

**BPJ 421**

**Project Report**

**Development of TrenStar onsite depot for reusable packaging at  
Ford**

**by**

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## Executive Summary

Ford Motor Company is planning to build a new range of T6 Ford Ranger vehicles and needs an onsite depot to handle reusable packaging to accommodate approximately 200 vehicles per day. TrenStar provide many of the suppliers with reusable packaging to transport the parts to manufacture the new T6 Ford Rangers. Ford has requested that TrenStar design an onsite depot at the Ford factory in Silverton. The TrenStar onsite depot will only handle the empty TrenStar reusable packaging.

Information gathering and research was done on yard management and what is expected outcome and objectives of a yard. Technology used to track the reusable packaging has been briefly discussed in the report. The type of reusable packaging and their specification that will flow through the onsite depot has been identified and these TrenStar packaging are collapsible cages, bins, interlayers and specialized containers

A capacity model has been created to calculate how many reusable packaging is needed to build the required amount per day. Information has been gathered from the PFEP (plan for every part) and sorted that only the parts that use the TrenStar packaging is taken into account. Then calculations on how many parts are needed for every type of vehicle and model and how many parts are placed in the type of packaging has been taken into account to work out how many reusable packaging of every type is needed per day.

After the capacity model is build, the space required for all the reusable packaging is calculated, with stacking heights taken into account and the area that the packaging will occupy. This information is used to make conceptual designs for the depot.

Using the Muther's Systematic Layout Planning (SLP) procedure to create layout designs for the new depot, four alternatives were developed and Alternative A has been decided by TrenStar to be the most practical design. Staging area outside the depot has been designed as well and the processes for the depot have been stipulated.

The depot design that has been developed for the project, meets all the criteria identified by TrenStar and Ford Motor Company. The current design can handle the volumes of reusable packaging, has the identified areas required to perform all the functions that is needed to service, store and prepare the reusable packaging for dispatch. A staging area has also been designed to support DHL truck's with loading of the reusable packaging. This new depot must provide Ford and their suppliers with the best support and service with reusable packaging, as well as tracking the packaging from the depot to the suppliers and back, giving total visibility to the supply chain.

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## Definitions

**Reusable Packaging** – is containers, pallets and dunnages that move products, parts and subassemblies effectively, efficiently and safely throughout the supply chain. It can be used over and over again.

**Receiving** - Ford sends empty reusable packaging to the onsite depot, which is received and scanned in at receiving area at the onsite depot.

**Inspection** - The reusable packaging is packed out one by one and inspected to see whether it needs to be cleaned, damaged or if it needs barcode replacing.

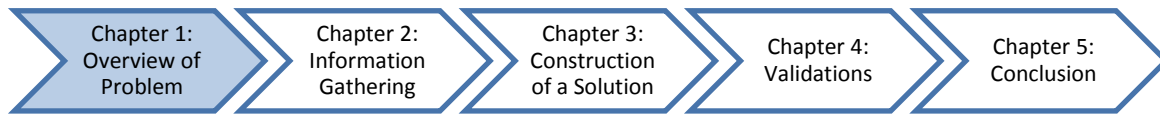
**Storage** - Storage is the allocating of space to an equipment to await picking or further processing. Packaging is moved to the designated area and waits to be picked for staging.

**Picking** - Picking is the activity that relates to collecting the equipment that has been ordered by the customer.

**Staging** – It is the activity of placing the picked products in an area so that when the truck arrives to collect the order, the batch can be loaded directly onto the truck without waiting for the product to be picked.

**Dispatching** – The sending of reusable packaging to suppliers using transport (trucks), after that supplier places and order.

# Chapter 1: Overview of Problem



## 1. Introduction

TrenStar is an integrated logistics and asset management solutions company, which deals with a large range of customers in various industries. Their solution range from reusable packaging on one side of the logistics field, to receiving, dispatching and cross-docking management in the middle and finally electronic warehouse management on the other side. TrenStar tracks various assets through the supply chain, to give total visibility of customer's assets, as well as container collection, cleaning and storage of reusable containers. TrenStar's reusable packaging is cages, bins, pallets, interlayers that fit into the cages and specialized containers.

TrenStar is currently providing a service for Ford Motor Company of Southern Africa. They provide various parts from their suppliers, as well as a service, including onsite service relating to reusable packaging and management thereof.

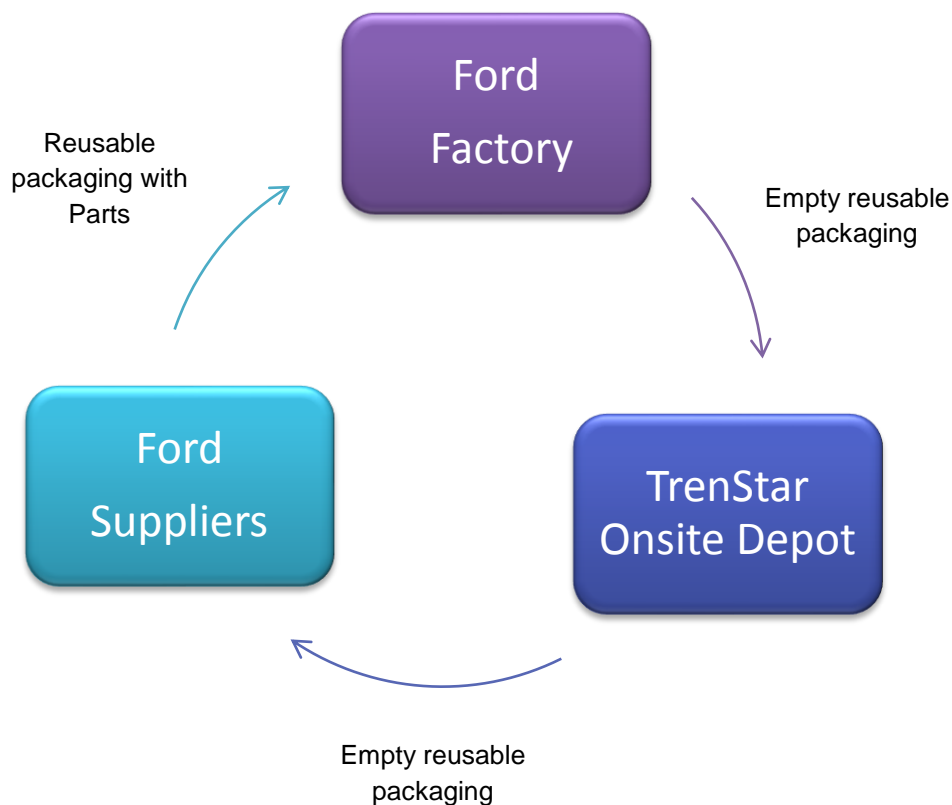
The new T6 Ford Ranger automobile is going to be manufactured by Ford Motor Company, South Africa in Silverton, Pretoria. Ford SA receives different parts for the vehicle from various suppliers throughout South Africa and has requested that TrenStar provide a service that supports their requirements in the evaluation and redesign of supplier reusable packaging for components and sub-assemblies received from national or international markets, for the T6 project.



Figure 1: T6 Ford Ranger

The project requires that TrenStar design and manage a new onsite depot within the Ford SA Pretoria grounds, manage returnable packaging, support milk run solution, receive packing in plant, as well as assist with the tracking of their components indirectly from their suppliers.

Currently there is an area allocated for the new depot, inside Ford SA, Silverton, with a wash area already built within the legal requirements for drainage. TrenStar would like to optimize the efficiency through the depot by concentrating on the physical flow of the packaging through their onsite depot. This would include the design layout of the onsite depot, minimizing of material handling, setting up standard procedures that would state how packaging should be handled, inspected, washed and stored. TrenStar wants to minimize idle time of the packaging on the site and wants to upgrade current material handling equipment and processes.



## 2. Project Background

### 2.1. Problem Statement

A new onsite depot at Ford Motor Company must be designed to facilitate the flow, inspection, washing and temporary storage of empty reusable packaging after the parts and subassemblies have been delivered to the factory to use in the manufacturing of the T6 Ford Ranger.

### 2.2. Project Aim

The designing of a new TrenStar onsite depot which is fully equipped to handle a whole range of empty reusable packaging returned from the factory after the parts has been used in the building of the vehicle.

### 2.3. Project Objectives

Design an onsite depot to cater for the returned reusable packaging that was used to transport parts to build approximately 200 units per day and this should include:

- The receiving, storage and return of reusable packaging to suppliers.
- The inspection of reusable packaging.
- The cleaning of returnable packaging.
- The scanning of the reusable packaging for tracking purposes.
- Staging of equipment for truck loading must be developed.
- The returning of reusable packaging to suppliers throughout South Africa.

Facilities planning for onsite depot needs to minimize material handling to reduce the idle time of reusable packaging.

