Development of detailed designs for the proposed new distribution facility for ABC Beverage Company

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i. Executive Summary

ABC Beverage Company is one of the leading beverage distributors in South African market. The 'true' name of the company may not be disclosed due to sensitive information which may not be made public. ABC Beverage Company employs over 900 people and has approximately 10 distribution and depot facilities throughout Southern Africa.

ABC Beverage Company has experienced significant growth in recent years and has thus developed a range of new distribution centres nationally to support its expansion plans. The Pretoria distribution facility is the first new facility to be constructed and serves as the ideal opportunity to develop best practice processes and internal operations designs to be used as a 'blue print' for future facilities and operations.

This report focuses on demonstrating the development and evaluation process which was followed to produce a final internal facility layout and material handling selection for the Pretoria Distribution Center.

Key resources from Industrial Logistics Systems (ILS) and ABC Beverage Company where identified for their knowledge of the beverage industry and experience in the field of facilities design.

The design was focused around best practice processes flows and recognised industry standards. The main aim was to ensure efficient, streamline operations flows.

A range of storage and picking systems were evaluated. In the final design block stack was selected for fast moving product. The design provided for slower palletized product to be stored in selective racking with live case picking at ground level. A carton live system was designed for the efficient pick and replenishment of loose units (bottles).

Sprinkler systems were designed within the various storage systems to meet local fire regulations. Support services such as the battery charging bay were designed to enable quick turnaround of lift trucks.

A core component of the design was security of goods inbound and outbound. A range of cages were designed to reduce shrinkage but also enable unobstructed flow.

In addition to the internal layout, external truck flows and turning circles were reviewed and optimised to allow unhindered integration between the internal and external functions.

The outcome of this project was a final internal facility design and material handling specification for the proposed new ABC Beverage Company Pretoria facility.

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1. Introduction and Background

1.1 Introduction to Industrial Logistic Systems (ILS)

Industrial Logistic Systems (ILS) was established in 1987 and is a professional consulting firm specialising in supply chain and logistics, providing expertise from strategy to execution. ILS is an independent company and thus acting in the best interest of the client to provide the most innovative, practical and cost effective business solution. ILS has both local and international experience in many industries as well as fast moving consumer goods (FMCG).

1.2 Introduction to ABC Beverage Distributors

ABC Beverage Company distributes a range of beverages within Southern Africa and are leaders in their market with sales volumes continuing to grow. The recent growth has seen it necessary for ABC to re-engineer their distribution network and develop a range of new distribution facilities to support the increased demand.

1.3 Project Background

ABC Beverage Company approached ILS to assist their team in developing internal operations designs for their new Pretoria Distribution Centre (DC).

The project focused on the internal design and implementation of material handling infrastructure for a proposed new distribution facility to service the Pretoria area. This project is significant as it is the first of a range of new facilities that are to being developed for ABC Beverages. The design has been accepted as a 'blue print' for all the future operations.

The aim was to evaluate ABC Beverages current and future warehousing and distribution requirements, and to assist in developing internal designs for the proposed new warehouse facility.

Process flow is critical to the design of any warehouse facility. In addition to developing internal flows, ILS reviewed the external process flows (truck turning etc) and interfaces to the building design, so as to ensure integration to the internal operations.

The benefits to ABC Beverages of opening a Distribution Centre (DC) in the Pretoria region include: expand the business, increase profits, streamline the distribution network, lower distribution cost, increase the volumes of product distributed, cater for future growth and provide good customer service to the surrounding area.

The following report describes each of project phases (from the initial operations process review, through concept design to detailed design and costing) undertaken to develop the final design for the ABC Beverages Pretoria distribution facility.

2. Project Scope & Objectives

The main aim of this project was to:

- Develop optimised process flow in the facility (from receiving to dispatch)
- To evaluate a range of internal storage layouts to maximize both storage capacity and picking efficiency (bulk, case / unit picking, high value and call in)
- To evaluate correct storage equipment mix (based on stock profile)
- To evaluate high value and loose case / unit picking system
- Evaluate various materials handling options available to maximize storage and picking requirements and the use of cube space within the facility (building foot print and cost)
- Facilitate the in-rack sprinkler design
- Review of the building design and infrastructure to support the warehouse operations (doors, side loading facilities, battery charging, etc)
- Prepare cost estimates for each option considered (materials handling & associated equipment)
- Technical specification and installation timing of materials handling and related equipment and related infrastructure. This includes the following:
    - Storage Systems (static rack etc)
    - Picking Systems
    - In-Rack Sprinklers
    - Industrial Lift Trucks
    - Fencing
    - Internal Floor Demarcation
    - Battery Charging Equipment
    - Bollards

The outcome of this project was a final internal facility design and material handling specification for the proposed new Pretoria facility.

The methodologies followed are based on and supported by standard Industrial Engineering techniques and principles, which are described and clarified in the literature review.

3. Literature Review

The purpose of the literature review is to describe and define technical terminology used in the report as well as provide further detail on the source of information used to formulate decisions during the project.

3.1 Definition of a Distribution Centre

A distribution centre is a warehouse or specialised building; with refrigeration or air conditioning; which stocks products or goods that are to be redistributed to retailers, wholesalers or directly to customers in the surrounding area. A distribution centre normally distributes goods to retail stores, an "order fulfilment centre" commonly distributes goods directly to consumers and a cross-dock facility stores little or no product but distributes goods to other destinations.

The DC receives inbound trucks of product which is stored until such time that the retailer's order and correct quantities are dispatched. DC's are the foundation of the supply chain network. Some DC's have a 'call in customer collection' interface where the customer may order and collect product directly for the DC.

Large retailers can have a vast number or suppliers and stock keeping units, making it impossible for the suppliers to deliver directly to the stores and therefore companies invest in DC's to make the distribution network more efficient and reliable. Many retailers own and run their own distribution networks, while smaller retailers may outsource this function to dedicated logistics firms that coordinate the distribution of products for a number of companies.

3.2 Storage Systems

Eight basic types of racking are commonly used including:

1. Adjustable beam selective pallet racking
2. Mobile racking
3. Cantilever racking
4. Dynamic storage (flow or live racking)
5. Drive through and drive-in-racking
6. Push back racking
7. Mole or radio shuttle racking
8. Double deep racking

The drawings below describe the various types of racking, along with reference to the specific components of the racking. Selective racking is the most common storage system and is thus focused on in the review.

3.2.1 Static Racking or Adjustable Pallet Rack

Static racking or adjustable pallet racking system is a very common and flexible storage system for any size warehouse. The components of the rack (beams, frames, bolts, base plates, bracing etc) can be designed and modified to sustain the loading on the system. Static rack can be a standalone structure or can be integrated with complex system within the warehouse. The frame depth, beam length and bracing are designed to accommodate the pallet size and quantity of pallets being stacked on the rack. There are different beam profiles which sustain increasing loads namely C-section, box beam or sigma beam. Frames are manufactured to any heights to accommodate storage flexibility.

Figure 1: Adjustable beam selective racking

Beams

Beams are usually designed on the basis of equal load being uniformly distributed over the whole length of the beam and on the basis that the load is equally shared between the front and back beam pair. Should the above case not be true, the manufacturer should take cognisance of the type of load and adjust the safety parameters accordingly.

Beam deflection should not exceed 1/250th of the span.

Frames

Most frames are made up of perforated columns joined by bracing members. The design of frames is based on a complex integration of loading and material type. Frame loading limits are either calculated from known material and profile parameters coupled to a particular testing. If frames are based on particular testing, the recommended safety factor is a minimum of two times load before system failure. The smaller the beams levels are apart, the lower the upright would be.

It is very important that racking systems are designed to correctly interface with the industrial lift trucks used for storage. Industrial lift trucks interface with racking based on the following types of racking aisles:

- Wide aisle racking- aisles in excess of 3.2m largely used for counter balance lift trucks
- Narrow aisle racking- aisles between 2.6m and 3.2m, generally designed for side loaders and reach trucks.
- Very narrow aisle (VNA) – aisles between 1.3m and 2.6m used for turret trucks (lateral stacking trucks), order picking trucks with elevating operators, articulated trucks or storage and retrieval systems.

Numerous intermediate aisle widths are also possible.

