white paper

Boxed Beef Automated Fulfillment

An Evaluation of Various Best-in-Class Technologies for Box Storage

We Optimize Your Supply Chain | DEMATIC

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Abstract

Beef packing is a competitive industry. Smaller and slow-to-change packers are now lagging the remainder of the industry in the use of warehouse automation. As a result, those companies are unable to derive some of the benefits automation delivers. This ultimately puts those companies at a competitive disadvantage. This white paper outlines technologies available today and can serve as a blueprint for a competitive response.

Executive Summary

The white paper begins with the global landscape, looking at long-term trends that are predicted to affect the Consumer Purchased Goods (CPG) sector in the decades to come.

The market beef packers serve is changing — new niche markets continue to develop — supply chains are evolving to unprecedented levels of collaboration, putting ever-increasing demands upon the producers. There also are opportunities to increase profits by using tactics such as price optimization.[1]

To better quantify the relationship between these trends and the industry business objectives impacts on Sales, Customer Service, Performance and Cost are all evaluated in detail.

From a Sales perspective, the impact on system performance of “Store Door Pallets”[2] serving growing number of market niches and deriving revenue through price optimization are all explored.

1 Price optimization — the practice of providing heavier boxes to those customers with paying a higher price point and lighter boxes to a customer paying a lower price point.

2 Store door pallets — historically retail customers would receive goods for all stores in their chain in the form of multiple pallets. Each of these pallets would have one or more products. The retail chain would then go through the process of re-apportioning that order to that various stores that required the contents of the delivery. Building “Store door” pallets is the process of building a unique pallet for each store at the supplier. This allows the retailer so simply “cross-docks” the pallets, thereby minimizing touches at the retail warehouse; this practice though puts tremendous added burden on the supplier side.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

The relationship between Customer Service, customer retention and maximizing revenue will always remain strong. The customer[3] preference for "oldest on top"[4] requirement boxes of specific age and weight as well as the trend to lighter boxes all will affect system performance differently — some technologies will perform better than others.

The efficiently fulfilling orders is another key component to serving customers effectively — so fundamental, it is its own point of evaluation in this white paper. The throughput and storage capacity, the system availability[5] and maintenance requirements are all key components of providing sufficient throughput capacity to be able to satisfy — various technologies provide different amounts of output capacity. Additionally, any future requirement that more specifically defines the contents of a particular pallet can negatively influence output capacity.

In the competitive beef industry, minimizing costs is of fundamental importance. Costs such as labor, ergonomic impacts, old age beef, the use of refrigerated trailers for storage, as well as shipping costs themselves can all be minimized to varying extents dependent upon the type and technology employed and the specific design requirements of the system. Of course, these costs need to be balanced against capital cost for the equipment and building costs (should an addition be required).

These objectives are then mapped against the long-term trends — as one might expect, there is a strong affinity between the long-term trends and a packer's outwardly focused business objectives.

3 Customers – customers of beef packers include retail grocers, food service providers, value added operations such as case ready plants and export markets.

4 Oldest on top – this is simply the process of assembly the goods on the pallet in such a way that the oldest product is on the top of the pallet.

5 System availability – a common phrase for availability is system uptime; it is the percentage of the time that the system is available to do productive work

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

This White Paper strives to peek into the future — identify business objectives and highlight those that align with future trends. It will then go on to explore various best in class solutions to box storage:

- Voice pick module
- Mini-load AS/RS
- Carousel based solution
- Shuttle AS/RS

The Pugh[6] chart shown here compares how each of the alternative technologies is suited to the objective as compared to a manual box storage operation.

The key strategic question: Is there a means or technology available that not only allows packers to catch up, but in fact, surpass the competition? Not to give away the ending, but the answer is **yes**!!!

		manual warehouse	miniload	carousel	shuttle
Sales	store door pallets		+	+	++
	price optimization		+	+	++
	exploit unique market niches		+	+	++
Customer service	oldest on top				++
	date code management		+	+	+
	add new small box types				++
Performance	throughput capacity		+	+	++
	system availability		-	-	+
	maintenance personel		-	- -	
Cost	labor		+	+	+
	ergonomics		+	+	+
	old age management		+	+	+
	minimize energy usage		+	+	++
	minimize use of storage trailers		+	+	+
	reduced shipping costs		+	+	+
	capital		-	-	- -
			9	8	18

6 Pugh Concept Selection — a quantitative technique used to rank the multi-dimensional options of an option set. It is frequently used in engineering for making design decisions but can also be used to rank investment options, vendor options, product options or any other set of multidimensional entities.

A basic decision matrix consists of establishing a set of criteria options which are scored and summed to gain a total score which can then be ranked. Importantly, it is not weighted to allow a quick selection process. (http://en.wikipedia.org/wiki/Decision-matrix_method).

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Automated Fulfillment Discussion

This section is intended to serve as a roadmap, guiding beef packers to the best choice for Automated Fulfillment. There is a high capital expenditure associated with automating boxed beef order fulfillment. Given this fact, it is important to assure alignment between current state requirements and future state objectives — linking to strategy — contributing to revenue growth.

This section has five major sub-sections:

- A discussion regarding the *Beef Industry Business Environment*; this discussion will be done in the context of the broader Consumer Product Goods (CPG) segment.
- *Business Objectives* as they relate to Automated Fulfillment
- An evaluation of performance against those business objectives in the context of the *Competitive Environment* you do business in
- A discussion of various *Box Storage Alternatives* considered best in class
- A *Conclusion* that summarizes the recommendation for future automated fulfillment solutions

Beef Industry Business Environment

The beef packing industry has historically been a relatively low margin business. Additionally, there are a host of factors such as disease, energy cost, drought, corn prices, foreign markets, changing North American eating habits and the rather complex cattle supply chain that all add to the challenge.