### 2.4. Project Constraints

- **Actual capacity for reusable packaging:** Ford plans to manufacture approximately 200 units per day. The actual capacity of reusable packaging needed, must be determined so that the site can be designed to handle the volume for the maximum cycles, hence shortest turnaround (2 days).
- **Staging:** The process of loading reusable packaging for suppliers into trucks needs to be developed in a way that material handling will be minimized and trucks will be loaded within allocated 30 minutes at the site.
- **Space constraints:** Space in the new depot might be a problem with the anticipated volumes. Facilities layout will have to be accurate to ensure that the depot can handle the volumes and can handle higher volumes if capacity changes at Ford.

## 2.5. Project Deliverables

- Volumes of packaging to flow through depot.
- Depot design that meets objectives.
- Staging design that can cater for DHL schedule.
- Defined depot processes.

## 2.6. Stakeholders

- **TrenStar:** Is the reusable packaging specialist. TrenStar is responsible for the supplying of reusable packaging and specialized packaging (interlayers) to transport and store parts for the new T6 Ford Ranger. TrenStar is also responsible for the tracking and managing of the reusable packaging. The main TrenStar employees involved and that will be affected by this project is:
  - **TrenStar Management**
  - **TrenStar onsite supervisor**
  - **Yard Operators and Forklift drivers**
  - **Bin Coordinator**
  - **Command Center monitors**
- **Ford Motor Company:** Ford is the client. Ford Motor Company is in charge of the building of the T6 Ford Ranger and thus decides on the number of units they would like to manufacture.
- **DHL:** is responsible for the outbound and inbound transport. This is transport of empty reusable packaging from the TrenStar onsite depot to the suppliers and full reusable packaging from suppliers to Ford receiving.
- **Schnellecke:** is responsible for transport within the Ford Motor Company, in Silverton. Therefore any parts, dunnages, equipment to different areas within the Ford plant will be moved by Schnellecke. They are responsible to bring the empty reusable packaging from the Ford factory to the TrenStar onsite depot.
- **Ford Suppliers:** Ford receives parts from many suppliers spread across South Africa and the World. Many of the South African suppliers use TrenStar packaging to transport their parts to the Ford Factory in Silverton.

## 3. Project Scope

### 3.1. Information and research gathering

The first stage of the project will be concerned with research for the problems stated above. A study on the different types of tracking technology used by TrenStar, various types of reusable packaging with its specifications and understanding their Enterprise Asset Management system (EAM) that TrenStar practices.

Literature review will help find the best facilities layout methodology and principles for Ford Motor Company, which will allow TrenStar to implement best practice methods for the material handling, layout design, picking and staging of the reusable packaging.

Current processes will have to be studied at one of TrenStar's existing depots to grasp the full picture of what must happen in the new depot and to find existing problems and solving them for the new depot.

### **3.2. Calculation of Capacity**

The next vital stage is the calculation of volume that will flow through the new depot. The capacity will depend on the number of parts needed to build one unit, multiplied by the number of units to build, divided by how many parts fit into the packaging type. Fords standards of packaging must be taken into account when calculating parts per reusable packaging.

### **3.3. Space requirements**

When the amount of reusable packaging has been worked out per day, the space required for each packaging needs to be calculated. This will be affected by stacking heights and types.

### **3.4. Facility layout designs**

Once the capacity and space has been worked out, different facility layout options must be designed to find the best blueprint to handle the reusable packaging with minimal material handling and idle time. Resources need to be defined to meet the criteria.

### **3.5. Evaluation of different solution and selection**

Assessment of the different facility layouts must be done by appropriate evaluation techniques. This can be listing advantages and disadvantages, weight factor comparison and economic comparison. Best facility layout will be chosen that meets the requirements specified.

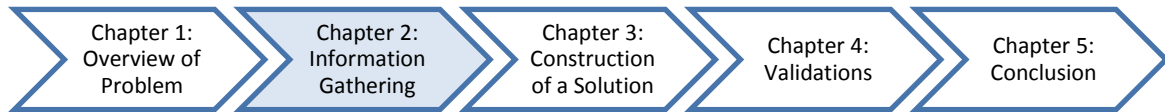
### **3.6. Specify Processes in depot**

Processes of the new depot must be developed and stipulated to support the new layout. Inspection, washing, storage, picking and staging must be defined to help the flow of the depot new layout.

### **3.7. Present Solution**

The selected layout is presented to the relevant stakeholders. This presentation will be in a form of a report with the relevant recommendations and presented orally.

## Chapter 2: Information Gathering



### 1. Literature Review

Literature review is extremely important to help the researcher/designer use the right methodologies, principles and discover new knowledge. It can make one aware of new methods, tools and technologies that were used in similar projects.

Yard management is researched to get a better understanding of what is needed in a yard management system and what factors are important to ensure that the TrenStar depot design covers all these factors.

Tracking technology, TrenStar Enterprise Asset Management system, supplier's online ordering process and reusable packaging is also discussed in this review to get a better understanding of TrenStar business, processes and packaging.

Processes needed for the new onsite depot was also researched at existing depot on other sites, to identify what areas are needed, what is done in these areas and what are the processes and standards in these areas.

Finally in the literature review, facilities layout methodology has been reviewed, to ensure that the right procedure to produce designs for the depot is used in this project.

#### 1.1. Yard Management

##### **What is Yard Management System (YMS)?**

YMS provides visibility of inbound and outbound assets to the yard. It facilitates and organizes the coming, going and staging of assets in a yard that serves a warehouse, distribution or manufacturing facility.

##### **Information that is needed for an YMS is:**

- What assets are currently in my yard?
- Where are the assets within my yard?
- What are the statuses of the assets?
- What are the statuses of each dock door and yard slot?
- Who was the last driver?

There are various means to acquire this information; manually, barcoding, scanning, RFID, etc.

### Why use Yard Management System (YMS)?

- To get assets in and out the yard on time.
- To have enterprise wide visibility of what is in the yard.
- Eliminate idle assets and reposition asset based on need.
- Able to plan and sequence docking, unloading and loading.
- Reduce idle dock times and plan for peak times
- Receive reports on the complete history of the yards activities.
- Can receive alerts when wrong activities occur. (HighJumpSoftware Inc, 2011)

### For effective Yard Management

- **Active 100% visibility of assets** – This means being able to track the asset as it enters the yard until the time that it leaves the yard. This also applies when locating the asset when it is needed.
- **Have a single point for Yard Command and Control** – Being able to assess real-time information about the activities in your yard, helps efficiency in the yard.
- **Managing dispatching events proactively** – Late shipments affect your dispatch of your facility, making it harder to deliver to your customer. A proactive approach can decrease the costs associated with late arrivals.
- **Maximizing Space Utilization** – When wasted space is reduced, it will give you additional room for storage and eliminates the need to expand your facility unnecessarily.
- **Facilitating Scheduling** – Planning and communicating your schedule for the yard will help activities run smoothly and reduce late dispatches. (Wireless Communications Alliance, 2007)

## 1.2. Tracking Technology

### What is Scanner/Barcode technology?

To collect data on assets one needs to uniquely identify each asset. Barcoding, Radio Frequency IDentification (RFID) is used to track assets across the supply chain. Unique barcode is given to an asset to identify it and provides a certain amount of data so that a scanner can rapidly read it and relay this information to an information system, information of what the asset is and where has it been scan last, etc.

#### Scanning

TrenStar uses a multitude of different scanning tools that work in union with their barcodes and RFID tags. The scanners are programed with TrenStar's EAM moby software and are integrated with the EAM system.

A GPRS enabled wireless handheld barcode scanner allows it to operate as a self-contained device that includes GPRS based communication connection. General Packet Radio Services (GPRS) is a packet-based wireless communication service that is based on Global System for Mobile (GSM) communication and complements existing services such as cellular phone connections and the Short Message Service (SMS).

### How does the scanning work?

- 1.1. The container is moved to an area, an operator can scan the container to where he is going to move the container (dispatch scan) or scan the container when he receives it (receive scan). This process is called a movement scan and gives the position of the container.
- 1.2. Barcode of container is scanned with wireless GPRS handheld scanner, the horizontal laser light line is held over the barcode. The scanner registers the barcode on the scanner and then the wireless scanner download the information to the EAM information system.



- 1.3. Other functions can also be logged with the scanner, depot functions like damage assessment, where the barcode is scanned and the damage on the container is logged onto the scanner that is connected to the information system. Inspection can be done with the scanner and a whole variety of other functions can be programmed onto the scanner.



Figure 2: GPRS scanner

### What is RFID technology?

RFID (radio frequency identification) technology works by the fixed RFID reader wirelessly communicating with the RFID tags (technically known as transceivers) on the assets, allowing TrenStar to capture the identification and information on this tag that is linked to the asset that the tag is connected to. The reader is a device that has one or more antennas that emits radio waves and receives signal back from the tag. The reader then passes this information in digital form to a computer system. The computer system then transfers the information to TrenStar's information system via a modem. (Dave Harrington, RFID Technologist at TrenStar, 2011)



Figure 3: RFID reader

There are also wireless handheld RFID scanners that can be held near the container and the scanner will read the tag on the containers and log this information to the information's system.