NO	DESCRIPTION	TYPICAL CAPACITY	TYPICAL LIFT	TYPICAL AISLE
1	Counterbalanced Diesel, LP Gas & Petrol Fork Lift Truck	1000kg to 7000kg	4,5m to 6m	4,5m to 5m
2	Counterbalanced Electric Fork Lift Truck	1000kg to 5000kg	5m to 6m	3,5m to 4,5m
3	Reach Truck	1000kg to 2500kg	6m to 10m	2,6m to 3m
4	Side Loader (IC powered or Electric)	1000kg to 5000kg	4,5m to 8m	2,2m to 3m
5	Turret Truck (Lateral Stacker)	1000kg to 2000kg	8m to 12,5m	1,6m to 1,8m
6	S/R Crane	1000kg to 4000kg+	7m to 35m	1,3m to 1,6m
7	Low Level Order Picker/ Electric Pallet Truck	2000kg to 3000kg	0m to 1m	n/a
8	High Level Order Picker	300kg to 1000kg	1,5m to 9,5m	1,3m to 1,6m

Table 1: Typical industrial lift truck features

Aisle Width Calculations

For wide and narrow aisle racking, minimum aisle widths should be calculated as follows:

Determine the turning circle of the industrial lift truck utilising the largest pallet to be stacked in that aisle.

To this theoretical turning circle (which is obtained from the manufacturer of the specific industrial lift truck or from actual experimental use of the truck), you add a further clearance of a recommended 300mm

Recommended Aisle = Turning circle = 3000mm

It is not recommended that intrusive stacking is used for storage of pallets in racking unless throughputs are very slow and drivers are highly skilled. Intrusive stacking in when the pallet storage slot is used as part of the aisle

For very narrow aisle racking, the aisle width is dependent on:

- Specific machine design
- Lift height
- Floor clearance
- Type of fork mechanism
- Need to rotate pallet in aisle
- Aisle widths for narrow aisle are thus determined on a case by case basis

Operating Clearance

The drawing shows typical dimensions of pallets located in static rack. The drawing overleaf shows typical recommended operating clearances for selective racking systems. Clearance for back to back between pallets may need to be modified from the suggested operating clearance if in-rack sprinklers are installed. Generally in-rack sprinklers are required for any installation above 4.5m to the top of the highest pallet (depending on product type and risk category).

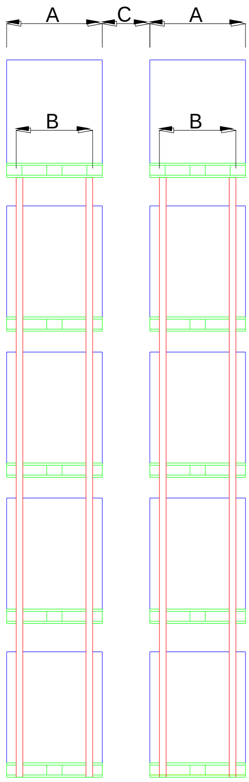

Figure 2 : Typical dimensions of rack and pallet

2 Way Entry Pallet			4 Way Entry Pallet		
A Pallet Depth	B Frame Depth	B Back to Back	A Pallet Depth	B Frame Depth	B Back to Back
1000mm	750-850mm	200mm *	1000mm	900mm	200mm *
1100mm	800-900mm	200mm *	1100mm	1000mm	200mm *
1200mm	900-1000mm	200mm *	1200mm	1100mm	200mm *

* Will depend on sprinkler system setup. Many sprinkler experts call for a minimum clearance of 250mm and some authorities request 350mm. The back to back clearance must include pallet overhang

Table 2: Suggested 2/4 way pallet and frame combination

- For reach trucks where straddle arms are narrower than the pallet, dimension A must be increased by the height of the straddle arm.
- If order picking at bottom level, depending on overall layout, the bottom beam may be raised to facilitate access to the bottom pallet.
- The dimensions shown can be reduced if a driver elevating cab is utilised.
- If throughputs are high, clearances must be increased by 20-30%.
- All clearances must take into account the maximum pallet overhang.

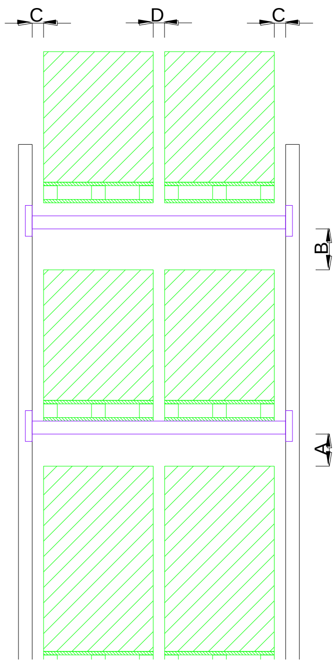

Figure 3: Operating clearances for rack

Beam Heights (up to)	A	B	C	D
3000	150*	100	75	100
6000	150*	100	100	100
9000	150*	100	100	100
10500	150*	100	100	100
* Recommended minimum clearance				

Table 3: Clearance between pallets

Compatibility

For an installation to be successful there needs to be a successful interface between all elements of the storage system. This includes the compatibility between:

- The pallets used
- The load on the pallet
- Securing of load and pallet
- Material Handling equipment used
- Operating Aisles and run-outs
- The building floor quality
- Any related building structures
- Sprinkler systems
- All other aspects of the warehouse facility
- All human interfaces

3.2.2 Drive in Type Racking

Drive-In or Drive-Thru pallet rack systems are a high-density storage solution. This static system has rails running the full depth of the rack for pallet placement. The only limitation to the depth of pallet storage is the capability to drive deep within the system. The rack depth reduces the need for aisles and drastically increases space utilization. Drive-In systems load and retrieve from the same aisle, creating last-in-first-out (LIFO) inventory retrieval organization. Drive-Thru systems load from one side and unload from the other to create first-in-first-out inventory retrieval. Forklifts can enter from either aisle.

Specific and careful attention needs to be paid to the design of drive-in racking type systems. This includes drive thru rack and mole or shuttle type systems. By nature, drive-in racking systems are far less stable than conventional racking systems. This is because drive-in racking systems have extremely slender non-bracing support columns, which are subject to high bending stresses and high abuse.

Because of the nature of abuse of drive-in-racking, extensive precaution should be taken to protect the drive-in-racking from lift truck damage in the form of bollards and guides into the racking. In general the safety factor used in drive-in-racking should be increased substantially beyond those used in the design of the conventional selective racking.

The overall safety factor recommended for selective racking are typically in the order of 2:1. For the use of drive-in racking, it is recommended that safety factors be increased to a point as high as 3:1.

Figure 4: Drive-in rack

3.2.3 Live Pallet Racking

Carton Flow Rack

Carton flow rack is a gravity driven storage system which separates the picking aisle from the replenishing aisle, therefore creating less aisle congestion. The stock keeping units (SKU's) are separated by lane dividers and therefore minimising damage to the product. Carton flow is a good inventory control system as inventory rotation is forced with a first in first out (FIFO) approach, improves visibility with a tilted display shelf and therefore picking accuracy is improved. Carton flow is a good system for loose product picking and caters for numerous pick faces in a space constrained storage area. Carton flow systems can be integrated with other storage solutions which include:

- Conveyers in-feed network
- Conveyer out-feed network
- Pick to light system
- Scanning and recognition system
- Sortation system
- Control and management system.

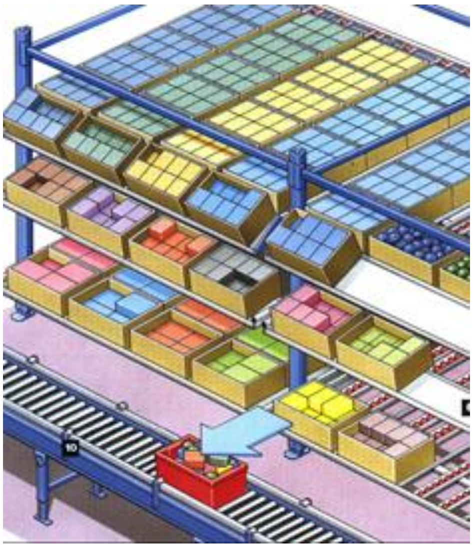

Figure 5: Case live system

Pallet Flow Rack

Pallet flow rack works on the same principle as carton flow rack. The system uses heavy duty skate wheels and is also gravity driven promoting a FIFO inventory rotation. Pallet flow rack is typically used for very fast moving product as it is easily accessible, unlike a static system like drive in rack. This is a high density storage system which accommodates fewer aisles. The pallets can be stored up to 20 pallets deep but then the use of a speed breaking system will be critical.

Speed controller rollers controls the speed of the pallets as they gravitate from replenishment face to picking face, without these rollers, the pallet, the pallet would travel in an uncontrolled manner and would be unsafe. Speed controllers are designed for certain weights, throughputs, slope and speed and must be specified accordingly. Incorrectly specifications to the system requirements will cause system failure and may even lead to fatal accidents.