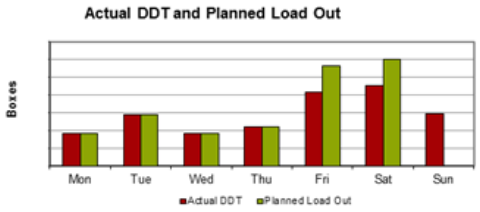
Business Environment

A beef packer's world today is vastly different from the earliest days in the packing industry when customers purchased meat in steer quantities with 6 boxes per steer and all boxes were floor loaded to the bed of a refrigerated trailer.

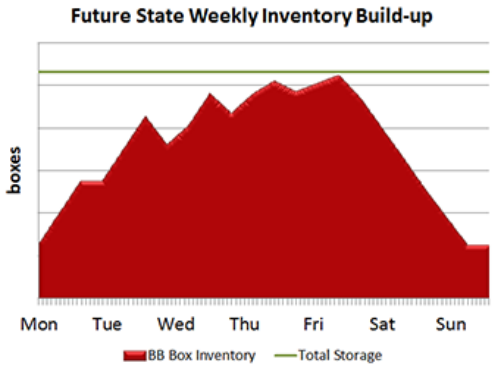
The early evolution had customers rapidly learn that they no longer had to buy the whole steer but instead could purchase only the cuts they wanted. In the past few years, the protein branding that Perdue pioneered in the 1960s has spread to the beef industry.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

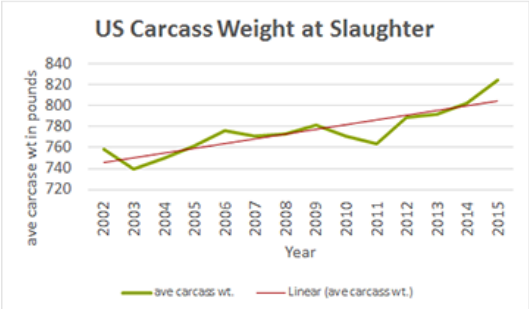
All these factors have caused product codes to multiply, orders have increase in complexity and the number of boxes on an order has continually shrink. In addition to all the changes described above, the required departure time[7] (DDT) has moved the majority of the outbound orders to the end of the week.



While the shipping requirement has shifted, the production rate through a beef operation remains relatively level from day to day. The result of this is a rather significant build-up of inventory over the course of the week (see chart to the right).



Several other factors are affecting existing warehouses — cattle have been getting heavier at a rate of 0.6% per year. This coupled with market forces requesting lighter boxes. These two opposing forces result in the number of boxes per steer growing from 6 boxes per steer in the early 1960s to 9–12 boxes per steer today. The "box inflation" is the result of combined effects of the majority of the shipping being week ending, heavier cattle and lighter boxes.



The net effect on the packer is that many of the existing warehouses are undersized. Most frequently, the capacity of the warehouse is expanded by holding product in refrigerated trailers out in the packer parking lot. The fuel alone for these refrigerated trailers serving as "portable warehouses" has exceeded $1 million per year in many instances.

7 Departure Time — the time an order is scheduled to depart so that it arrives at the customer's location in the prescribed time window.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Beef in Context of Broader Consumer Industry

1. Make Our Business More Sustainable

2. Optimize a Shared Supply Chain

3. Engage with Technology-Enabled Consumers

4. Serve the Health and Wellbeing of Consumers

The beef industry is part of the broader Consumer Product Goods segment. Several years ago, over 400 executives from around the globe from companies including Ahold, ConAgra, Kraft, Meijer, Nestle, and Wegmans met as part of an initiative entitled Future Value Chain 2020[8]. The intent of that effort was to anticipate what would be expected of their supply chains in 2020 and tailor their strategy roadmap to the projected trends.

8 "Future Value Chain 2020 – 2020 Future Value Chain: Building Strategies for the New Decade" — the third report published as part of the Future Value Chain initiative, a think tank designed to develop a collective future vision and response for our industry in light of the rapid changes impacting consumer goods and retail companies.

The report is published under the auspices of The Consumer Goods Forum, with support from Capgemini, HP and Microsoft. "2020 Future Value Chain" provides a framework to help the industry and individual companies understand the trends that impact our business, envision how they will impact, and then formulate plans to benefit our business from those changes.

The report draws on insights from nearly 200 retailers, manufacturers, academia; logistics service providers, consultants and subject matter specialists worldwide in order to present a comprehensive vision of the industry's future. This ensures that the report reflects what our industry feels – it is truly an initiative by the industry, for the industry. http://www.futurevaluechain.com/about-the-study/

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

This group identified 12 major[9] trends that will shape the Consumer Product Goods sector in the coming decades. Seven of the twelve identified trends are clearly in place today. Those seven trendshave particular relevance to beef packers are:

- Increase in consumer service demands
- Increased importance of health and wellbeing
- Growing consumer concern about sustainability
- Shifting economic power
- Scarcity in natural resources
- Rapid Adoption of Supply Chain Technology Capabilities
- Increase in Regulatory Pressure

That evaluation process led to the following objectives:

In the next sub-section Business Objectives will be discussed in detail and mapped against Future Value 2020 Objectives.

9 12 major trends — the twelve trends identified in the Future Value Chain 2020 analysis are as follows (http://www.futurevaluechain.com/key-findings/trends-what-is-driving-our-objectives/):

- *Increased Urbanization* and the rise of mega-cities will impact the size of stores, logistics and the supply chain, and distribution infrastructures, among other factors.
- *Aging Population* will have economic and political consequences related to the amount of money spent on necessities like food and drink, and the type of delivery services, store formats and locations offered to older consumers.
- *Increasing Spread of Wealth* will lead to a growing middle class in developing regions, impacting consumption and availability of food items and providing a source of growth for manufacturers and retailers.
- *Increased Impact of Consumer Technology Adoption* will be reflected not only in consumers' own behavior but also in their ability to influence the buying behavior of other consumers as the use of social and digital media continues to spread.
- *Increase in Consumer Service Demands* will define new service models, offered via the Internet, that move beyond selling individual products and will bring different types of "solutions" to consumers and shoppers.
- *Increased Importance of Health and Wellbeing* will have significant ramifications as sales of healthful products and services are expected to nearly quadruple in the coming five years.
- *Growing Consumer Concern About Sustainability* will lead consumers to look to governments and companies to play a major role in combating climate change.
- *Shifting of Economic Power* to countries like China and India will cause trade areas to evolve and a new generation of globally competitive companies from these developing markets to emerge.
- *Scarcity of Natural Resources* like energy, water and food will become a growing issue as demand is projected to outstrip easily available supplies over the next decade, resulting in increasing production costs.
- *Increase in Regulatory Pressure* will be seen particularly for hot-button areas like the environment, sustainability and food safety.
- *Rapid Adoption of Supply Chain Technology Capabilities* will enable a more synchronized value chain with greater visibility and traceability.
- *Impact of Next-Generation Information Technologies* like cloud computing will lead to a new way to deal, jointly, with business and technology in the consumer goods industry.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