RFID allows for real-time visibility within your yard, permitting companies to manage their activities and yard operations, to become easier and more efficient (Falken secure networks, 2011):

- Speeding up gate processing
- Helping scheduling
- Manage your docks more effectively
- Reduce bottlenecks
- Link with ERP, WMS and TMS

### Three types of RFID tags

1. **Active RFID tags:** battery operated, with a processor and local intelligence tag that has to communicate with multiple receivers concurrently.
2. **Passive RFID tags:** no battery, no intelligent processing RFID Tags that are read by RFID readers.

**Semi-passive (BAP) RFID tags:** battery assisted passive (BAP) which has a small battery on board that is activated when in the presence of an RFID reader

| Issues  | Active RFID tags   | Passive RFID tags  | Semi-passive RFID tags   |
|---|--|--|--|
| <b>Tag power source</b>                             | Internal to tag  | Energy transferred from the reader                       | Internal power source  |
| <b>Availability of tag power</b>                    | Continuous   | Only when found in the field of the reader               | Use their battery to power chip only, require a reader to interrogate them first |
| <b>Required signal strength from reader to tag</b>  | Low  | High   | Not available  |
| <b>Available signal strength from tag to reader</b> | High   | Low  | Not applicable   |
| <b>Communication range</b>                          | Long range( Can be 30 m or more)                             | Short range(Typically under 3 m)                         | Long range (This research will find out how much this range is?)                 |
| <b>Multi-tag collection</b>                         | Scanning of thousands of tags from a single reader           | Scanning of a hundred of tags within 3 meters from       | Not available  |
| <b>Multi-tag collection</b>                         | Scanning of up to 20 tags moving at more than 100 miles/hour | Scanning of 20 tags moving at 3 miles/hour or slower     | Not available  |
| <b>Sensor capability</b>                            | Ability to monitor continuously monitor sensor input         | Monitor sensor input when tag is powered from the reader | Not available  |
| <b>Data storage</b>                                 | Large  | Small  | Large  |
| <b>Weight</b>                                       | 120-13g  | 6-54g  | Smaller size and lighter than active tags  |
| <b>Capabilities</b>                                 | Read/Write   | Read only  | Read/Write   |
| <b>Operational life</b>                             | 5-10 years   | Unlimited  | Over than 5 years  |
| <b>Cost</b>   | High   | Low  | Medium   |
| <b>General applications</b>                         | Tracks high value items over long range.                     | Tracking low value consumer goods;                       | Tracks cold consumer goods.  |

Table 1: Differences among active, passive, and semi-passive RFID tags (Emcis, 2011)

### 1.3. Enterprise Asset Management

EAM system is a software system developed by TrenStar that helps clients track and manage their assets. This software delivers information to its customers by providing a multitude of different types of reports, tailor made for the specific customer. Reports vary from asset movement, aging of asset on site, equipment status, etc.

EAM can also provide proof of delivery notification when assets are scanned in. Short shipment notifications when the delivery of assets is not complete. This software helps TrenStar manage customer's assets and needs to be linked to the new Ford onsite depot.

### 1.4. Suppliers Online Ordering

TrenStar has a web-based application connected to their EAM information system that allows their customers to order rental packaging equipment online. Ford Motor Company requires that all their suppliers order their packaging for the T6 Ford Ranger project, online so that Ford can keep track of payment and stock that has been ordered.

This system also helps TrenStar manage the picking instructions for the day of collection by DHL and supports DHL milk run schedule. The supplier is required to place an order for reusable packaging 48 hours before collection, which will give TrenStar time to plan packaging, staging and collection.

*Figure 4* below shows the process flow of the online ordering process. The supplier logs onto the EAM web application and places an order (or edit), this sends an "Order Receipt Acknowledgement" via email to the supplier, to confirm that the order was received. The bin coordinator (TrenStar employee) checks whether there is stock in the depot to fulfil the order. If there is stock, the Bin Coordinator will confirm the order, sending the supplier an "Order Confirmation Notification". If there is not stock, the Bin Coordinator will change the order, inform the supplier and confirm it on the system. On the day of collection the EAM system will send the Onsite Depot a picking instruction for the supplier.

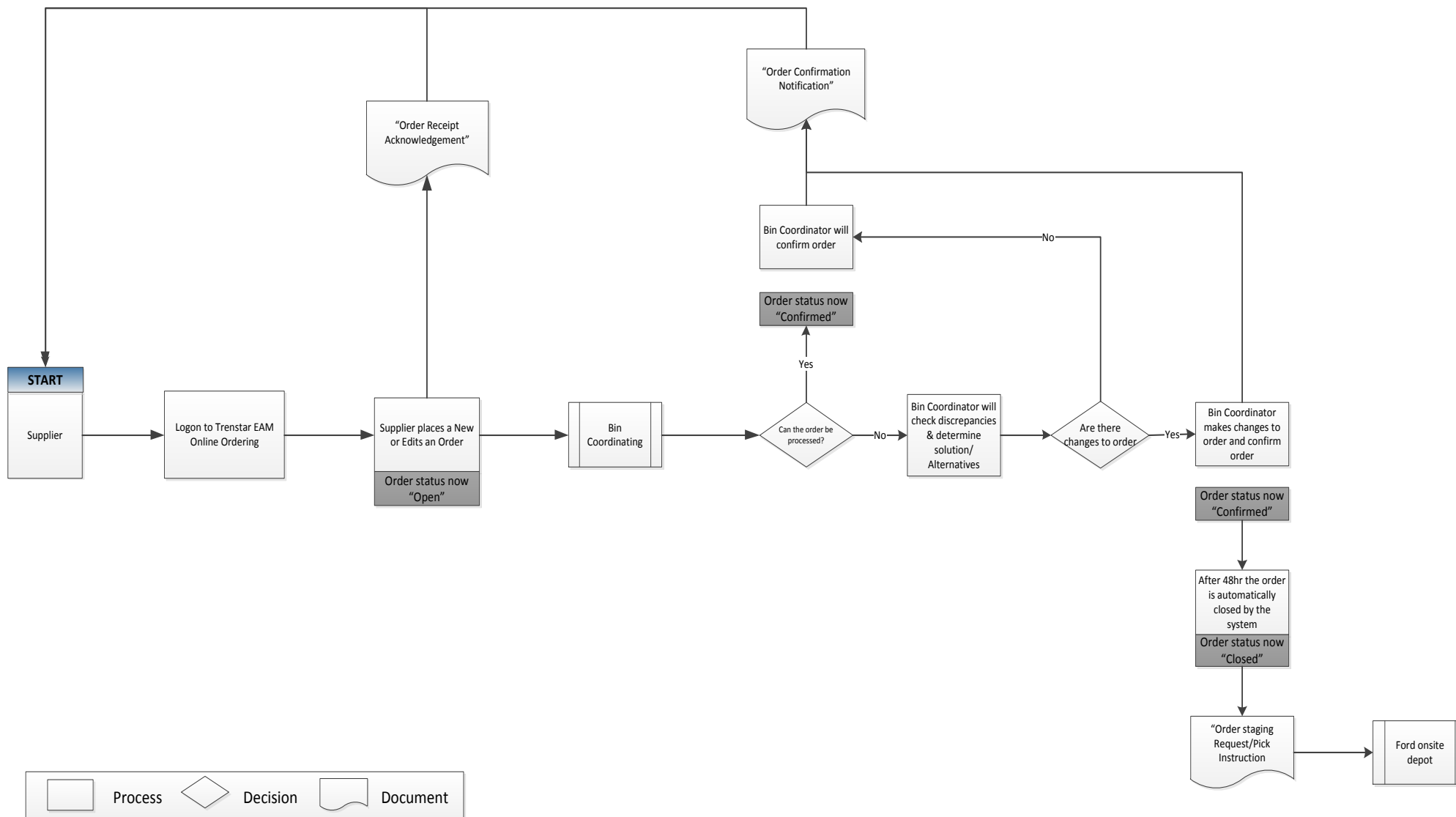


Figure 4: Online Ordering Process

## 1.5. Reusable Packaging

TrenStar reusable packaging varies from different cage sizes to various bin sizes. It allows customers like Ford to receive products in bulk as well as design specialized interlayers to fit in the cages so that the parts do not get damaged.

All of the packaging has a unique barcode to identify the type of packaging and all the packaging for Ford Motor Company will be RFID tagged, to make tracking faster through the depot. In *appendix C* below are examples of the TrenStar reusable packaging and specialized interlayer.

### Packaging Types and Specification

#### Cages

There are many types of cages, varying in size and material type. Solid Sided containers are splash proof and can handle high load capacities. The mesh cages have a flat mesh exterior to ensure the safe keeping of goods. Both types of cages are equipped with unique identification numbers for tracking and tracing. TrenStar cages can be collapsed to help with storage space and truck utilization or it can be fully assembled to carry parts.