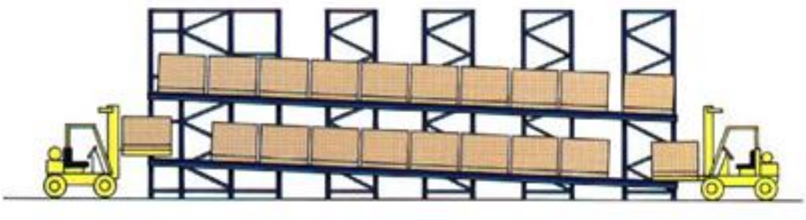

Figure 6: Pallet flow rack

3.2.4 Push Back Rack

Push Back Racking works by loading a pallet on a nesting cart which rolls forward by gravity on the rigid structural steel rails. As a pallet is loaded from the front, it pushes the pallet behind it, back one position. The front pallet is removed when unloading, and the rear pallets automatically come forward to the front picking position. This allows for easily accessible Last-In-First-Out (LIFO) inventory management. Products can be stored from 2-5 pallets deep depending on the design, with front-only loading from a single aisle. Push back system is a more versatile storage than drive-In rack because each lane flows independently and vertical storage operates separately from lanes below. Multiple pick facings for a variety of SKUs can be stored and retrieved without disturbing other product above or below in a single-lane or double-lane format.

Figure 7: Push back racking system

3.3 Material Handling Equipment

Lift truck are the heart of an operation. Trucks must focus on being reliable, serviceable and available. It is crucial to have the right machine for one's operation. The machine and storage system have to be compatible and are thus designed and specified simultaneously.

There are a number of industrial lift trucks to choose from in the industry and are discussed below:

3.3.1 The internal combustion engine counterbalanced forklift truck

The internal combustion engine counterbalanced fork lift truck is one of the most commonly used item of materials handling equipment**.**

It is highly flexible and can be used for many purposes in warehouses, in factories, on building sites or in yards. Typical uses include:

- Loading and unloading trucks
- Transporting pallets
- Storage of pallets in block stacks
- Storage of pallets in rack
- General maintenance work

The counterbalanced forklift truck is commonly powered by internal combustion engines, typically fuelled by:

- Diesel
- Petrol
- LP Gas

Many different forklift trucks are available for different handling applications. These may vary from a 40-ton diesel powered lift truck handling large sea containers to a 1-ton forklift handling pallets in a warehouse. Nearly every factory and warehouse in the world makes use of a counterbalanced forklift.

The basic operating principal of the counterbalanced fork lift truck is shown in the diagram below.

Basic operating principal of a fork lift truck

The counterbalanced forklift truck carries its load on the outside of its wheelbase and relies on a counterbalance weight (and the weight of the engine) to stop it tipping around the front wheels. The counterweight thus operates like a “seesaw” and stops tipping and insures stability.

3.3.2 The electric counterbalanced forklift truck

The electric counterbalanced fork lift truck is powered by an electric battery and is a commonly used item of materials handling equipment

It is highly flexible and can be used for many purposes in warehouses and in factories. Typical uses include:

- Loading and unloading trucks
- Transporting pallets
- Storage of pallets in block stacks
- Storage of pallets in rack
- General maintenance work

It is commonly used indoors and is not as robust as a diesel or LP gas powered forklift. Many different forklift trucks are available for different handling applications. These may vary from a 8 ton special forklift to a 800 kg 3 wheel compact lift trucks used in warehouses.

The forklift trucks below are commonly used in indoor applications for transport and storage operations. With a typical capacity of up to 1,5 tons at 600mm load center, this forklift can maneuver in very tight aisles (3m to 3,5m aisle). In this application the electric forklift truck is being used indoors to block stack pallets.

Figure 8: 3 wheel electric forklift truck

The battery

This picture shows the battery of an electric forklift truck exposed for removal. The battery can be charged in the truck or removed (swapped). Removal is effected using a hoist to lift the battery out of the truck.

Figure 9: Forklift battery

3.3.3 The reach truck

Reach trucks are one of the most commonly used industrial trucks for the storage of pallets in warehouses. Reach trucks differ from counterbalanced forklift trucks in that they carry their load within their wheelbase. This allows the reach truck to operate in a smaller aisle than a counterbalanced forklift truck and to lift to greater heights.

The reach truck is thus ideally suited to operate efficiently at good space utilization and high efficiencies.

The main advantages of a reach trucks are:

- Highly efficient
- Competitively priced
- Commonly used and commonly available
- Relatively simple machine
- High lift capability (up to 11,5m)
- Narrow aisle (2,7m to 3m)
- Fast
- Highly flexible
- Reliable

As reach trucks have hard (solid) small wheels they are only suited to indoors applications where floors are fairly good. While reach trucks do not require the very high tolerance floors used by turret trucks, they do require better floors than counterbalanced forklift trucks. All reach trucks are battery powered and many manufacturers supply numerous model types.

The most common reach truck applications are for handling of pallets in racking. Reach trucks are not commonly used for block stacking. In recent years reach trucks have been developed with substantially improved performance capabilities – including increased lift heights (up to 11,5m).

Reach Truck Turning Circle (aisle width)

The plan view below of a reach truck shows the standard aisle width calculation. The aisle width also depends on:

- Quality of drivers
- Speed of operations
- Quality of pallet
- Rack fit tolerances

If one increases the aisle tolerances there is less chance of rack damage. However this will lead to poorer space utilization.

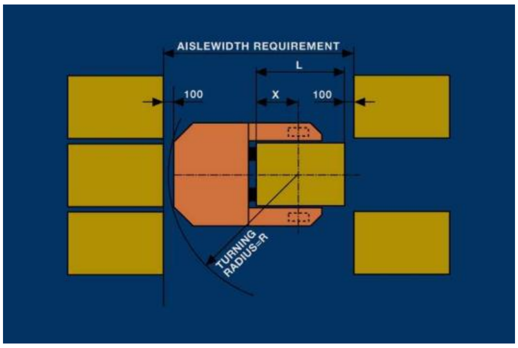

Figure 10: Reach truck aisle width application

A Basic Reach Truck Application

The operator of this reach truck is storing and retrieving pallets from racking. Reach trucks are ideal for this type of operation. This reach truck operates with pallets that have no bottom stringer due to its design. This reach truck is thus best suited to handle Euro pallets. Other reach trucks are designed to handle South African CHEP pallets. The reach truck thus has to be carefully matched to a specific application.

Figure 11: Reach truck

3.3.4 The turret truck

The turret truck or lateral stacking truck is a battery-powered narrow aisle industrial truck which is commonly used inside warehouses for storage of pallets in rack.

The turret truck differs from the reach truck in that it swivels its mast to provide access to rack – rather than turning the whole vehicle. This allows the turret truck to operate in very narrow aisles. Generally turret trucks can be divided into 2 types – that is:

- Man up types where the operator goes up with the load.
- Man down types where the operator stays at ground level.

Turret truck application

In the application below the man up turret truck is being used for order picking. While occasional order picking can be done with a turret truck, the turret truck is generally far better suited to pallet handling. The turret truck is especially suited to very narrow aisle operations – where high-density storage operations can be achieved.

Figure 12: Turret truck

3.4 Storage Containers

The product arriving at the DC has to be stored in various types of storage containers which correspond to the specific storage location and quantity of product in order to be manageable and transportable.

Specialized and appropriate material handling equipment is used to handle the various types of containers. The following is a list of some of the names and characteristics of common storage containers:

- Intermodal containers (shipping containers) are used for the efficient transportation of goods. Standards that specify the volume and dimensions of containers to facilitate efficient handling.
- Pallets are one of the most commonly used means to store and move product in a distribution center. There are many specialised MHE used to handle pallets for example forklift truck, pallet jack etc. Pallets can be stored on the floor or in various pallet racking systems
- Cases and Cartons are boxes usually containing many items of the same SKU or various SKU's. In distribution centers there is a generally accepted distinction made between the terms "carton" and "case", although both are boxes. Goods are received and stored in cartons, while goods are shipped in cases. A stored carton is called a case once it has been picked or pulled for shipment.
- Totes are reusable containers used to hold and transport goods.

The most common pallets used in South Africa are the code 1 and code 15 chep pallets

- Pallet length: 1200mm
- Pallet depth: 1000mm
- Entry 4 way
- Pallet capacity: 1000kg

Figure 13: Pallet

It is important that rack beams sit under the end blocks if storing a 4 way pallet. This implies typical beam spacing of 900mm if the pallet is stored with the 1200mm face in the aisle, or beam spacing of 1100mm if the pallet is stored with the 1000mm face in the aisle.

If other pallets are used, the rack should be set up accordingly- taking full cognisance of pallet design, configuration and access. If a wide variety of pallets are stores, it is recommended that racking is decked to improve operational safety.