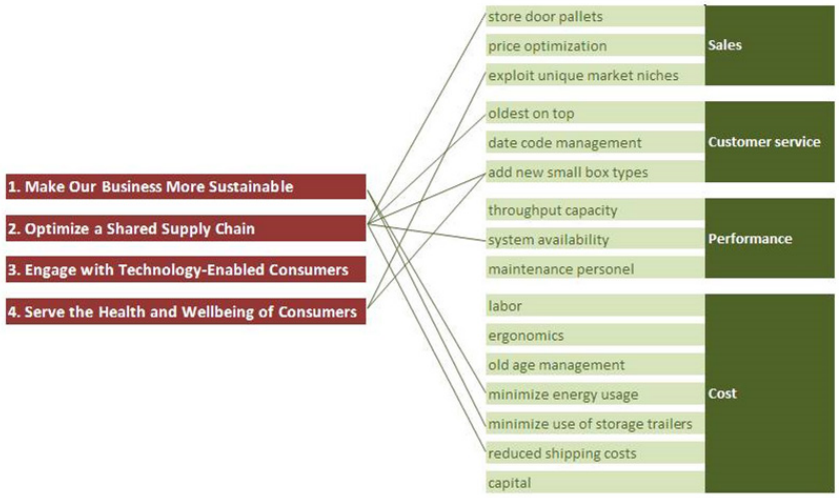
Business Objectives

After numerous discussions with beef industry executives, a group of objectives was identified. The trends listed in the previous section align well to the future state objectives that have been outlined. The business objectives were further grouped into the following categories.

- Sales
- Customer Service
- Performance
- Cost

Mapping Macro Trends to Business Objectives

There exists a strong mapping between the long-term direction for the Consumer Product Goods (CPG) sector and the more specific business objectives of the beef packing industry. This alignment reinforces the importance of these objectives from a strategic perspective.



Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Sales

Increasing "top line" revenue is based on providing a product or service that has or is perceived to have value to the purchaser and/or exploiting an opportunity. For the purposes of this white paper, the following sales opportunities will be explored:

- **Store Door Pallets**

  A recent objective of many customers in an effort to reduce their distribution and handling costs is the concept of "store door pallets". In the current operating mode, a large customer who orders in full truck load quantities may have one or more pallets of a particular product code. When the truck is received, the products on that truck would then need to be broken down and re-palletized by "store order." For the purchaser, this double handling increases cost, creates a delay in the process and creates opportunity for handling damage as cases are removed from the receiving pallet and distributed across many store pallets. By producing "store ready" pallets, the customer can realize a significant cost savings, thereby creating an opportunity for a somewhat higher price from the supplier based upon a greater value-added delivery. It should be noted that a requirement to produce "store door pallets" would put a significant strain on virtually every system installed in the beef packing industry.

- **Exploit Unique Market Niches**

  Several of the niches that exist today are Global markets, unique customer preference resulting from increased ethnic mix as well as consumer preference towards a specific diet (demand for grass fed, hormone free beef being an example case-in point). Adequately served, there exists reduced priced sensitivity for suppliers which can satisfy those unique needs. There are several downsides to the niches. A direct affect is the increase in product codes. These niches also allow entrance for smaller, less efficient packers to gain a further foothold given the higher price point. A box storage system with individual box accessibility allows packers to efficiently serve these pockets of opportunities, resulting in increased revenues and margins.

- **Price Optimization**

  Customers are willing to pay the different amount for the same product. Given the variable nature of the steer being slaughtered there can be a measurable difference in box weight of the same product code. By having the ability to sell heavier boxes to those customers who pay higher price per pound and lighter boxes to the customers paying less, there can be an appreciable change realized at the bottom line. Current systems are inefficient in trying to both exploit the unique niches that exist today and that are sure to grow in the future. These niches as well as realizing the potential gains price optimization are all dependent upon having individual box selectivity.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Customer Service

Good customer service is a key to maintaining current customers as well as maximizing customer loyalty. Done at an extraordinary level, it can reduce price sensitivity thereby enhancing margin. Points of customer service discussed in this white paper are:

- **Oldest on Top**

  With a perishable product such as meat, a customer always wants to ship the oldest product in inventory first.

  From a producer perspective, it is very common to have multiple manufacturing dates for the same product being held in inventory. In traditional flow through systems, the product is typically in the flow rack first in first out — or the oldest product in front. When the product is then palletized, the oldest product is then on the bottom of the pallet. (note: this situation may not always be the case should newer product need to be shipped before older product). Whenever a customer receives product with the oldest product on the bottom labor needs to be added to that pallet to insure that the oldest product is shipped first. This increases customer cost and creates a delay in their receiving operation.

  It should also be noted, that requirement for a mini-load or carousel system to insure the oldest remains on top significantly reduces system output capacity due to the specific sequencing requirement imposed. This occurs because each mini-load crane or carousel can only perform one task at a time. The more general the pick assignment, for example, pick one of the next forty boxes, the higher the likelihood of there being productive work to do given any of the forty boxes would satisfy the requirement. Conversely, if the requirement is to pick an exact box in an exact sequence; work available for each aisle is far more limited. Frequently a machine will then wait for another aisle to complete its task prior starting its retrieval.