**Figure 5: Collapsed cages**

To work out the space requirements for the depot we need to take the size of cage in consideration, as well as stacking height, quantity for each type of equipment. The data below gives the specifications for the TrenStar Standard Cages that will enter the depot:

| Type of Cages | Width (m) | Length (m) | Area (m <sup>2</sup> ) | Collapsed Height (m) | Qty. of cages per day | Allowable Stacking amt. | No. of stacks for 1 day |
|---------------|-----------|------------|------------------------|----------------------|-----------------------|-------------------------|-------------------------|
| AD            | 1.2       | 1          | 1.2                    | 0.345                | 418                   | 10                      | 41.8                    |
| AB            | 1.2       | 1          | 1.2                    | 0.315                | 32                    | 10                      | 3.2                     |
| BA            | 1.62      | 1.2        | 1.944                  | 0.32                 | 156                   | 10                      | 15.6                    |
| DA            | 1         | 0.595      | 0.595                  | 0.3                  | 20                    | 10                      | 2                       |
| DB            | 1         | 5.95       | 5.95                   | 0.265                | 12                    | 10                      | 1.2                     |
| 1A            | 1.2       | 1          | 1.2                    | 0.32                 | 12                    | 10                      | 1.2                     |
| 1Z            | 1.2       | 1          | 1.2                    | 0.345                | 33                    | 10                      | 3.3                     |
| 2Z            | 1.62      | 1.2        | 1.944                  | 0.345                | 1                     | 10                      | 0.1                     |
| 3Z            | 2.58      | 1.4        | 3.612                  | 0.345                | 7                     | 10                      | 0.7                     |

**Table 2: TrenStar Cages Specifications**

The legal stacking quantity for cages on Ford premises are ten collapsed cages on top of each other. This was decided by Fords management and safety personnel, and is legal requirements that TrenStar must comply to. In the *figure 6* below is an example of how the cages are stacked.



**Figure 6: Stacked Cages**

**Barcode on TrenStar Packaging**

Each cage has two aluminium barcode that can be scanned to uniquely identify the cage. The cage can be tracked to its last scanned area on the EAM system.



**Figure 7: Example of Aluminium Barcode**

### Bins

TrenStar bins are produced from polypropylene and come in different sizes. The bins lids are able to lock or seal to avoid pilferage and each bin has a unique identification number to enable management and tracking. These bins can be nested when empty to save on storage or transport space. Below are the specifications on the TrenStar bins:

| Type of Bins | Width (m) | Length (m) | Area (m <sup>2</sup> ) | Collapsed Height (m) | Qty. of bins per day | Allowable Nesting amt. | No. of stacks for 1 day |
|--------------|-----------|------------|------------------------|----------------------|----------------------|------------------------|-------------------------|
| 1P           | 0.594     | 0.396      | 0.2352                 | 0.315                | 91                   | 20                     | 4.55                    |
| 2P           | 0.4       | 0.297      | 0.1188                 | 0.315                | 32                   | 20                     | 1.6                     |
| 3P           | 0.3       | 0.2        | 0.0600                 | 0.182                | 55                   | 20                     | 2.75                    |
| 4P           | 0.714     | 0.465      | 0.3320                 | 0.356                | 311                  | 20                     | 15.55                   |

**Table 3: TrenStar Bins Specifications**

### Interlayers & Specialized

Interlayers are plastic support that is designed to holds a specific part, to protect the part from getting damaged while being transported. The Interlayer is designed to be interlinked so that it can be stacked on top of each other without damaging the part and thus saving on space. The interlayers are placed into a cage, so that it can be easily transport and the cage can be locked.



Figure 8: Example of Interlayers

| Interlayer Code | Width (m) | Length (m) | Area (m <sup>2</sup> ) | Qty. of Interlayers per day | Allowable Stacking no. | No. of stacks |
|-----------------|-----------|------------|------------------------|-----------------------------|------------------------|---------------|
| AD              | 1.2       | 1          | 1.2                    | 569                         | 25                     | 23            |
| BA              | 1.62      | 1.2        | 1.944                  | 177                         | 25                     | 8             |
| LV              | 1.22      | 1.14       | 1.3908                 | 263                         | 25                     | 11            |
| MG              | 1.36      | 1.15       | 1.564                  | 113                         | 25                     | 5             |
| Shurlock        | 0.56      | 0.39       | 0.2184                 | 51                          | 25                     | 3             |

Table 4: Interlayers Specifications

Specialized containers are specially developed cages or holders to hold certain equipment that cannot be placed in an interlayer. Specialized containers are not the standard containers that TrenStar rents and uses for reusable packaging. They are usually designed and made for a specific customer and is used for a specific part. Below is an example of specialized equipment:



Figure 9: Specialized equipment without part

Figure 10: Specialized equipment with part

The table below shows the specifications on the specialized equipment that will be used in the new depot:

| Specialized Code | Width (m) | Length (m) | Area (m <sup>2</sup> ) | Height (m) | Qty. of specialized per day | Total Width | Total Length | Total Height | Allowable Stacking no. | No. of stacks |
|------------------|-----------|------------|------------------------|------------|-----------------------------|-------------|--------------|--------------|------------------------|---------------|
| MS               | 1.53      | 0.33       | 0.5049                 | 0.118      | 4                           | 0           | 0            | 0            | 5                      | 1             |
| MG               | 1.36      | 1.15       | 1.564                  | 0.163      | 51                          | 0           | 0            | 0            | 5                      | 11            |
| GR               | 2.5       | 1.7        | 4.25                   | 0.9        | 34                          | 0           | 0            | 0            | 2                      | 17            |
| GS               | 1.745     | 1.734      | 3.0258                 | 0.925      | 24                          | 0           | 0            | 0            | 2                      | 12            |
| GF               | 0.8       | 0.6        | 0.48                   | 0.3        | 102                         | 1.6         | 1.2          | 0.9          | 3                      | 6             |
| GH               | 0.8       | 0.6        | 0.48                   | 0.3        | 102                         | 1.6         | 1.2          | 0.9          | 3                      | 6             |
| GI               | 0.8       | 0.6        | 0.48                   | 0.3        | 102                         | 1.6         | 1.2          | 0.9          | 3                      | 6             |
| GJ               | 0.8       | 0.6        | 0.48                   | 0.3        | 51                          | 1.6         | 1.2          | 0.9          | 3                      | 3             |
| GK               | 0.8       | 0.6        | 0.48                   | 0.3        | 51                          | 1.6         | 1.2          | 0.9          | 3                      | 3             |
| LV               | 1.22      | 1.14       | 1.3908                 | 0.87       | 48                          | 0           | 0            | 0            | 10                     | 5             |

Table 5: Specialized specifications

## 1.6. TrenStar existing depot processes

At the other TrenStar depot, processes have been identified and standards have been defined. The main activities in the depot are to receive, inspect, store, pick, stage and dispatch. This new depot must support these following services:



Figure 11: Flow of Reusable packaging in depot

## 1.7. TrenStar flow processes loop

In *Figure 12* below, it shows the complete process from where the supplier orders reusable packaging up till where it will leave the TrenStar onsite depot by the Ford Factory.

It starts off where the supplier places an online order on the EAM system. The bin coordinator does his processes to approve the order or change the order. DHL will collect the reusable packaging that has the T6 Ford Ranger parts within it from the supplier and deliver these parts to Ford.

The packaging is used within the Ford Factory until the packaging is empty and then Schnellecke transports the empty reusable packaging to the TrenStar onsite depot.

The packaging runs through the depot processes until where the depot receives the picking instructions from the EAM system (that was made from the online ordering) and the empty reusable packaging is staged for DHL and dispatched back to the supplier.