Pallet bearers may break and the entire pallet may fail. This can lead to the pallet spilling its load. If the pallet is:

- Too weak
- Damaged
- Has been overloaded
- Is supported in the wrong place
- Is badly positioned in the rack

Stock Volumes

In many various industries there are peak months for certain products or peak seasons like Christmas time. To prepare for the busy season of the year the retailer is required to stock up and thus some DC's might double the amount of inventory on hand and manage the inventory level as the season commences. This strategy is critical to adopt for imported product, as lead times are so much longer than locally produced product. Promotional product will also spike a stock holding prior to the roll out of the specials in the retail stores. The scenario stated was relevant to ABC Beverage Company and thus the Pareto analysis was used to identify the fast movers from medium to slow movers.

3.5 Industrial Engineering Techniques

3.5.1 Ergonomics

Ergonomics is the scientific study of how humans interact effectively with machines. Ergonomics is 95% science and 5% art. Operator comfort, safety and productivity will have long term benefits for a company and the future health care costs will be reduced and operator satisfaction will increase. The design of an optimal work station, picking slot or machine is based on visibility, size, reach, support, pressure, temperature etc

3.5.2 Pareto Analysis

To have an efficient and effective warehouse layout it is imperative to know what volumes, throughput and value the stock is moved at. The warehouse can be designed for a number of philosophies. The Pareto analysis is only one tool to define the popularity of the product. The categories used are called:

- A items - for fast moving stock, highly active stock
- B items - for medium moving stock or moderate activity
- C items - for slow moving stock or infrequently active stock

The popularity of the item assists the design engineer in making decisions as to the storage system to be used. The popularity philosophy says that you should plan your warehouse layout for the small number of SKU's which make up majority of your sales. In theory the A items should be located close to the point of use and must be easily accessible for the lift trucks to reduce travel time. A items would be assigned to the most optimal, practical picking locations, most ergonomic and easiest replenishment location. In the majority of cases 20% of the SKU's make up 80% of the sales

Classification	Percent of SKU's	Percent of Movement
A	20%	80%
B	25-30%	15%
C	50-55%	5%

Table 4: 80/20 Principle

3.5.3 FIFO (First in First Out)

Many high density solutions provide a FIFO inventory control system without the need of any sophisticated controls or management system. The system ensures physical rotation of product which is necessary for products in the food or beverage industry. LIFO is only relevant when strict FIFO by unit load is not required.

4. Project Methodology and Phase Description

The design of ABC Beverages' distribution facility was undertaken in 5 phases. Each phase was critical in determining the Client's needs and developing and selecting appropriate flows, layouts, technologies and systems.

The Phases undertaken included:

Phase1: Operational Flow Process Analysis

Phase2: Data Analysis

Phase 3: Concept Design Development

- Develop block layouts
- Develop conceptual materials handling layouts
- Develop cost estimates for each option
- Evaluate and select the preferred option

Phase 4: Develop Detailed Design and Technical Specification

Phase 5: Evaluate Building Interfaces and External Flows

The approach and methodology of each phase is outlined and described below.

4.1 Phase 1: Operations Flow Process Analysis – Existing Facility

This phase focused on the review and evaluation of existing processes and operational activities at the ABC Beverage Company's existing warehouse.

Initially the ILS team spent time with the ABC Company's operations team, understanding the existing physical process flows from receiving to dispatch. Time was spent plotting flows between each operational area within the distribution facility as well as undertaking a detailed review of processes within each of the operational areas.

Processes within each of the following operational areas were reviewed.

- Receiving
- Dispatch
- Storage for bottles and cans
- Pilot office
- Battery charging
- Secure areas (High value cage, POS cages)

A key element to this phase was to highlight bottlenecks and identify non-value adding activities (i.e activities that increased the activity cycle times and product turnaround within the DC)

Various standard industrial engineering techniques and principles were used to record information regarding the existing processes.

Time studies where undertaken to determine cycle times for certain of the operational activities. The times recorded were used as a base to determine potential for improvement and to measure results of the final implementation. Warehouse activities were identified and assisted in highlighting the most important operational areas.

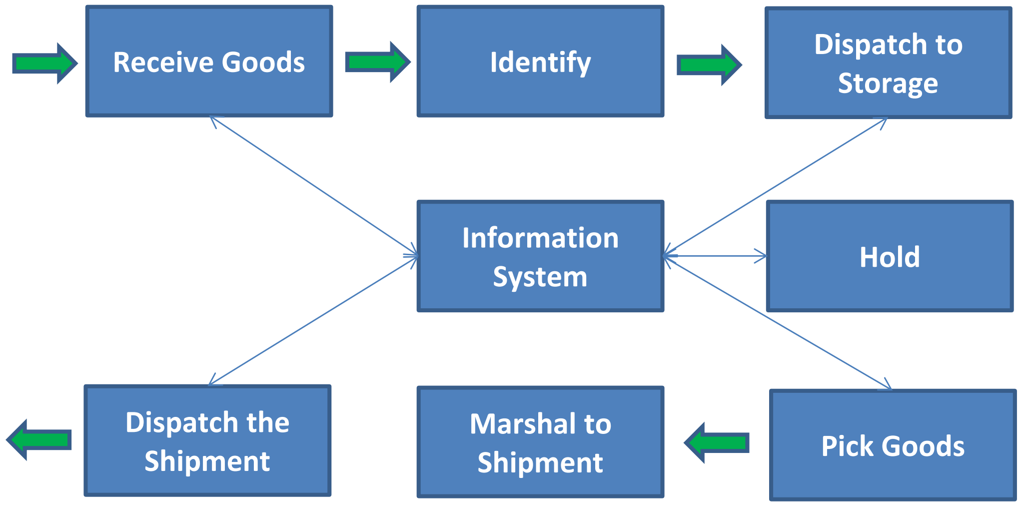

Figure 14: Warehouse Activities

The string diagram below was just one of the many tools used to assist ILS with the layout of the facility. The blocks represent each of the operational areas which had to be considered in the design. The relationship and volume of movement between these blocks were tracked and indicated on the string diagram.

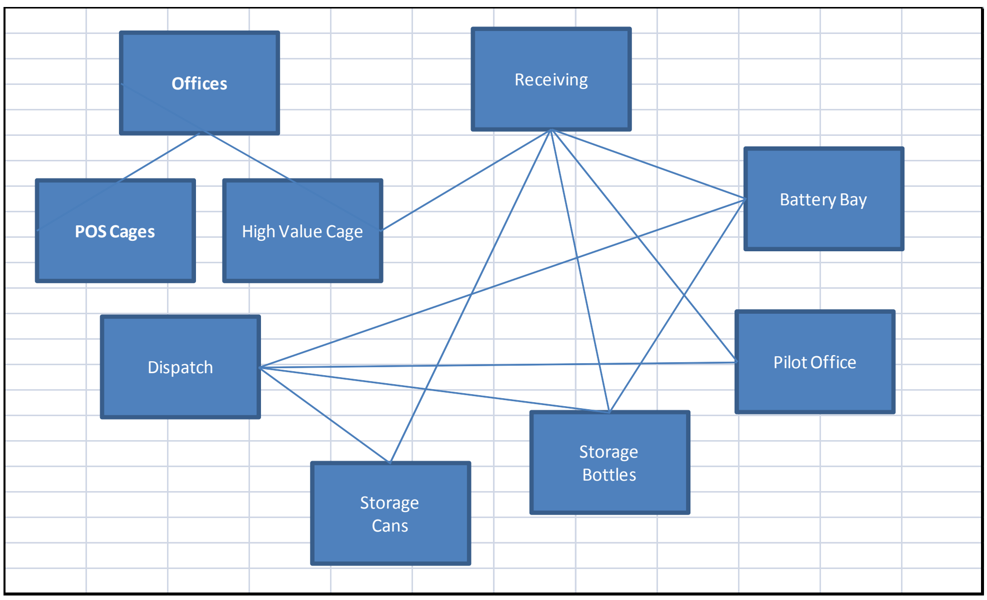

Figure 15: String diagram

From the string diagram it was clear that most the traffic travelled between receiving, storage and dispatch. This was an accurate measure since the main function of a warehouse is to receive new stock, put the stock in the appropriate location and dispatch stored stock to the relevant destination.

As a result of the string diagram is was crucial to reduce travel time between receiving storage and dispatch, and therefore ILS prioritized these operational areas to prime positions which best accommodated the volumes of movement.

During ILS's operations study at ABC Beverage Company, a number of challenges were identified as problem areas and were taken into consideration when designing the new warehouse. Opportunities existed in the following areas:

- Full pallet storage
- Case and unit picking

The challenges regarding operational areas which were identified at the current operation were taken into consideration and improved in the block layout:

- Space was congested in the receiving and dispatch area
- Storage was inadequate to accommodate the quantities of stock being stored
  There was a shortage of pick faces at ground level, which forced pickers to lift heavy product above the ergonomic height or alternatively use ladders. Pick cycle time was longer than it should have been.
- Fast moving product was not treated differently to the rest of the product

The table below is a summary of the challenges identified on site with the relevant implication they had on the operation. The challenges were investigated in detail and design options were created to best suit the operation. The objective was to eliminate the unnecessary bottlenecks in the operation.