  A corollary is that there multiple consecutive retrievals need to be performed from the same aisle; this then limits the throughput of the system for that time to the throughput capacity of that aisle until those consecutive retrieves are completed.

  A more tangible example is that several mini-load systems that are considered current best in class have a crane utilization of approximately 70% even though the system uptime is 99.9%+. This occurs because even when there are a relatively large number of boxes to pick at any one time, an over-worked crane aisle causes other aisles to have to wait on the over-work crane(s).

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

- **Date Code Management**

  Meat age range selectivity is an expectation of customers for a variety of different reasons. Any technology that does not provide individual box selectivity makes date code management extremely challenging and time consuming.

- **Increasing Number of Smaller Box Types**

  Several trends support this direction — end customers wanting lower inventories on hand — intermediaries such as Sysco wanting to provide their customers smaller quantities without need for re-packaging within their order fulfillment operation — the objective of reducing workplace injury. Regardless of the reason, there will be continued pressure toward an increase in the number of box types. It should be stated that virtually all the beef industry automated installed base would be extremely challenged to efficiently satisfy this customer expectation of an increasing variety of small boxes in the future.

Performance

The industry order patterns have evolved. While there is a slight variation based upon the geography of the producing and consuming locations, in general there is a significant peak shipping demand on the end of the work week. It had become the norm to design the warehouse throughput and storage capacity for closer to an average condition than to peak. The result of these two opposing forces is that a significant amount of product becomes “warehoused” in (relatively speaking) energy inefficient reefer trucks. This practice frequently leads to product being double handled prior to shipping. The net result is energy wastes, artificially inflated shipping costs, delays added to the process, increased labor costs due to double handling and increases the opportunity for damage.

Additionally, systems have been designed so that 2 shifts of production over 5 days typically required three shifts over six day to ship and 6 days of production typically required 7 days to ship.

The discussion regarding performance will be broken into three sub-sections:

- **Throughput Capacity**

  Designing systems with higher throughput serve to correct or improve the conditions described in the narrative above. It should be noted that the majority of current “state of the art” systems have been designed for much higher throughputs than what had been the case historically. It is typical for these operations to operate shipping the same number of shifts and days as production. Current “state of the art” systems have also been designed with more storage capacity than what had been the case historically.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

It should be noted though that the future state requirements such as store door pallets, oldest on top, and price optimization will all compromise the throughput capacity of the current “state of the art” systems.

The only means to compensate for this reduction in speed would be to add downstream buffering automation such as additional sort lanes, or dedicated sequence buffers.

Note: As a general rule of thumb, the higher the selectivity requirement and or the greater the sequencing requirement, the slower mini-load and carousel based systems will operate.

- **System Availability**

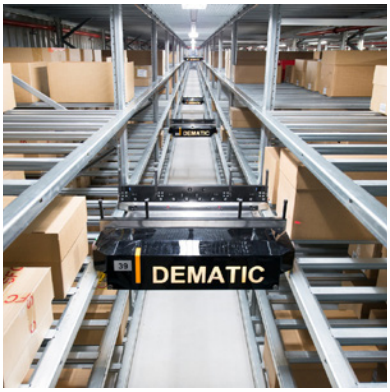
  System availability (uptime) is the measure of the percentage of time a system is available to perform the intended task. It is one of the most important measures in having high predictability in satisfying customer orders. System availability for the sake of this discussion refers to the impact of unplanned events, whether that is “jams” or physical equipment failure.

  Robustness of the design is the most important factor in unplanned downtime. A robust equipment design can maximize the mean time between repairs. A robust design can also result in less “jams” due to product irregularities such as rounded carton bottoms, uneven pack, wet bottoms, excessive glue, etc.. Another significant factor in availability is the ease and speed in which a fully functioning unit can be substituted for one that has failed. Lastly, is the overall impact to the system operation of the failed entity.

  Various alternative system configurations will be discussed later in this white paper, these various technologies will have different system availability percentages.

- **Maintenance Personnel**

  There is a correlation between the quantity and skill level of maintenance personal/practice and system availability. A general rule of thumb is that the higher the level of technology the higher the skill level of maintenance technicians required to insure high system availability.



Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Cost

Cost is an extremely important metric in the extremely low margin beef packing industry. A number of elements of cost that can be affected by the solution type. Factors included in this white paper are:

- **Labor**

  Labor cost does have a measurable cost on box storage and handling. In largely manual systems there are impacts from planned process activities such as putaway, picking and palletizing but also special handling processes such as retrieving boxes of a specific date range or pre-loading a trailer due to insufficient warehouse space.

- **Ergonomics**

  Ergonomics impacts in box storage are largely repetitive motion injuries involved with the handling of comparatively heavy boxes. It is fair to assume that the future will continue to bring increasingly stringent rules and more serious consequence for repetitive motion injuries. The use of any automated box storage means virtually eliminates any risk associated with product putaway and picking.

- **Minimizing Old Age Product**

  It is the norm that as product ages it has less value to the purchaser due to lost weight from moisture being released from the meat into the Cryovac™ bag. This lesser value results in a lower sales price and a reduction of profit margin on boxes that become “old age”. Flow through and manual systems make it very challenging to manage boxes individually. Virtually all systems that store boxes as individual entities provide much greater capability to manage date codes and thereby reduce profit loss associated with product becoming “old age”.

- **Minimizing Energy Usage**

  Energy costs are affected in many areas within box storage function. Direct measurable affects are from conveyor and automated equipment operating in a process and elimination of heat gain from people, lighting, equipment and the exterior by refrigeration. Storing product in refrigerated trailers as opposed to a better insulated, more efficient refrigerated building will also inflate energy costs.

  The more space efficient a storage system the more compact the building required and thereby the lower the building refrigeration load.