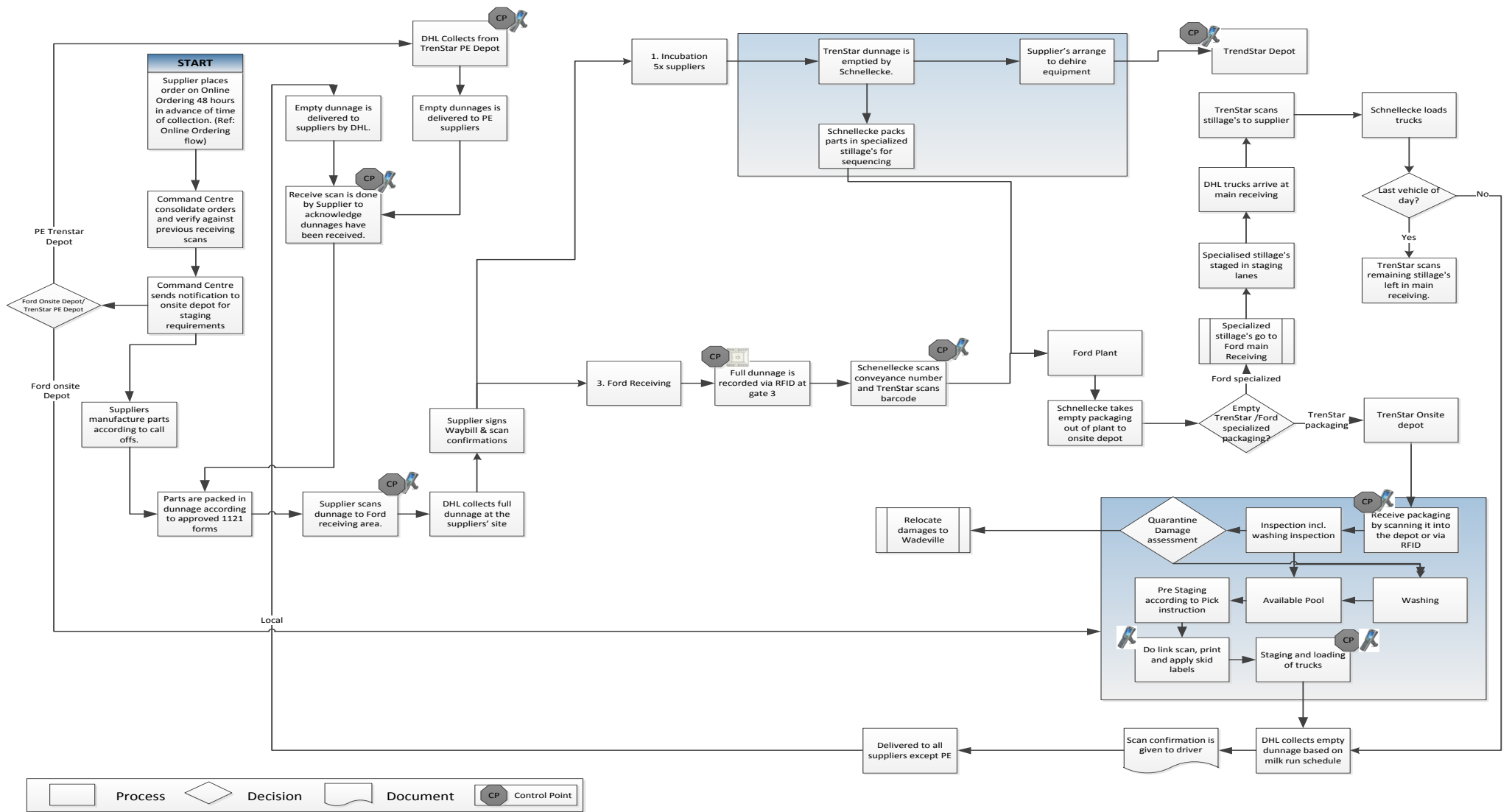


Figure 12: Complete Process Flow

## 1.8. Facilities layout methodology

Facility layout procedure needs to be followed to help aid in developing alternative layouts for the depot. Construction layout methods will be used to help construct a new depot from scratch.

A following method will be used to design a layout for the TrenStar onsite depot:

### **Muther's Systematic Layout Planning (SLP) Procedure**

Muther's SLP procedure uses a number of different methods and incorporates it in the following steps to create a perfect layout. This procedure can be used sequentially to develop a block layout and then detailed layout, the following steps is used for SLP (Muther, R 1973; Tompkins, J.A., White, J.A., Bozer, Y. A., Tanchoco, J.M.A., 2010):

1. Flow of materials
2. Activity relationships
3. Relationship diagram
4. Space requirements&Space available
5. Space relationship diagram
6. Modifying considerations
7. Practical limitations
8. Develop layout alternatives
9. Evaluation

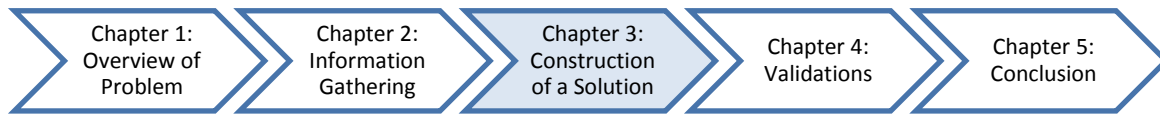
## 1.9. Conclusion to literature review

In this literature review the various aspects were reflected. Yard Management factors will be needed to be taken in consideration, for example; reducing asset idle time within the yard, maximising space utilization and 100% visibility of assets.

Tracking technology will have to be taken in regard when planning the depot. RFID technology should be at the entrance and exits of the depot. The types of reusable packaging that will move through the depot are the most important aspect to plan the design. Space that the packaging consumed, stacking height and type of reusable packaging should be looked at when planning space requirements.

The various processes that the reusable packaging will have to go through will need designated areas for, e.g. receiving, washing, inspection, etc. Finally the procedure used to design the depot is important. If there is no structure to a design, important aspects can be missed.

## Chapter 3: Construction of a Solution



### 1. Building Capacity Model

Ford Motor Company provided TrenStar with a Bill of Material which they call PFEP (plan for every part) and the trimming percentage for models of Rangers which are double cab, rap cab and super cab that Ford estimates to build. The types of models could vary from petrol, diesel, 4x2, 4x4, etc. The PFEP had the following useful information that TrenStar could use to work out the capacity of packaging needed each day for the project:

- Part Code
- Part Description
- Container Type
- Number of parts in the packaging
- Number of parts per type of model
- Supplier Code
- Number of parts per unit

The trimming percentage for models of Rangers is estimated as follows:

- Double Cab = 58% (38 different types of Double cabs)
- Rap Cab = 23% (17 different types of Rap cabs)
- Super Cab = 19% (18 different types of Super cabs)

The schedule of exact amounts could not be given as this would be worked out by Ford, weekly as the project goes live. Thus TrenStar has to work on estimation and a 15% variance (safety factor) has been used to ensure that there is enough space for all the equipment.

To build the capacity model for TrenStar, all the relevant information had to be extracted from the PFEP, this would be the above mentioned data for all the parts that TrenStar would provide reusable packaging for. There are about 850 different types of parts that need TrenStar reusable packaging.

Not every part is used for every model or every type of Ford Ranger, so the trimmings for each part must be worked out. To do this, the following calculations were done, for example:

- When 200 units are to be built per day, 116 units will be Double cab, 46 units will be Rap cab and 38 Super Cabs will be built.

$$200 * 0.58 = 116 \text{ double cabs per day}$$

- If 2 types of Double Cab, 1 type of Rap Cab and 7 types of Super Cab uses a part A.
- Then the trimming percentage will be calculated as follows for part A:

$$\text{Number of Double cabs} = \left(\frac{2}{38}\right) * 116 = 6 \text{ double cabs}$$

$$\text{Number of Rap cabs} = \left(\frac{1}{17}\right) * 46 = 3 \text{ rap cabs double cab}$$

$$\text{Number of Super cabs} = \left(\frac{7}{18}\right) * 38 = 15 \text{ super cabs}$$

$$\text{Trimming for part A} = \left(\frac{6 + 3 + 15}{200}\right) = \frac{24}{200} = 12\%$$

- This means out of 200 units to be built per day, only 12% will have this part in it or 24 units will have this part. This formula was used for all the parts that use TrenStar packaging.

| Part Number | No. of DC types that have part | No. of RC types that have part | No. of SC types that have part | No of units for DC out of 38 types | No of units for RC out of 17 types | No of units for SC out of 18 types | Req. amt. of part trimming per day |
|-------------|--------------------------------|--------------------------------|--------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| AB A        | 2                              | 1                              | 7                              | 6                                  | 3                                  | 15                                 | 11.79%                             |
| AB A        | 14                             | 12                             | 11                             | 44                                 | 33                                 | 24                                 | 49.21%                             |
| AB A        | 10                             | 7                              | 2                              | 31                                 | 19                                 | 4                                  | 26.84%                             |
| AB A        | 16                             | 2                              | 0                              | 50                                 | 6                                  | 0                                  | 27.13%                             |
| AB A        | 5                              | 1                              | 0                              | 16                                 | 3                                  | 0                                  | 8.98%                              |
| AB A        | 17                             | 3                              | 0                              | 53                                 | 8                                  | 0                                  | 30.01%                             |
| AB A        | 0                              | 1                              | 1                              | 0                                  | 3                                  | 2                                  | 2.41%                              |
| AB A        | 1                              | 1                              | 0                              | 3                                  | 3                                  | 0                                  | 2.88%                              |
| AB B        | 38                             | 17                             | 18                             | 118                                | 47                                 | 39                                 | 100.00%                            |
| AB C        | 2                              | 1                              | 7                              | 6                                  | 3                                  | 15                                 | 11.79%                             |
| AB C        | 35                             | 14                             | 10                             | 109                                | 39                                 | 22                                 | 82.92%                             |
| AB C        | 1                              | 2                              | 1                              | 3                                  | 6                                  | 2                                  | 5.29%                              |
| AB E        | 6                              | 1                              | 4                              | 19                                 | 3                                  | 9                                  | 14.73%                             |
| AB F        | 0                              | 0                              | 3                              | 0                                  | 0                                  | 6                                  | 3.17%                              |
| AB E        | 3                              | 5                              | 3                              | 9                                  | 14                                 | 6                                  | 14.51%                             |
| AB F        | 0                              | 0                              | 6                              | 0                                  | 0                                  | 13                                 | 6.33%                              |
| AB E        | 13                             | 3                              | 0                              | 40                                 | 8                                  | 0                                  | 23.90%                             |