	Full Pallets	
	Problem	**Implication**
1	poor product slotting	long travel time for put away & pick
2	block stacked	poor control and housekeeping
3	no location control	waste time looking for correct product
4	only single pallet handling	reduce throughput, less capacity per hour
5	pick rate - 17 pallets per hour	improved to 48 pallets per hour
6	empty travel	waste of time, one could be doing a let down of replenishing stock etc
	Case Picking	
	Problem	**Implication**
1	block stack	very poor cube utilization
2	pick locations above 1700mm	decrease picks per hour
3	no dedicated pick face	time wasted looking for product
4	case and full pallets mixed	broken pallets- double handling
5	back up stock far away	long travel time, cycle time increases
6	pick rate - 38 cases per hour	improved to 75 cased per hour
	Loose Unit picking	
	Problem	**Implication**
1	pick deck height not ideal	inaccurate picking
2	picking from deck location	high number of replenishing cycles
3	no warehouse management system	poor control of stock
4	pick rate - 80 bottles per hour	improved to 120 bottles per hour

Table 5: Challenges identified on site

The table above became a good reference to work from. Before analysing the data in detail one could already get some direction on where to focus the improvements.

The basic principles that were considered to improve the processes were as follows:

- A split between high volume movers ,medium and slow volume movers with Pareto analysis
- Storage systems would need to accommodate picking of cases and loose items
- Improved accuracy when picking loose items
- High density storage for heavy fast moving full pallets
- Reduce the cycle time of loading in-bound and out-bound vehicles
- Better utilize the height of the building with the medium to slow moving product
- Reduce picking cycle times to increase pick rates
- Dedicated locations to reduce unproductive time

4.2 Phase 2: Data Analysis

It was important to analyse stockholding data for the purpose of developing and selecting the most appropriate storage methodology and layout, This phase was crucial to the development of initial facility layouts.

Basic data requirements were needed to meet the requirements set by ABC Beverage Company. They required 7690pallets in a 7500 square meter building. The following goals were considered and were met in the project:

When designing a warehouse, it is important to base decisions on accurate data. The table below outlines key data reviewed, the purpose for the data and analysis type undertaken.

Num.	Data Required	Design Purpose	Analysis
1	Sales by product (SKU,throughput, ABC analysis)	Product movement	Pareto
2	Storage capacity by product/SKU	Space requirements Storage system selection	Space planning
3	Order information (peak by invoice)	bin hits/ hour	Frequency analysis
4	Peak volumes weight	Cube utilization and storage selection	Slotting
5	Growth	Future expansion	Space and capacity planning

Table 6: Data required and analysis technique

General questions were proposed to the client in the form of a data request sheet. The necessary data required is displayed below with the related reason for the data:

- **Sales by product:** allowed ILS to identify the peak months and thus capacity requirements of the warehouse. Peak times of the year like the Christmas season; stock in the warehouse will have to ramp up in order to keep up with the increase in sales. The facility has to be able to cope comfortably at peak.
- **Volumetric information by product:** this was displayed as the length, breadth, height and weight of the unit, box (carton) and pallet. This information was used to design the sizing of the areas within the warehouse, the slotting in the racking system, the weight specification of the racking system.

- **The number of SKU's** (stock keeping units): this information assisted us with the internal arrangements of the warehouse for example: the number of pick faces required (one for each SKU/product) preferably at ground level to accommodate picking by foot, rather than using order pickers. This would reduce picking cycle time. SKU quantity was also used in a Pareto analysis, which will display the 80/20 principle as seen later in the report.
- **The truck types:** loading requirements for receiving and dispatch were used in this specific case to develop the ideal storage option. It was also used to prepare the dock face design of the building, as each truck (4t, 8t, 14t, 16t, interlink) has a different dock height and is catered for in the design.
- **The forecasted growth:** when designing the new facility it was important to look at the business in its current state and the projected volumes that it would escalate towards in the short, medium and long term. This contributes to making important decisions for eg: increasing

throughput would increase the number of doors, capacity of storage and thus increase the foot print of the building etc.

- **Pallet sizes:** Material handling systems all revolve around the size and volume of product being stored. Racking systems are designed to cater for specific pallet sizes. ABC Beverage Company has 1000mmx1200mm pallets and thus the rack depth was designed to handle that pallet.
- **Security:** Internal supporting activities had to be understood eg: ABC Beverage Company had a specific method of storing high values stock, storing point of sale goods and dispatching mixed pallets. Security philosophy within the business had to be respected and catered for in the design.

The data which was available from ABC Beverage Company allowed ILS to make the necessary decisions stated above. A snap shot of the data is displayed below with some changes made to the tables due to the confidentiality of the project.

					UNITS (cm & kg)				CASES (cm &kg)				PALLET (cm & kg)				
CODE	PRODUCT NAME	PACK SIZE	CS PER PAL	CS PER LAYER	LENGTH	WIDTH	HEIGHT	WEIGHT	LENGTH	WIDTH	HEIGHT	WEIGHT	LENGTH	WIDTH	HEIGHT	WEIGHT	STACK HEIGHT
0056	SKU 1	48X0.050	180	18	3.4	3.4	9.6	0.06	28.8	21.5	11	2.9	110	115	140	575.6	3
0047	SKU 2	12X0.750	60	10	9.2	9.2	25	1.2	36.5	27.9	22.6	14.72	120	100	116	638.8	3
0059	SKU 3	12X0.750	70	14	6	6	26.3	1.18	34	20.5	26.5	14.68	120	100	151	1077.6	2.5
0040	SKU 4	24X0.375	66	7	4.2	4.2	19	0.68	35	26	19	16.84	120	100	134	1161.44	3
0060	SKU 5	48X0.050	240	24	3	3	9.8	0.06	24.7	18.7	11.5	2.86	120	100	126	746	3
0170	SKU 6	12X0.750	70	14	7.5	7.5	30.6	1.22	30	29.5	23	14.92	120	100	158	1094.4	2
0511	SKU 7	48X0.050	66	18	4	4	19.4	0.7	36	28	20	17.06	120	100	133	1181.24	3

Table 7: Sales data by SKU

		Forcast Sales for December				Projected stock holding pallets			
CODE	PRODUCT NAME	2012	2013	2014	2015	2012	2013	2014	2015
0015	SKU 8	58 cs	68 cs	89 cs	92 cs	1	1	1	1
0016	SKU 9	289 cs	344 cs	397 cs	465 cs	5	6	7	8
0151	SKU 10	364 cs	433 cs	500 cs	585 cs	6	7	8	9
0152	SKU 11	11 cs	13 cs	18 cs	18 cs	1	1	1	1
0153	SKU 12	7 cs	9 cs	12 cs	12 cs	1	1	1	1
0155	SKU 13	5 cs	7 cs	12 cs	13 cs	2	2	3	3

Table 8: Stock holding by SKU

There were a number of different product packaging to consider namely; cans, large 50L containers, small, medium and large bottles of concentrate and premix. Each product has to be catered for in the warehouse.

From the information which ILS was provided with, a table was compiled to split the category of the products as different products are stacked and stored differently due to regulations, weight restrictions or quantities on a truck.

Typically in the beverage industry, pallets are stored in a block stack fashion. It was evident that canned beverages were very fast movers, while the majority of the bottled concentrate products had lower throughputs and thus were thought to be stored in a different manner to the cans to better utilize the height of the building.

The table below is a simple Pareto analysis to display which SKU's make up 80% of bottle sales and the SKU's which make up 80% of canned beverages. In the table below we see that 12 SKU's made up 81% of concentrate bottle sales and 12 SKU's make up 80% of premix and medium bottles sales.