  In general, any “wasted” motion (e.g. conveyors operating with no product on them) or mass in motion (relatively high weight mini-load cranes) increases energy consumption.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

- **Minimizing the Use of Storage Trailers**

  Storage trailers have both direct and indirect hidden costs. The easiest direct cost to measure is the fuel cost associated with keeping product at temperature. Additionally, there is the labor associated with loading and unloading these trailers when they are used to "warehouse" product. As product is double handled in and out of these trailers there is increased risk of handling damage. Lastly there is a hidden shipping cost that will be discussed further in the next section. While a somewhat minor cost, there is also the creation and maintenance of the parking space for these trailers.

- **Reduced Shipping Costs**

  As implied in the previous section, there is an inflated shipping cost associated with refrigerated trailers being used as a "warehouse". The picture in figure 8 shows a typical example of trailer staging.[10] Based upon history, owners of the trailers know the percentage of time that the trailers sit idle "warehousing" product. These costs are ultimately reflected in the shipping cost that beef packer pays.

  Additionally, trailers will be unavailable for the transportation company for extended periods of time, many smaller, more competitive operators that need to keep their equipment productive are not part of the transportation pool available. By being able to load and dispatch trailers in a short timeframe, there would be a greater pool of shippers available and a net reduction in shipping cost.

- **Capital Requirements**

  This is a complex calculation that relates not only to direct costs of the equipment involved but also the cost associated with building and mechanical equipment such as engine room capacity. Deployment of capital also is strongly impacted by the impacts on strategy and the overall competitive marketplace within a given industry.

  Note: Providing future state (strategic) capabilities can have a cost impact on a project. Including those costs without recognition of the financial benefits of those strategic capabilities has frequently made projects financially unattractive, and thereby never realizing the game changing results.

10 Trailer staging — the process of loading boxed beef into a refrigerated trailer and using that trailer as a temporary warehouse.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Beef Packer Competitive Environment

The competitiveness in the Beef Packing Industry is high. There is competition both for fed cattle on the supply side and for customers on the user side. There are varying levels of automation employed across the industry.

The evaluation below is largely qualitative. It is the result of facility audits, direct involvement or determined through private research. For the majority of the packing- houses, the level of automation varies by site. Any scoring assigned is an approximate average across their entire operation.

While the results are not absolute, it is the opinion of the writer that they are representative at this point.

		Packer 1	Packer 2	Packer 3	Packer 4
Sales	store door pallets	3	2	2	3
	price optimization	3	1	8	7
	exploit unique market niches	2	4	3	4
	Sales	**3**	**2**	**4**	**5**
Customer service	oldest on top	1	2	2	4
	date code management	3	7	8	9
	add new small box types	1	1	1	1
	Customer service	**2**	**3**	**4**	**5**
Performance	throughput capacity	2	7	6	8
	system availability	7	5	6	7
	maintenance personel	6	5	4	5
	Performance	**5**	**6**	**5**	**7**
Cost	labor	4	7	8	9
	ergonomics	4	6	7	8
	old age management	5	8	9	9
	minimize energy usage	4	5	4	6
	minimize use of storage trailers	2	3	4	5
	reduced shipping costs	2	1	1	1
	capital	6	4	5	3
	Cost	**4**	**5**	**5**	**6**

In the table above, each sub-categories was scored from 1 to 10, 10 being best. The larger numbers for each category are a simple average of the sub-categories. The best-in-class for the category is green and the worst performer is shown in red.

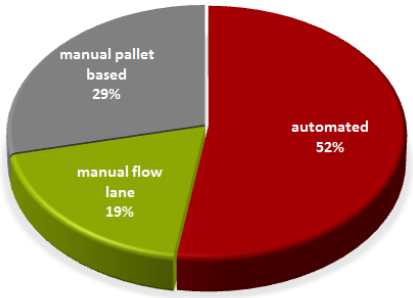
A significant portion of the Big 4 operations are automated. In general, the larger the percentage of the better the performance when evaluated on the warehouse operations impact on Sales, Customer Service, Performance and Cost.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

All of the automated systems shown in the table on the previous page are installed in the Big 4. The majority of those operations processed a minimum of 4,000 steer per day. There has been a growing interest from the next tier of slaughter operations.

Customer expectations as the industry operation environment have changed dramatically over that time. Many of those operations that implemented automation earlier could benefit from the technological innovations that are just now coming online.

Fed Cattle Warehouse Solution
(Top 30 Packing Companies - by head per day)



The other point of interest is that the newest technology may provide a payback advantage to smaller operations. This is being borne out currently in Australia where the operations are typically smaller scale and have been the first adopters of next generation technology. This rationale will be explored further in the next section of this white paper.

Order Fulfillment Requirements and Metrics

In this section, we will review the various order fulfillment requirements and metrics, and how they affect existing manual systems. The subsequent section will discuss the various automation technologies and each technology's relative performance.

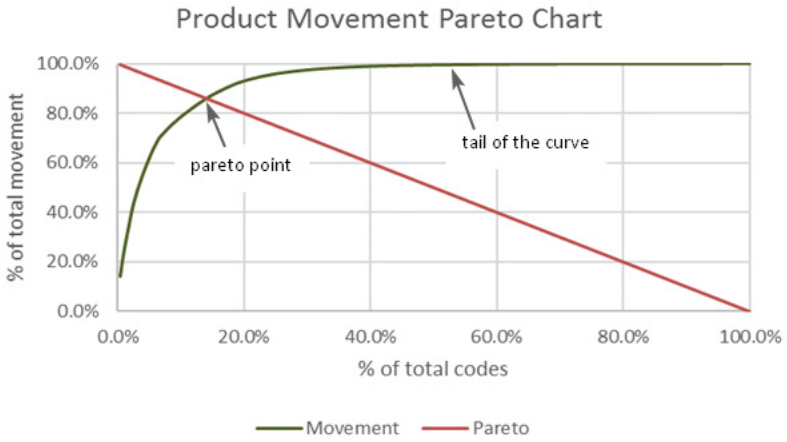
Order Fulfillment Requirements

- **Product Code Proliferation**

  As discussed earlier in this white paper, the proliferation of product codes has exploded from the early days where one steer was essentially packed into 6 boxes. The factors leading to this reality are largely branding, customer preference and meat packers striving to carve out more margin by producing finer cuts on the production floor.