Table 6: Model to Calculating the trimming per model type

Next, the daily amount of packaging for each part has to be worked out. This is done by using the amount of parts that can fit in the packaging type, the amount of parts used per units and the trimming. The following calculations describe how this was done:

- **Daily part requirements** =  
 $Units\ to\ be\ built\ daily * trimming * No.\ of\ parts\ to\ be\ used\ per\ unit$
- **Daily part requirements** =  $200 * 0.83 * 1 = 166\ parts\ required\ per\ day$
- **Max amt. dunnage per day** =  $\frac{166}{200} = 0.83 \approx 1\ dunnage\ required\ per\ day\ (round\ up)$

| Part Number | Container Type | Supplier Code | No. of parts used per unit | Trimming | Daily part Req. | Part per Container | Max # of Dunnage per Day |
|-------------|----------------|---------------|----------------------------|----------|-----------------|--------------------|--------------------------|
| AB312000B   | 1Z             | CGNCA         | 2                          | 100%     | 400             | 72                 | 6                        |
| AB312000C   | 3P             | CGPEA         | 1                          | 12%      | 24              | 200                | 1                        |
| AB312000C   | 3P             | CGPEA         | 1                          | 83%      | 166             | 200                | 1                        |
| AB312000C   | 3P             | CGPEA         | 1                          | 5%       | 10              | 200                | 1                        |
| AB312000E   | 4P             | CGRFB         | 1                          | 15%      | 30              | 8                  | 4                        |
| AB312000F   | 4P             | CGRFB         | 1                          | 3%       | 6               | 8                  | 1                        |
| AB312000E   | 4P             | CGRFB         | 1                          | 15%      | 30              | 8                  | 4                        |
| AB312000F   | 4P             | CGRFB         | 1                          | 6%       | 12              | 8                  | 2                        |
| AB312000E   | 4P             | CGRFB         | 1                          | 24%      | 48              | 8                  | 7                        |
| AB312000E   | 4P             | CGRFB         | 1                          | 37%      | 74              | 8                  | 10                       |
| AB312000D   | DA             | CGSTA         | 1                          | 39%      | 78              | 100                | 1                        |
| AB312000D   | DA             | CGSTA         | 1                          | 52%      | 104             | 100                | 2                        |
| AB312000D   | DA             | CGSTA         | 1                          | 3%       | 6               | 100                | 1                        |
| AB312000D   | DA             | CGSTA         | 1                          | 6%       | 12              | 100                | 1                        |

Table 7: Example of model to calculate Daily requirements and Max dunnages per day

This maximum amount of dunnage required per day, is if every part was used in the packaging by the end of the day, but unfortunately this will give the worst case scenario and not what will happen per

day. Thus the next step was to calculate how many packaging will enter the onsite depot each day. Thus the amount of dunnages for 50 days was calculated:

For day 1, the exact amount was calculated in the model as the following below;

- **Exact amount of dunnages per day** = (Daily parts Req.)/(Parts per Container)
- **Exact amount of dunnages per day** =  $\frac{70}{80} = 0.88$
- **Day 1** = **if** (Exact amt. of dunnages per day) < (Max # of Dunnages per day) **then Round down** (Exact amt. of dunnages per day) **else round up** (Exact amt. of dunnages per day)
- **Day 1** =  $0.88 < 1 = 0$

Normally, containers will have parts left in it, so a usage of that bin had to be calculated, to work out how much parts must be carried over to the next day, as shown below;

- **% Usage 1** = (Exact amt. of dunnages per day) – (Day 1)
- **% Usage 1** =  $0.88 - 0 = 0.88$  of dunnage used

For day 2, the amount of parts used on day 1 must be taken in account. Therefore, if the amount of dunnages plus the usage of day 1 is less than the maximum dunnage, day 2 amount of containers will be the exact amount of dunnages per day rounded down. The usages will be the exact amount of dunnages per day plus the usage of day 1 minus what was used for day 2.

- **Day 2** = **if** ((Exact amt. of dunnages per day) + (Usage 1)) < (Max # of Dunnages per day) **then round down** (Exact amt. of dunnages per day) **else round up** (Exact amt. of dunnages per day)
- **Day 2** =  $(0.88 + 0.88) > 1 = 1$
- **% Usage 2** = (Exact amt. of dunnages per day) + (Usage 1) – (Day 2)
- **% Usage 2** =  $0.88 + 0.88 - 1 = 0.76$

To view which day has the most containers entering the depot, Day 2's formula has been applied right though up to day 50. The generic formula has been given below, with X being the number of day:

- **Day X** = **if** ((Exact amt. of dunnages per day) + (Usage (X – 1))) < (Max # of Dunnages per day) **then round down** (Exact amt. of dunnages per day) **else round up** (Exact amt. of dunnages per day)
- **% Usage X** = (Exact amt. of dunnages per day) + (Usage (X – 1)) – (Day X)

| Part number | Container Type | Daily parts Req. | Parts per Container | Max # of dunnage per day | Exact amt. of dunnages per day | Day 1 | % Usage 1 | Day 2 | % Usage 2 | Day 3 | % Usage 3 | Day 4 | % Usage 4 |
|-------------|----------------|------------------|---------------------|--------------------------|--------------------------------|-------|-----------|-------|-----------|-------|-----------|-------|-----------|
| AB1234AB    | 1Z             | 408              | 72                  | 6                        | 5.67                           | 5     | 0.67      | 6     | 0.33      | 6     | 0.00      | 5     | 0.67      |
| AB1234BC    | 3P             | 25               | 200                 | 1                        | 0.13                           | 0     | 0.13      | 0     | 0.25      | 0     | 0.38      | 0     | 0.50      |
| AB1234EC    | 3P             | 170              | 200                 | 1                        | 0.85                           | 0     | 0.85      | 1     | 0.70      | 1     | 0.55      | 1     | 0.40      |
| AB1234GC    | 3P             | 11               | 200                 | 1                        | 0.06                           | 0     | 0.06      | 0     | 0.11      | 0     | 0.17      | 0     | 0.22      |
| AB1234HE    | 4P             | 31               | 8                   | 4                        | 3.88                           | 3     | 0.88      | 4     | 0.75      | 4     | 0.63      | 4     | 0.50      |
| AB1234FE    | 4P             | 7                | 8                   | 1                        | 0.88                           | 0     | 0.88      | 1     | 0.75      | 1     | 0.63      | 1     | 0.50      |
| AB1234IE    | 4P             | 30               | 8                   | 4                        | 3.75                           | 3     | 0.75      | 4     | 0.50      | 4     | 0.25      | 4     | 0.00      |
| AB1234IF    | 4P             | 13               | 8                   | 2                        | 1.63                           | 1     | 0.63      | 2     | 0.25      | 1     | 0.88      | 2     | 0.50      |
| AB1234IE    | 4P             | 49               | 8                   | 7                        | 6.13                           | 6     | 0.13      | 6     | 0.25      | 6     | 0.38      | 6     | 0.50      |
| AB1234IE    | 4P             | 77               | 8                   | 10                       | 9.63                           | 9     | 0.63      | 10    | 0.25      | 9     | 0.88      | 10    | 0.50      |
| AB1234AD    | DA             | 79               | 100                 | 1                        | 0.79                           | 0     | 0.79      | 1     | 0.58      | 1     | 0.37      | 1     | 0.16      |
| AB1234BD    | DA             | 106              | 100                 | 2                        | 1.06                           | 1     | 0.06      | 1     | 0.12      | 1     | 0.18      | 1     | 0.24      |
| AB1234CD    | DA             | 7                | 100                 | 1                        | 0.07                           | 0     | 0.07      | 0     | 0.14      | 0     | 0.21      | 0     | 0.28      |
| AB1234DD    | DA             | 13               | 100                 | 1                        | 0.13                           | 0     | 0.13      | 0     | 0.26      | 0     | 0.39      | 0     | 0.52      |

Table 8: Model Example of amount of containers used per day

The above *table 8* is an extraction of the model to calculate the amount of packaging entering the depot per day and only the first four days has been shown for demonstration purposes, as the rest is repetitive. The following tables are the overall data for TrenStar reusable packaging:

| Packaging Type | Total # of Dunnage for max day | Max day stock with Buffer |
|----------------|--------------------------------|---------------------------|
| 1A             | 12                             | 14                        |
| 1Z             | 31                             | 36                        |
| 2Z             | 0                              | 0                         |
| 3Z             | 7                              | 9                         |
| 1P             | 97                             | 112                       |
| 2P             | 29                             | 34                        |
| 3P             | 56                             | 65                        |

|               |             |             |
|---------------|-------------|-------------|
| 4P            | 317         | 365         |
| AD            | 426         | 490         |
| DA            | 17          | 20          |
| BA            | 164         | 189         |
| DB            | 13          | 15          |
| AB            | 34          | 40          |
| <b>Totals</b> | <b>1203</b> | <b>1389</b> |