Concentrate sales forcast for December 2012						
Code	Product	# of cases sold/month	cases / pallet	pallets sold /month	% of concentrate sold	% of concentrate sales
2150	SKU 10	165881	75	2100	22%	22%
2160	SKU 11	82106	70	1099	12%	43%
2170	SKU 12	175997	196	930	9%	43%
2232	SKU 13	56301	60	915	9%	52%
2234	SKU 14	49190	70	710	7%	59%
1956	SKU 15	39035	75	508	5%	64%
1997	SKU 16	26978	68	388	4%	68%
2038	SKU 17	23016	65	352	3%	72%
2079	SKU 18	22856	66	347	3%	75%
2120	SKU 19	18313	75	250	2%	77%
2161	SKU 20	10988	60	187	2%	79%
2202	SKU 21	8703	50	175	2%	81%

Table 9: 80/20 principle for sales of concentrate

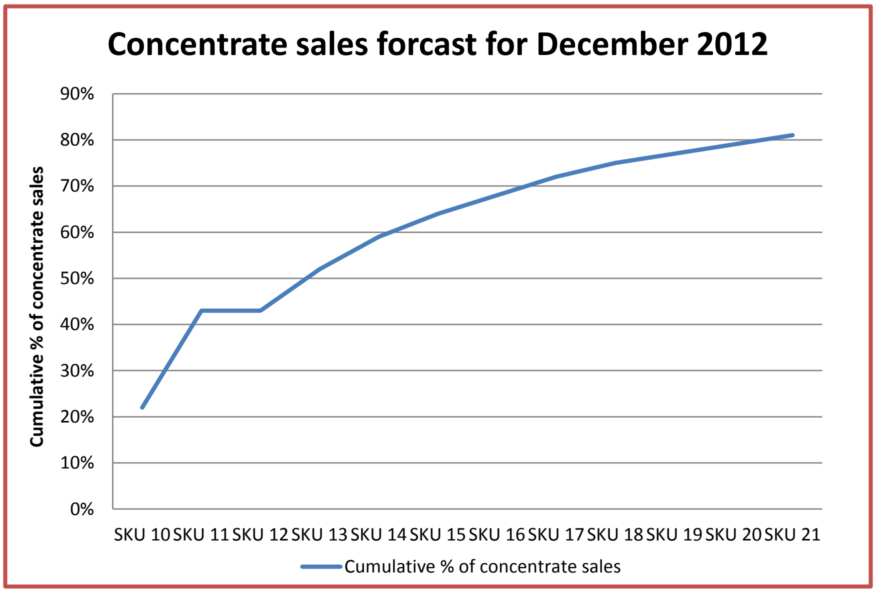

Figure 16: Cumulative Graph for concentrate sales

Premix sales forcast for December 2012					
Code	Product	cases / pallet	pallets sales FC /month	% of total sales/ month	% of concentrate sold
8578	SKU 22	60	36029	28%	28%
8588	SKU 23	82	12018	11%	39%
8650	SKU 24	82	8895	7%	46%
8412	SKU 25	90	8524	7%	53%
2988	SKU 26	60	5622	5%	58%
2989	SKU 27	60	5474	4%	62%
8651	SKU 28	60	4820	4%	66%
8652	SKU 29	82	4577	4%	70%
2245	SKU 30	54	4451	4%	74%
8770	SKU 31	82	4398	3%	77%
8772	SKU 32	82	4191	2%	79%
8771	SKU 33	60	2944	1%	80%

Table 10: 80/20 principle for sales of pre-mix

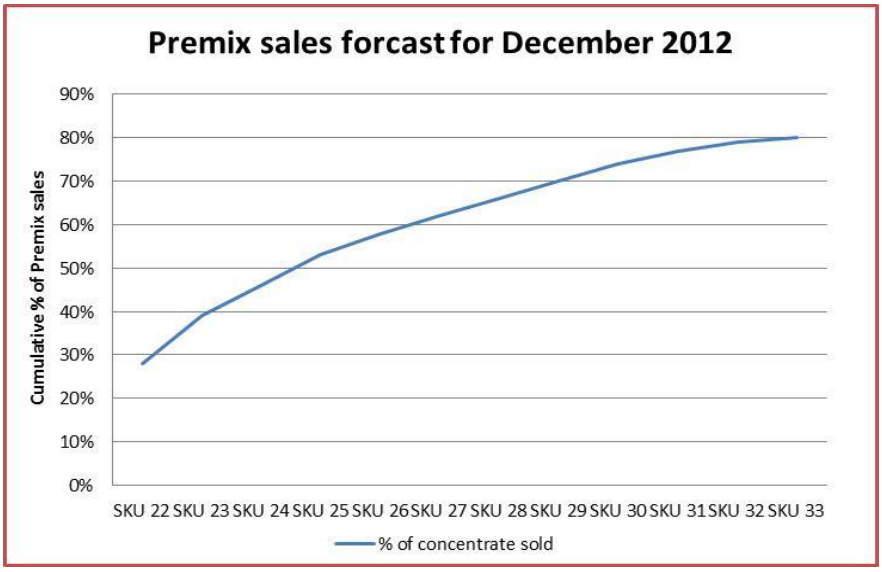

Figure 17: Cumulative graph for premix sales

Now that the products are sorted according to category and volumes of stock moved per month, the different stacking or storage techniques can be discussed.

Storage systems could now be evaluated to handle the high volume stock, medium moving case picking and slow moving unit picking.

4.3 Phase 3: Concept Design

4.3.1 Develop Block Layouts

The first step in conceptual design layouts was to prepare a range of high level block layouts of the main "puzzle pieces" or operational areas (identified above). During this phase the inter relationships between the key areas were identified and a range of block configurations were evaluated to determine the best fit within the facility envelope. The aim was to select a configuration of operational areas which enabled streamlined flow, reduced travel time and double handling and allowed growth. This phase also served as a first pass space planning exercise – the outputs from the areas measured during the operations review and data analysis undertaken were used to estimate the size of each block.

Key operational area inter-relationships were identified as follows:

Receiving and dispatch had to be located close to the doors in order to decrease travel time from truck loading area to receiving. This would also increase security as the checking station as paperwork was filled out at receiving.

The bulk storage area had to be located close to the **receiving and dispatch doors** as they are the fast movers that make up the majority of ABC Beverage Company's sales. By doing this forklift travel time per pallet handled is reduced –enabling an increased hourly throughput.

The unit picking area was identified as needing to be close to dispatch (as opposed to receiving) to again reduce the distance pickers have to walk, thereby optimising the picking cycle times, reducing truck waiting times and ultimately improving customer order lead times.

Receiving and dispatch needed a large secure area for staging pallets. This was to improve control when stock is received or dispatched. ABC Beverage Company had an airlock cage security system which had to be respected and implemented in the ILS design for dispatch of mixed pallets. The philosophy states that goods are placed in the cage at one end, the gate is locked, the load is checked and then the gate is opened at the other end and goods are loaded onto vehicle.

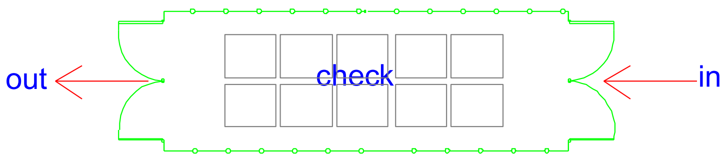

Figure 18: Airlock security philosophy

The pilot office had to be located between receiving and dispatch with the intention to share resources eg: computers, data cabling, office area, personnel etc. The positioning and visibility over the loading area was essential for decent control of the trucks arriving and exiting the site.

PnD stations (pick and deposit) are typically located at the end of the rack. This station is typically a painted block on the floor or a cantilever beam where the pallet is placed down by the forklift truck and picked up by the reach truck to put away.

Below is the optimal block layout presented to ABC Beverage Company, indicating the location and appropriate sizing of the operational areas. This was determined by the current measurement on site, the data analysed above as well as the projected growth.