  Existing manual operations in beef packing warehouses consist of either a pick from pallet or put to and pick from flow lanes.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage



The chart above depicts a relationship between product codes and their relative velocity. The steepness of the movement line will vary from company to company. This chart is commonly referred to as the 80/20 rule. As product code proliferation has become a growing reality, in many instances the pareto point has shifted up and to the right. The portion of the movement curve that is relatively flat to the right of the pareto point is frequently referred to as the tail of the curve.

The “tail” is typically associated with slower moving products, frequently created to carve out higher margins. In a conventional pick solution, a long “tail” has a profound negative effect on productivity and responsiveness.

A secondary effect of product code proliferation is a marginal increase of days on hand and thereby an increased storage requirement. More importantly, it creates a greater likelihood of a product becoming “old age”.

- **Manual Pallet Warehouse**

  The impact of this on conventional manual pallet warehouses is very significant. The percentage of single SKU full pallets that can be produced directly from production decreases. This decrease results in an increase in partial pallets and/or multi-product code pallets. The net result is a reduction in cubic storage efficiency and decrease in picking efficiency. The reduction in picking efficiency translates to a picker taking longer to pick an order, increasing labor cost and congestion. The increased congestion can lead to delays in picking an order.

- **Flow Lane Box Storage**

  Product code proliferation has an impact on manual flow lane systems as well. Each time a new code is created there needs to be a place to assign

the new code. Strategies to accomplish this including taking a lane that was originally 2 boxes wide and splitting into two separate lanes. The result is similar to the manual pallet warehouse, namely that the cube efficiency of the system decreases. The other approach is to add shelving for lower volume SKUs. The shelving approach for slow moving codes is far more flexible than dedicated lanes and provides better cube utilization, at the tail of the curve as depicted in Figure 11. Assuring order accuracy becomes increasingly difficult for codes that are held in shelving due to the potential for human error.

- **Box Weight and Date**

  Many customers have rules around age and weight range. Flow lane systems are notoriously challenged for assuring date code integrity when shipping requires picking in a modified FIFO[11] fashion.

  Picking boxes of a specific weight range is challenging for any manual system, it is extremely challenging for flow lane solutions.

- **Order Size**

  As stated previously in this white paper, order size has consistently diminished and the corresponding number of orders per day has increased; customers are ordering lesser quantities at one time but placing more orders per year.

  Order size, as a single criterion, has minimal performance impact on a manual warehouse. In the flow lane solution, the pick/walk ratio become more unfavorable lessening the picker productivity.

- **Order Lines per Order**

  The combination of smaller sized orders and more lines per order has a significant impact on warehouse productivity. This combination greatly increases order complexity and reduces the percentage of order lines that will be satisfied by a full pallet pull. The negative impact is the greatest in a manual pick from pallet operation because the increased complexity creates a higher likelihood of congestion due to pickers interfering with each other.

  The congestion increases the dwell time between beginning and completing an order. That increase in dwell time:

  – Requires more staging space for orders being assembled

  – Lessens the number of loads shipped per hour or requires a higher number of shipping doors.

11 Modified FIFO (modified first-in first out) — in general, a packer will want to ship out the oldest product first and first-in first out rules would seem to apply. The caveat is that the frequent objective is to deliver products to customers in the same age range, regardless of the geographic proximity to the customer. In practice then the packer will try to ship 2 day old product to a customer 2 days (transit time) away and 3 day old product to a customer 1 day away so they both get to the respective customers with the same “age.”

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

- **Departure Time**

  The two biggest impact of departure time compression is the increased picking/shipping capacity required over the comparatively small number of peak days and the need for additional storage.

  The increased storage requirement typically is satisfied by “expensive” storage of product in refrigerated trailers.

  The additional picking/shipping requirements leads to increased congestion in all non-automated solutions. With flow-lane, based systems the conveyor system transporting boxes to shipping will also become a bottleneck. In pallet based picking solutions, the staging area and the number of shipping doors becomes a bottleneck. The net result is comparatively lower picking productivity, increased overtime and late shipments.

- **Boxes per Steer**

  The compound effect of heavier cattle (genetics/diet driven) and lighter boxes (customer driven) combined with many of the previously discussed factors has a significant impact on manual systems:

  – Increased storage requirements given the output of a facility is primarily driven by the number of steer per hour that can be processed. As the weight per steer increases, and if the box weight remained constant, the number of boxes produced would increase. With the compound effect of lighter boxes, there are more boxes produced per steer processed. The cubic utilization of the beef inside the box has decreased and thereby a net increase in the box storage requirement.

  – Picking productivity and transport speeds (on conveyor) are based on boxes per unit of time. The net increase of boxes per head increases the labor picking labor requirement and can lead to conveyor system bottlenecks.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Order Fulfillment Metrics

- **Customer Satisfaction – Claims**

  Order fulfillment is the last opportunity a packer has to affect the customer experience. That can either be positive leading to a strengthening of the relationship, or negative resulting in claims, and a weakening of the relationship. There are a number of factors that can impact the customer satisfaction. They include:

  – Box quality

  – Ability to satisfy unique requirements

  – Order fill rate

  – Order accuracy

  – On-time delivery

- **Box Quality**

  Box quality leaving a packer can be highly variable. It is widely accepted that the manual handling of beef boxes is a leading cause of reduction of box quality. The norm for both flow lane based and pallet based manual systems is to stack boxes in the time that they are buffered between manufacturing and shipping. Boxes sitting on top of other boxes while in storage will frequently lead to degradation. Many packers make extensive investment in packaging only to negate some of that benefit by shipping what would otherwise be a beautiful box in a damaged condition. Lastly, there are claims that can be attributable to box damage.