Table 9: Overall TrenStar packaging

| Interlayer Code | Type             | Total Usage / Day | Max day stock with Buffer |
|-----------------|------------------|-------------------|---------------------------|
| AD              | AD               | 558               | 642                       |
| BA              | BA               | 174               | 200                       |
| LV              | Kaymac           | 258               | 297                       |
| MG              | Wheel interlayer | 85                | 98                        |
| Shurlock        | Clam Shell       | 51                | 59                        |
| <b>Totals</b>   |                  | <b>1126</b>       | <b>1294</b>               |

Table 10: Overall Interlayers

| Specialized Code | Type                         | Total Usage / Day | Max day stock with Buffer |
|------------------|------------------------------|-------------------|---------------------------|
| MS               | Plastic bins                 | 4                 | 5                         |
| MG               | Specialized Pallet           | 51                | 59                        |
| GR               | Feltex Carpets + Interlayers | 34                | 39                        |
| GS               | Feltex Carpets + Interlayers | 24                | 28                        |
| GF               | EPP                          | 102               | 117                       |
| GH               | EPP                          | 102               | 117                       |
| GI               | EPP                          | 102               | 117                       |
| GJ               | EPP                          | 51                | 59                        |
| GK               | EPP                          | 51                | 59                        |
| LV               | Kaymac                       | 48                | 55                        |
| <b>Totals</b>    |                              | <b>569</b>        | <b>654</b>                |

Table 11: Overall Specialized packaging

## 2. Space Requirements

### *Cages, Bins and Interlayers*

To calculate the space required for the TrenStar Ford onsite depot, the quantities of packaging for each depot area needs to be worked out. The depot has eight distinct areas that have been identified so that space can be allocated towards them.

To calculate the percentage of stock that will be in the different area at a specific time, we worked on certain principles that was discussed and approved by the TrenStar Operational Manager.

- The depot works on an 8 hour day and the depot must keep two days stock in it.
- The principle of what enters the depot should also leave the depot.
- To calculate the receiving, pre-staging and staging percentages:
  - If 100 stocks enters depot per day, a 100 must leave the depot as well. Each hour 12.5 stock will enter and leave. Thus 12.5% of one day stock will be in receiving and 12.5% of one day stock will be in pre-staging and 1.5% in staging.
  - The extra 2.5% in receiving was added due to time constraints that might happen between receiving area and inspection area, as well as irregular deliveries from Schnellecke and 1.5% for pre-staging and staging.
- The ATP area must be able to keep one day stock, plus 15% extra for the day. Therefore:
$$ATP\ space = (No.\ of\ stacks\ per\ day) + (No.\ of\ stacks\ per\ day) * 1.15$$
- The inspection area needs space for packaging to be packed out and inspected one by one (no stacks), where it can then be moved to ATP, washing, awaiting repairs or barcode replacement. Thus this is the critical point and is most time consuming in the depot and thus 30% space was allocated to this area, to make provision for the queue that might occur.
- 7% of the equipment was estimated by operations manager to move through washing area, 4% to barcode replacement and 1% to awaiting repairs.
- For the Interlayers the operational manager had different values as they hardly get washed, inspection is quicker with them and the interlayer's cycle time is faster through the depot.

| Area's                   | Cages | Bins | Interlayer |
|--------------------------|-------|------|------------|
| Receiving                | 15%   | 15%  | 13%        |
| Washing                  | 7%    | 7%   | 5%         |
| ATP                      | 15%   | 15%  | 50%        |
| Inspection/ Wait to Wash | 30%   | 30%  | 5%         |
| Pre Staging              | 14%   | 14%  | 12.5%      |
| Staging                  | 14%   | 14%  | 12.5%      |
| Barcode Replacement      | 4%    | 4%   | 1.0%       |
| Repairs                  | 1%    | 1%   | 1%         |

**Table 12: Percentage of packaging in an area at a specific time**

The space for each type of packaging was worked out by taking the amount of packaging for each day and calculating how many stacks there will be. For example with the AD's:

$$AD's = \left(\frac{496}{10}\right) = 49.6 \text{ AD's stacks}$$

For each area of the depot, the amount of stacks was multiplied with the percentage of containers in that specific area at a point in time, multiplied with the area, as shown below:

$$AD \text{ receiving area's} = (AD's \text{ stacks}) * (\text{percentage of receiving area}) * (AD's \text{ Area})$$

$$AD \text{ receiving area's} = 49.6 * 0.15 * 1.2 = 8.93m^2$$

The length and the width of each packaging type are used to calculate the area of each packaging.

| Type of Packaging | Width (m) | Length (m) | Area (m <sup>2</sup> ) | 1 day stock with Buffer | Allowable Stacking amt. | No. of stacks for 1 day | Area (m2)    |              |               |               |              |              |                     |             |
|-------------------|-----------|------------|------------------------|-------------------------|-------------------------|-------------------------|--------------|--------------|---------------|---------------|--------------|--------------|---------------------|-------------|
|                   |           |            |                        |                         |                         |                         | Receiving    | Washing      | ATP           | Inspection    | Pre-Staging  | Staging      | Barcode Replacement | Repairs     |
| AD                | 1.200     | 1.000      | 1.20                   | 496                     | 10                      | 49.6                    | 8.93         | 41.66        | 68.45         | 178.56        | 8.33         | 8.33         | 2.38                | 0.60        |
| AB                | 1.200     | 1.000      | 1.20                   | 37                      | 10                      | 3.7                     | 0.67         | 3.11         | 5.11          | 13.32         | 0.62         | 0.62         | 0.18                | 0.04        |
| BA                | 1.620     | 1.200      | 1.94                   | 194                     | 10                      | 19.4                    | 5.66         | 26.40        | 43.37         | 113.14        | 5.28         | 5.28         | 1.51                | 0.38        |
| DA                | 1.000     | 0.595      | 0.60                   | 25                      | 10                      | 2.5                     | 0.22         | 1.04         | 1.71          | 4.46          | 0.21         | 0.21         | 0.06                | 0.01        |
| DB                | 1.000     | 0.595      | 0.60                   | 14                      | 10                      | 1.4                     | 0.12         | 0.58         | 0.96          | 2.50          | 0.12         | 0.12         | 0.03                | 0.01        |
| 1A                | 1.200     | 1.000      | 1.20                   | 14                      | 10                      | 1.4                     | 0.25         | 1.18         | 1.93          | 5.04          | 0.24         | 0.24         | 0.07                | 0.02        |
| 1Z                | 1.200     | 1.000      | 1.20                   | 38                      | 10                      | 3.8                     | 0.68         | 3.19         | 5.24          | 13.68         | 0.64         | 0.64         | 0.18                | 0.05        |
| 2Z                | 1.620     | 1.200      | 1.94                   | 2                       | 10                      | 0.2                     | 0.06         | 0.27         | 0.45          | 1.17          | 0.05         | 0.05         | 0.02                | 0.00        |
| 3Z                | 2.580     | 1.400      | 3.61                   | 9                       | 10                      | 0.9                     | 0.49         | 2.28         | 3.74          | 9.75          | 0.46         | 0.46         | 0.13                | 0.03        |
| 1P                | 0.594     | 0.396      | 0.24                   | 105                     | 20                      | 5.25                    | 0.19         | 1.73         | 1.42          | 7.41          | 0.17         | 0.17         | 0.05                | 0.01        |
| 2P                | 0.400     | 0.297      | 0.12                   | 37                      | 20                      | 1.85                    | 0.03         | 0.31         | 0.25          | 1.32          | 0.03         | 0.03         | 0.01                | 0.00        |
| 3P                | 0.300     | 0.200      | 0.06                   | 64                      | 20                      | 3.2                     | 0.03         | 0.27         | 0.22          | 1.15          | 0.03         | 0.03         | 0.01                | 0.00        |
| 4P                | 0.714     | 0.465      | 0.33                   | 366                     | 20                      | 18.3                    | 0.91         | 8.51         | 6.99          | 36.45         | 0.85         | 0.85         | 0.24                | 0.06        |
| <b>Total</b>      |           |            |                        |                         |                         |                         | <b>18.24</b> | <b>90.52</b> | <b>139.84</b> | <b>387.96</b> | <b>17.02</b> | <b>17.02</b> | <b>4.86</b>         | <b>1.22</b> |