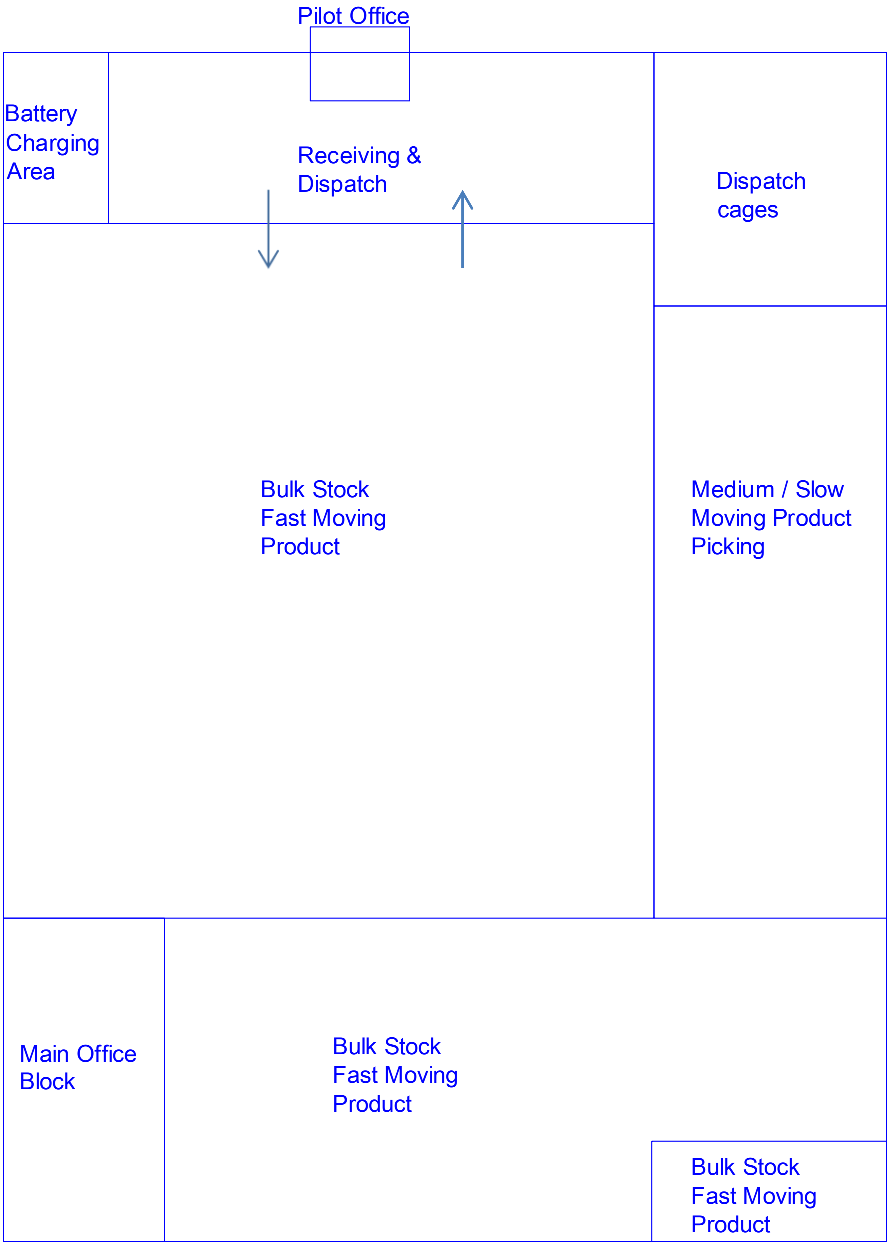

Figure 19: Optimal block layout

4.3.2 Develop Materials Handling Layouts

Once the final block layout had been developed and accepted we began developing internal materials handling layouts within each block.

4.3.2.1 Receiving & Dispatch

The **receiving and dispatch areas** were sized and designed to support the expected inbound and outbound volumes. The areas were then detailed to define product staging areas, checking areas as well as movement areas for people and materials handling equipment. The layout of the receiving and dispatch areas also included the design of the security (fencing) systems to allow improved control and reduce theft (as detailed above).

4.3.2.2 Storage System Selection

The storage and picking system selection made up a significant component of the concept design. It is during this phase that a range of potential storage systems and materials handling technology was evaluated to determine the best fit to ABC Beverages requirements. Systems for bulk pallet storage (fast, medium and slow movers), case picking and unit picking had to be selected.

When selecting storage, picking and materials handling systems – it is essential to review a wide range of criteria appropriate to the specific operation. In the case of ABC Beverages throughput (pallets handled per hour), foot print utilisation and equipment cost were priorities.

The fast to medium moving palletised product (12 SKU's) made up 80% of pallet stored. Due to the fact that the data indicated that ABC Beverages had a low number of SKU's but a high number of pallets per SKU – a range of high density pallet storage systems were reviewed. These included block stacking, push back rack, radio shuttle rack, drive-in racking and pallet flow rack. Although not a high density storage system, selective pallet rack was also considered due its wide spread use within warehousing environments.

The storage comparison matrix indicates the criteria which ILS followed to make the most practical decision on which storage systems to evaluate in the concept design phase.

	Evaluation Criteria								
Storage System	Height Utilization	Foot Print Utilization	Throughput	Safety	Industrial Lift Trucks	Flexibility	Cost per pallet	Operation Maintenance	Total
Unit of measure	m	sqm	Pallet/hr handled		Rand				
Block Stack	2	5	5	4	5	5	5	5	36
Static	5	2	4	3	3	4	4	4	29
Push Back	3	3	3	3	3	3	3	2	23
Radio Shuttle	4	5	3	3	2	2	1	1	21
Drive-in	4	4	1	1	3	2	3	4	22
Flow Rack	4	4	4	3	3	2	0	2	22

*Ranking represents a score between 1 and 5, 1 being poor and 5 being excellent in the relevant field

Figure 20: Storage system comparison matrix

It is evident from the table above (and graph on page 28) that the most practical options to evaluate further were:

- 1st Option: Block Stack
- 2nd Option: Static conventional racking

Push back, radio shuttle, drive-in and pallet flow rack were eliminated from the concept design phase. The trade-off between the high capital investment versus the storage capacity and throughput benefits achieved did not justify further investigation.

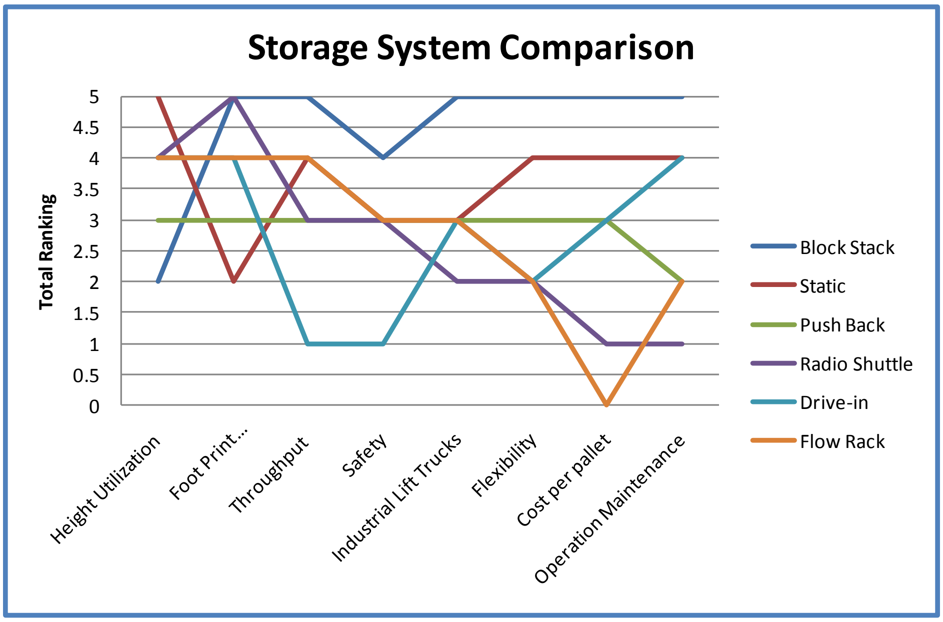

Figure 21: Storage system comparison

Following further evaluation it was decided that the design should include a mix of both **block stacking** for high volume pallet storage and **selective rack** for medium to slow pallet storage.

Block stack was selected as the optimum storage system for the high volume pallets – especially due to the ability to handle two pallets at a time with a forklift fitted with dual forks (not possible in any of the other storage options) and high density achieved (30 to 400 pallets per SKU). It should also be noted that block stack is the most commonly used storage methodology in the beverage industry.

The stack height was restricted because the weight of the pallets ranged from 600kg to 1450kg. The heavy pallets when stacked more than three on top of one another would damaging the product below.

The pallet lanes in block stack were restricted to being 100mm apart as the forklift truck handling double pallets would need to drive into the lanes to pick up the pallets without damaging or driving into the lanes adjacent to it.

Figure 22: Block stack

Selective rack was chosen due to its wide range of applications within the ABC Beverage operation. Firstly selective rack proved ideal for the storage and picking of the medium to slow moving palletised stock (typically 1 to 5 pallets per SKU) – enabling the full use of height within the facility.

Secondly the ground level positions within the racking were designed to allow for picking of full cases off pallets. In addition certain of the ground level positions were fitted with a carton live / flow system enabling efficient picking and replenishment of individual units (see the literature review for further detail).

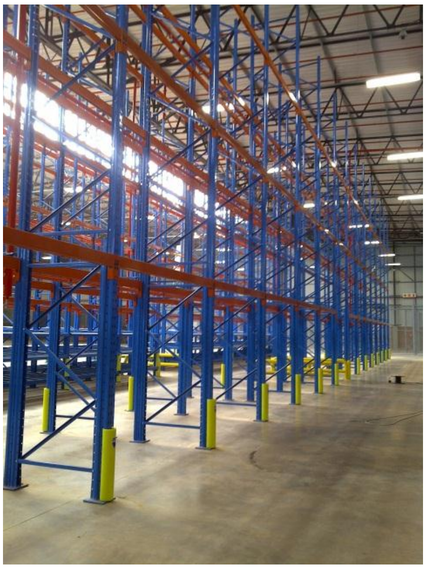

Figure 23: Selective racking

Figure 24: Case live system

The figures above are the actual photographs of the warehouse which was developed and fitted out with static rack and flow rack in a portion of the warehouse. The 'Required' column indicates the capacity which was required by ABC Beverage Company, while the design accommodated the numbers displayed in the 'Actual' column.