- **Unique Palletizing/Shipping Requirements**

  Beef packing is a business-to-business operation. Boxed beef is frequently shipping to another warehouse. Those downstream warehouses have a growing list of objectives to keep their internal process as efficient as possible. These objectives can include:

  – Oldest on top (or bottom) for a multi-date single code pallet

  – Grouping like product codes together on a multi-code pallet

  – Building cross-dockable “store-door” pallets

  Each of these objectives is time intensive at best and most often almost impossible in a manual warehouse.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

- **Order Fill Rate**

  Order fill rate is an important measure for high customer satisfaction. An accurate, accessible inventory is fundamental to maintaining high fill rates. Pallet based systems that require scanning into and out of a storage location provide a comparatively high inventory accuracy. Systems of this design remain subject to scanning errors. Additional order shortages can result from inaccuracies caused by an over-fill condition and boxes that became unusable due to handling damage. Well-designed manual systems can support a comparatively high order fill rate, though typically less than an automated system.

- **Order Accuracy**

  Order accuracy goes hand-in-hand order fill rate; customers want what they ordered in the quantity they requested. A well-designed manual system can achieve comparatively high order accuracy. Pallet based systems can be subject to manual scanning errors.

- **On-time Delivery**

  Many factors effect on-time delivery including product availability, picking/shipping capacity and system availability. Product availability is a function of whether it is in stock and can be located. Manual systems can have a negative impact on being able to locate product that is known to be in stock. This type of shortfall typically results from human error, frequently associated with an over full condition.

  Picking and shipping capacity are a function of system design in combination with order make-up. For a business where full pallet pulls are the majority of the outbound orders, a manual pallet based warehouse would be extremely time efficient in fulfilling orders. Unfortunately, the nature of the business environment is that the % of boxes being shipped as a single product code pallet is continually shrinking. Given this reality, a flow lane based manual system's performance is slightly less compromised when fulfilling complex orders during peak periods.

  System availability means the system is available to perform the task intended. In those instances where a system is not available, on-time delivery can be adversely affected. Given the comparative simplicity of pallet based manual system, there are minimal factors that can negatively affect system availability. Flow lane based systems typically rely on conveyors for transportation and sortation. While comparatively reliable, the availability of a flow lane based system will be slightly less than a manual pallet based system.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

- **Labor**

  Labor is one of the largest expenses in a shipping operation. Given the cold temperatures, and weight of beef boxes a packer warehouse is less desirable place to work. Additionally, there is a growing sentiment across the US to automate when possible due to lack of availability of labor. All of these factors, coupled with the reality of human error lead to an automated solution providing far better performance on virtually all critical metrics.

- **Discounts**

  Discounts reduce both revenue and profitability. Products being sold as old age, or needing to be frozen are both highly undesirable. In flow lane systems, modified FIFO shipping requirements are the largest contributor to products becoming old age. In a pallet based system old age will typically be amongst slower moving codes should multiple codes be stored on the same pallet. Also, when an overfill condition exists, accessibility to product will lead to an increase in old age. Lastly, human scanning errors can result in product being temporarily difficult to locate. This situation will lead to either newer product being substituted or an order being shorted. When the error condition is corrected, that product will then end up being sent to the freezer and sold as frozen product.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Box Storage Alternatives

There are varieties of different types of box storage systems that have been used. The oldest of which were pick from pallet and flow lane type solutions. Those that currently represent "best in class" are carousel, mini-load AS/RS, and a comparatively new technology to the beef packing industry called shuttles. The table shown in the chart below compares the various manual and automated solutions. In this table, "9"is the highest score and "1" is the lowest.

Areas of Comparison		Manual		Automated		
		Pallet	Flow Lane	Carousel	Miniload	Shuttle
Order Fulfillment Requirements	Code Proliferation	2	2	7	8	9
	Box Wt & Date	2	1	9	9	9
	Smaller Order Size	7	8	7	8	9
	Increase Lines per Order	3	4	7	8	9
	Departure Time Compression	2	3	5	8	9
	Increased Boxes per Steer	7	4	5	7	8
	Multiple Box Sizes	8	7	1	5	9
Order Fulfillment Metrics	Box Quality	1	3	8	8	9
	Unique Palletizing/Shipping Requirements	2	1	6	7	8
	Order Fill Rate	7	8	8	9	9
	Order Accuracy	7	8	7	9	9
	On-Time Delivery	4	6	7	8	9
	Discounts	6	2	9	9	9
Cost	Availability/Maintainability	9	8	5	6	8
	Capital Requirements	9	7	5	4	5
	Storage Cube Efficiency	9	5	8	6	7
	Labor Cost	1	2	7	8	9

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Carousels

Carousels were the leading technology for box storage prior to the implementation of the highly successful mini-load system at Cargill's Friona TX facility.

They are used by three of the big four packers. Carousels have historically been a lesser initial investment than mini-load AS/RS yet still provided reasonable individual box accessibility. One could infer that carousels were a better value than comparatively "slow" early mini-load AS/RS. As the throughput requirements have increased, carousels have largely fallen into favor.

The comparatively slow storage and retrieval rate of carousels required a larger number of units when compared to mini-load technology.

Strengths	Weaknesses
→ Date code management	→ Higher energy usage due to high amount of mass in motion
→ Minimize labor	→ Inventory inaccuracies resulting from tracking errors
→ Maximize ergonomics	→ Throughput capacity less than mini-load AS/RS
→ Minimize use of storage trailers	→ Maintenance costs higher and availability lower than other automation technologies
→ Enhances ability to explore new market niches	→ Throughput decreases when trying to produce store door pallets, oldest on top and to fully leverage price optimization
→ Reduction of shipping costs	→ Inflexible in supporting a wide range of box sizes
→ Product code proliferation has minimal impact	→ Requires a large amount of downstream conveyor to maximize output capacity
→ Provides individual box selectivity by weight and date	
→ High storage density	
→ Facilitates price optimization	
→ Less box damage than manual solution	

Mini-load AS/RS

Mini-load technology has been in use in the beef industry for over a decade. In the past few years' significant advances have been made in the control and load handler technologies that facilitate much high throughput and improved system availability.

