest based on volume, individual dimension and fill-capacity consideration.

MAKE EFFICIENT USE OF DUNNAGE

Configure product-specific dunnage and void-fill criteria, and make efficient use of materials while ensuring proper product protection.

ACHIEVE AUTOMATION & CONTROL

Dynamically define and control parameters, accept or reject packing proposals and leverage one-click packing for the optimal configuration.

SELECT THE MOST COST EFFECTIVE CARRIER

CSO, when used with XPS, SCT's multi carrier parcel shipping and manifesting solution, is the only available cartonization solution for SAP that compares freight charges in real-time for various packing proposals for preferred carriers, service and mode; a key area of functionality required to deliver true cost savings and efficiency.

REFERENCES

1. "Free Shipping is Going to Cost You More", The Wall Street Journal, October 22, 2014
2. "UPS Plans 4.9% Average Price Increase in U.S., Canada", The Wall Street Journal, October 20, 2014
3. "Paper and Packaging Prices on the Rise", Manufacturing Business Technology, September 24, 2014
4. Environmental Impact Calculator, Environmental Paper Network
5. "Turn 20,000 Cardboard Boxes into a 1 Ton Bundle", Modern Materials Handling, March 1, 2010
6. "At Peak, Amazon Sold a Whopping 306 Items Per Second in 2012", Venture Beat, December 27, 2012
7. "Cartonization Software Can Reduce Shipping and DC Labor Costs", e3neo

About SCT Software

SCT Software is a leading provider of innovative logistics execution software servicing the SAP® user community. SCT software solutions are used globally by manufacturers and distributors to streamline the logistics process. Focused executively on complementing SAP® logistics capabilities, our solutions enable customers to leverage the investment in their SAP® landscape while providing best-of-breed functionality.

Visit www.sctsoftware.com or email info@sctsoftware.com for more information.

217 Morris Ave, Suite 2C
Spring Lake, NJ 07762

P: 732.282.1000 **F:** 732.282.1005