	Required	Actual
Number of pallets in Blockstack	5124	5228
Number of Pallets in Rack	306	1112
Total Capacity of WH	**5430**	**6340**
Required 2012	5430	
Growth		17%
SKU's in Block Stack	37	
Utilization of the Static Rack	28%	

Table 11: Capacity of final design

Dynamic load on the floor

1450	MAX kg per pallet
3	Beam levels
2	pallets per frame pair
2	frames per pair
8700	kg per upright pair
4350	kg load per upright

$$1450 \times 3 \ \times 2 = 8700\ kg$$

$$8700 \div 2 = 4350\ kg$$

Equation 1: Dynamic load on floor

4.3.2.3 Industrial Lift Truck Selection

The selection of industrial lift trucks was a logical progression of the storage systems selected.

The block stack operation required a machine had the capacity to lift two 1.5Ton pallets to a lift height of 4.5m. The only machine that meets these criteria is a **4 wheel, 3.5Ton forklift** fitted with a dual fork attachment. Operator safety and ergonomics was a key element when selecting such a machine, thus the forklift selected was specifically modified to accommodate a raised cab enabling the driver to have a clear view over the top of the pallets. Four 3.5 Ton Forklifts were purchased for the ABC Beverage Company.

Figure 25: Forklift with double pallet handler

The selective racking required an industrial lift truck with the ability to lift a 1 ton pallet to 9m high. Three types of industrial lift trucks meet these criteria – they include:

- Reach Truck
- Articulated Forklift
- Turret Truck

The Reach Truck was chosen as the ideal lift truck for the application. The reach truck was the most cost effective and a flexible choice. The throughput calculations dictated that two machines be purchased.

Both the articulated forklift and the turret truck were eliminated due to cost. In addition the turret truck required a super flat floor and specialised wire guidance system, which rendered the design in flexible. It should also be noted that the articulated forklift and turret truck are best suited in a narrow aisle rack environment, while the ABC Beverage Company's design required a wide aisle configuration to enable picking in the same aisle at ground level.

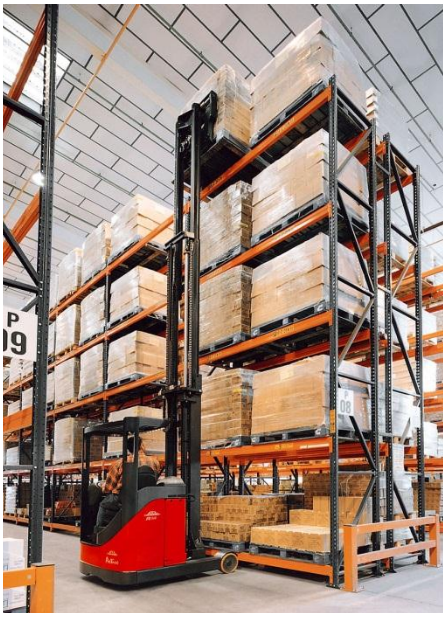

Figure 26: Reach truck

4.3.2.4 Sundry Elements

Fencing

High value stock had to be stored in a racked area which was secure and managed by one security guard. ILS located the HVC (high value cage) close to the offices which made it visible to the office staff. The HVC was also located close to the staff entrance, which had to be manned by a guard already. This would save the company from employing another guard just to man the HVC.

Point of sale cages (POS) are areas where all the promotional stock was to be stored. The requirement was for 3 cages each one with access to the exterior

In-Rack Sprinklers

Local fire regulations require in rack sprinklers to be installed when product is stored in racking above 4.5m. An in-rack sprinkler design was undertaken to meet the local council regulations, SANS and the Automatic Sprinkler Inspection Bureau standards. A 150mm back to back clearance (between products) in the racking was catered for to ensure heat and smoke can rise to the nearest sprinkler head in the event of a fire. Sprinkler pumps and tanks were also installed to ensure sufficient water pressure and a 90min water supply in the event of a fire.

Figure 28: Sprinkler head

Figure 27: Feeder pipe

Building & Equipment Protection (Bollards etc.)

It is recommended, where high throughputs occur or where turning circles are tight and damage is likely to occur that racking is protected by the use of bollards and frame protectors.

Many different types of bollards are available. Generally bollards are used to prevent minor collisions and minor damage to racking systems. Bollards will generally not protect racking against major collisions. The bollards below were strategically located to protect racking and aspects of the building within the ABC Companies facility.

Figure 30: Pipe bollard

Figure 29: End of aisle bollard

Battery Charging

The battery charging facility is a key component of a warehouse operation. The design of a typical battery bay should allow for the ability to both change and charge industrial lift truck batteries. The ABC Beverage Company operates a two shift operation. A typical lead acid battery has an 8hour life – thus it was necessary to design and install an overhead crane system to remove the batteries from the forklifts and reach trucks. In addition the battery bay was fitted with latest generation high frequency chargers.

The ABC Beverage Company follows strict safety and fire regulations and required the battery bay to be fully enclosed (as lead acid batteries have the potential to explode).

The following items influenced the battery charging area design.

- Type of machine (size, height, battery position etc.)
- Battery type (size, weight)
- No. of machines (no. of batteries at any one time)
- No. of shifts per day (complexity)
- Method of charging (charge on board or swop system)
- No. of changes required per hour (turnaround time)
- Physical space available (Floor and height)
- Process flow required
- Health & Safety Regulations
- Environmental aspects (drainage etc.)

Figure 32: Forklift battery

Figure 31: Overhead crane

Signage

Standard signage should be displayed clearly and fixed to the racking as required by the Occupational Health and Safety Act (OHS). This signage should be large enough and clearly displayed on the racking.

Signs include:

- Rack labelling (position labelling- related to operations)
- End of aisle tow labelling
- Weight restrictions on rack loading
- Equipment access to racking area

4.4 Prepare Cost Estimates

Once the materials handling designs were finalised, it was necessary to develop a cost estimate for the equipment proposed in the design. The cost estimate was used by ABC Beverage Company to prepare a CAPEX application as well as a reference during the procurement phase of the project to ensure that the project came within the budgeted amount. All costs prepared were within 5% of actual costs.

Some of the budgeted unit costs included:

- Selective Racking – R380 / pallet position
- In Rack Sprinklers – R130 / pallet position
- End of Aisle Bollards – R3,400 each
- Pipe bollards – R1,000 each
- Weld Mesh – R650 per m
- Reach Truck - R430,000
- Forklift with dual fork – R580,000
- Demarcation lines – R50 per m

4.5 Evaluation of building & site interfaces – Truck Flow

The building and site configuration is key to the planning of a new distribution centre and each constraint on site will affect the operation. Although the building design had already been developed, ILS was requested to provide input on certain of the design elements which directly affected the operations.

Truck Flow

Truck flow and circulation on site is a critical component to the design of a distribution centre. It is essential to ensure that there are no bottlenecks in the loading and unloading of vehicles on site – a bottle neck related to vehicle flow on site would cause a ripple effect with the internal operations.

A circular flow where the tucks would enter the site and drive all the way around the building to the exit was developed for the ABC Beverage Companies site. The issue with this design was that cars and trucks would be driving in the opposite direction around a blind corner at the office block and thus potentially have a collation.

It is best practice to split the car and truck traffic at the entrance, avoiding the safety risk completely. This methodology was followed in the second figure where trucks and cars were split with an island at the boomed entrance. Trucks would enter the site and exit the same way they entered. The only negative was that the large loading canopy had big columns to support the structure. These columns had to be painted in yellow and protected with foam barriers to prevent the drivers from colliding with them.

5. Conclusion

A distribution centre is a core component of ABC Beverage Company's business and distribution network. It is evident that proper facilities planning will improve the operations of the business. ILS followed a clear, tried and tested process flow, data analysis and design techniques to develop the most flexible, optimal design for ABC Beverage Company. The design was based on best practice bench marks set nationally and internationally.

ABC Beverage Company has gone live in the new Pretoria facility and all indications show that the facility can handle the throughputs as calculate. The facility will be running at full capacity within the next month to cater for the busiest season –Christmas.

6. Bibliography

Supply Chain Today Magazine. (2011, July). *Issue*.

Acrow Advertisement Supply Chain Buyers Guide. (2011/2012).

Bailey, M. (2010). *Rack User Guide.* Promech Publishing.

Bailey, M. (n.d.). Certificate in Storemanship. *Center of Logistics Excellence*.

Google Books. (n.d.). Retrieved August 5, 2011, from http://materialhandling%ots

ILS, D. o. (1997-2011). ILS Database.

SA Bureau of Standards. (n.d.). Retrieved from www.sabs.co.za

Thomas, C. (2011, May 30). (J. Fuller, Interviewer)

Thompkins. (2003). *Facilities Planning Third Edition.* John Wiley & Sons Inc.

Tompkins, J. A. (2003). *Facilities Planning.* United States: John Wiley & Sons.