Today, mini-load based solutions account for approximately 75% of the boxes shipped from automated solutions

Strengths	Weaknesses
→ Date code management	→ Throughput decreases when trying to produce store door pallets, oldest on top and to fully leverage price optimization
→ Minimize labor	→ System availability can be compromised by poor box quality
→ Maximize ergonomics	→ May be difficult to add new box types
→ Minimize use of storage trailers	→ Inflexible in supporting a wide range of box sizes
→ Enhances ability to explore new market niches	→ Requires a large amount of downstream conveyor to maximize output capacity
→ Reduction of shipping costs	
→ Higher output capacity than carousel solution	
→ Product code proliferation has minimal impact	

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Mini-load AS/RS remains a viable technology for current state box storage requirements. As mentioned previously in this section as well as the opening of this document, there are limitations to the technology.

Strengths	Weaknesses
→ Provides individual box selectivity by weight and date	
→ High storage density	
→ Facilitates price optimization	
→ Less box damage than manual solution	

Shuttle AS/RS

Shuttle technology was first introduced over ten years ago. Historically shuttles were applied largely in “each-pick” order picking operations for industries such as pharmaceuticals. As the cost point has dropped and the order complexity has increased in full case palletizing operations, there has been a recent increase in applying shuttles for these applications. The first successful beef packing application was implemented by Dematic in Australia in 2014. The success of that project has led to others in Australia in several protein segments.

Shuttle solutions provide a number of benefits over competitive AS/RS solutions. Most notably speed, density, and a very high system availability. The high availability (uptime) is the result of the relative ease in which a non-functioning shuttle can be easily pushed from the system and a spare shuttle substituted. Additionally the “finger style” load handler is capable of handling a wider range of carton types and conditions when compared to the load handlers typically used in the current mini-load applications.

Strengths	Weaknesses
→ Date code management	→ Higher capital comparative capital cost when compared to manual solutions
→ Minimize labor	→ Less cubic storage efficiency than manual pallet or carousel solution
→ Maximize ergonomics	
→ Minimize use of storage trailers	
→ Significantly enhances ability to explore new market niches	
→ Reduction of shipping costs	
→ High system availability	
→ Higher output capacity than carousel solution	
→ Product code proliferation has minimal impact	
→ Provides individual box selectivity by weight and date	
→ High storage density	
→ Facilitates price optimization and store door pallets	
→ Less box damage than manual solution	
→ Capable of handling a wide variety of carton types	
→ Requires less conveyor than carousel or mini-load solution	
→ Comparative ease of maintenance to mini-loads and carousels	

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Given the high throughput capability, density of storage and the comparatively high system availability shuttle technology has strong alignment to the current state needs of box storage. When looking at the future state objectives that require a higher degree of sequencing or specific box retrieval:

- Store door pallets
- Price optimization
- Exploiting unique market niches
- Oldest on top

Shuttle solutions are significantly superior to any competitive technology.

Mini-load and carousel based systems can also precisely sequence, but the sequencing requires an extensive conveyor system. Given the output capacity of a shuttle aisle is significantly higher than mini-load or carousel solutions, the downstream conveyor system can be simplified, thus reducing the system cost and enhancing the overall system availability.

Said differently, a shuttle based solution provides all the benefits of the earliest systems plus a more cost effective means of provide capabilities such as store door pallets, price optimization and oldest on top. The primary value has been delivered by the storage technology; an extensive conveyor sub-system has been a necessity to deliver that value.

Shuttle solutions also require conveyor, but the scale of the conveyor system necessary is greatly reduced in a well-designed solution. This reality is of particular important for next tier and cow/fed-steer operations. Given the lower overall volume, the necessary conveyor systems will be significantly less thereby enhancing that overall value resulting from the investment.

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

Conclusion

The beef packing industry continues to be in flux. The history strongly suggests:

- Product code proliferation will continue
- Steer will continue to get heavier
- Box weights will continue to decrease
- Orders will grow more complex
- Customer expectations will continue to become more demanding

There are multiple solutions available to minimize the impact of these changes. These solutions not only serve to cope with a more demanding future, but deliver improved financial results and increased operational flexibility.

The table below is a summary of the information in the table in “Box Storage Alternatives” on page 24. It is of some interest that the evolution in the industry went from Flow lane, to carousel, to mini-load. This evolution was the result of changing demands in the marketplace and the capabilities of automation technology.

It is also interesting that as marketplace expectations evolved the performance delineation between pallet based and flow lane based solutions diminished.

Going forward, automation will be of ever-increasing importance. The advent of shuttle technology has changed the playing field. Cost effective, high performance warehouse automation solutions are available for all.

	Manual		Automated		
	Pallet	Flow Lane	Carousel	Miniload	Shuttle
Fulfillment Requirments	4.4	4.1	5.9	7.6	8.9
Fulfillment Metrics	4.5	4.7	7.5	8.3	8.8
Cost	7	5.5	6.3	6	7.3
Overall	15.9	14.3	19.7	21.9	25

Key
Poorest
Best

Boxed Beef Automated Fulfillment: An Evaluation of Various Best-in-Class Technologies for Box Storage

About Dematic

Dematic is a leading supplier of integrated automated technology, software and services to optimize the supply chain. Dematic employs over 6,000 skilled logistics professionals to serve its customers globally, with engineering centers and manufacturing facilities located around the world. Dematic is one brand under the KION Group of companies and has implemented more than 6,000 integrated systems for a customer base that includes small, medium and large companies doing business in a variety of market sectors.

Headquartered in Grand Rapids, Michigan, Dematic is a member of KION Group, a global leader in industrial trucks, related services and supply chain solutions. Across more than 100 countries worldwide, the KION Group designs, builds and supports logistics solutions that optimize material and information flow within factories, warehouses and distribution centers. The company is the largest manufacturer of industrial trucks in Europe, the second-largest producer of forklifts globally and a leading provider of warehouse automation.

If you are interested in learning more about this topic and how we can help, please contact Dematic at (877) 725-7500 or visit: dematic.com.

Order-No. NA_WP-1061 | Printed in USA 02/18