**Table 13: TrenStar packaging space requirements**

## Interlayers

Below is the table of the interlayers and the area they require:

| Interlayer Code | Width (m) | Length (m) | Area (m2) | 1 day stock with Buffer | Allowable Stacking no. | No. of stacks for 1 day | Area (m2)   |              |               |              |             |             |                     |             |
|-----------------|-----------|------------|-----------|-------------------------|------------------------|-------------------------|-------------|--------------|---------------|--------------|-------------|-------------|---------------------|-------------|
|                 |           |            |           |                         |                        |                         | Receiving   | Washing      | ATP           | Inspection   | Pre-Staging | Staging     | Barcode Replacement | Repairs     |
| AD              | 1.200     | 1.000      | 1.200     | 654                     | 25                     | 27                      | 4.21        | 39.26        | 48.60         | 39.26        | 4.05        | 4.05        | 0.30                | 0.39        |
| BA              | 1.620     | 1.200      | 1.944     | 204                     | 25                     | 9                       | 2.27        | 19.79        | 26.24         | 19.79        | 2.19        | 2.19        | 0.49                | 0.34        |
| LV              | 1.220     | 1.140      | 1.391     | 302                     | 25                     | 13                      | 2.35        | 21.03        | 27.12         | 21.03        | 2.26        | 2.26        | 0.35                | 0.25        |
| MG              | 1.360     | 1.150      | 1.564     | 100                     | 25                     | 5                       | 1.02        | 7.82         | 11.73         | 7.82         | 0.98        | 0.98        | 0.39                | 0.12        |
| Shurlock        | 0.560     | 0.390      | 0.218     | 59                      | 25                     | 3                       | 0.09        | 0.64         | 0.98          | 0.64         | 0.08        | 0.08        | 0.05                | 0.00        |
| <b>Total</b>    |           |            |           |                         |                        |                         | <b>9.94</b> | <b>88.54</b> | <b>114.68</b> | <b>88.54</b> | <b>9.56</b> | <b>9.56</b> | <b>1.58</b>         | <b>1.10</b> |

Table 14: Interlayers space requirements

## Specialized Equipment

Below is the table of specialized equipment and the space requirements that has been worked out for them, according to the percentage table in *table 12*.

| Specialized Code | Width (m) | Length (m) | Area (m2) | 1 day stock with Buffer | Allowable Stacking no. | No. of stacks for 1 day | Area (m2)    |              |               |              |              |              |                     |              |
|------------------|-----------|------------|-----------|-------------------------|------------------------|-------------------------|--------------|--------------|---------------|--------------|--------------|--------------|---------------------|--------------|
|                  |           |            |           |                         |                        |                         | Receiving    | Washing      | ATP           | Inspection   | Pre-Staging  | Staging      | Barcode Replacement | Repairs      |
| MS               | 1.530     | 0.330      | 0.505     | 4                       | 5                      | 1                       | 0.50         | 0.25         | 0.13          | 0.06         | 0.03         | 0.02         | 0.01                | 0.00         |
| MG               | 1.360     | 1.150      | 1.564     | 51                      | 5                      | 11                      | 17.20        | 1.01         | 5.55          | 4.69         | 3.13         | 3.13         | 1.56                | 1.56         |
| GR               | 2.500     | 1.700      | 4.250     | 34                      | 2                      | 17                      | 17.00        | 12.75        | 26.59         | 17.00        | 12.75        | 12.75        | 4.25                | 4.25         |
| GS               | 1.745     | 1.734      | 3.026     | 24                      | 2                      | 12                      | 6.05         | 6.05         | 51.00         | 9.08         | 6.05         | 6.05         | 3.03                | 3.03         |
| GF               | 0.800     | 0.600      | 0.480     | 102                     | 3                      | 6                       | 2.88         | 0.48         | 2.88          | 0.96         | 0.48         | 0.48         | 0.48                | 0.48         |
| GH               | 0.800     | 0.600      | 0.480     | 102                     | 3                      | 6                       | 2.88         | 0.48         | 2.88          | 0.96         | 0.48         | 0.48         | 0.48                | 0.48         |
| GI               | 0.800     | 0.600      | 0.480     | 102                     | 3                      | 6                       | 2.88         | 0.48         | 2.88          | 0.96         | 0.48         | 0.48         | 0.48                | 0.48         |
| GJ               | 0.800     | 0.600      | 0.480     | 51                      | 3                      | 3                       | 1.44         | 0.48         | 1.44          | 0.48         | 0.48         | 0.48         | 0.48                | 0.48         |
| GK               | 0.800     | 0.600      | 0.480     | 51                      | 3                      | 3                       | 1.44         | 0.48         | 1.44          | 0.48         | 0.48         | 0.48         | 0.48                | 0.48         |
| LV               | 1.220     | 1.140      | 1.391     | 48                      | 10                     | 5                       | 2.78         | 1.39         | 6.95          | 1.39         | 1.39         | 1.39         | 2.78                | 1.39         |
| <b>Total</b>     |           |            |           |                         |                        |                         | <b>55.06</b> | <b>23.86</b> | <b>101.74</b> | <b>36.07</b> | <b>25.75</b> | <b>25.74</b> | <b>14.03</b>        | <b>12.63</b> |

Table 15: Specialized equipment space requirements

## 3. Apply Facilities Planning Methods

### 3.1. Onsite Depot Layout

Currently Ford Motor Company has given TrenStar an area at the factory that is demarcated to TrenStar for a new onsite depot. The area has a wash bay facility with the correct drainage already on the site.

The new onsite depot will be 35 m wide and 75 m in length, with the wash bay facility situated at the back of the depot in the middle. In appendix A, a layout design is shown.

The Muther's Systematic Layout Planning (SLP) procedure was chosen to evaluate and develop a facilities plan for the depot. Below is the implementation of Muther's procedural steps. (Muther, R 1973; Tompkins, J.A., White, J.A., Bozer, Y. A., Tanchoco, J.M.A., 2010)

## Step 1: Flow of Materials and Information

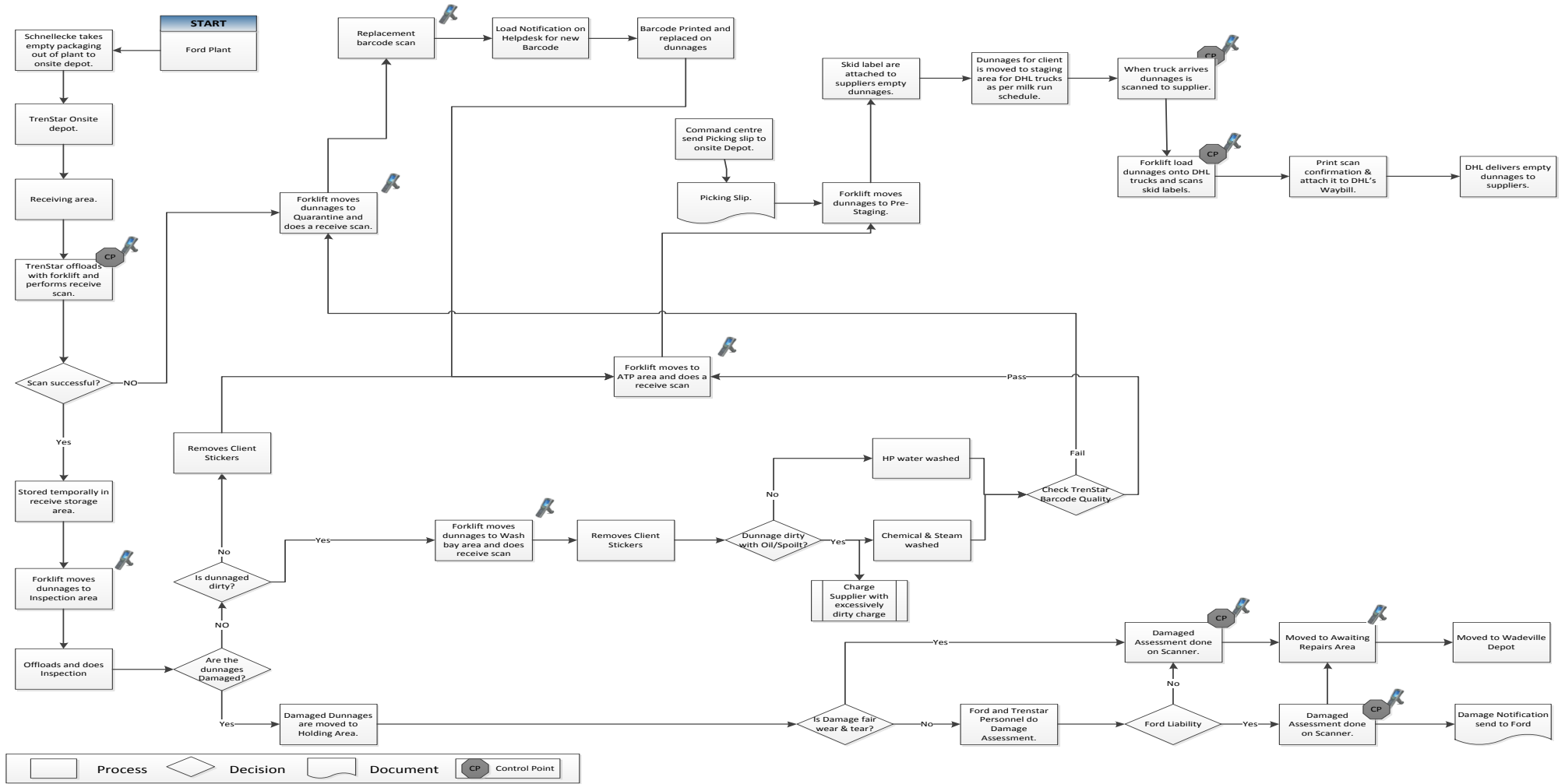


Figure 13: Process flow within the depot.

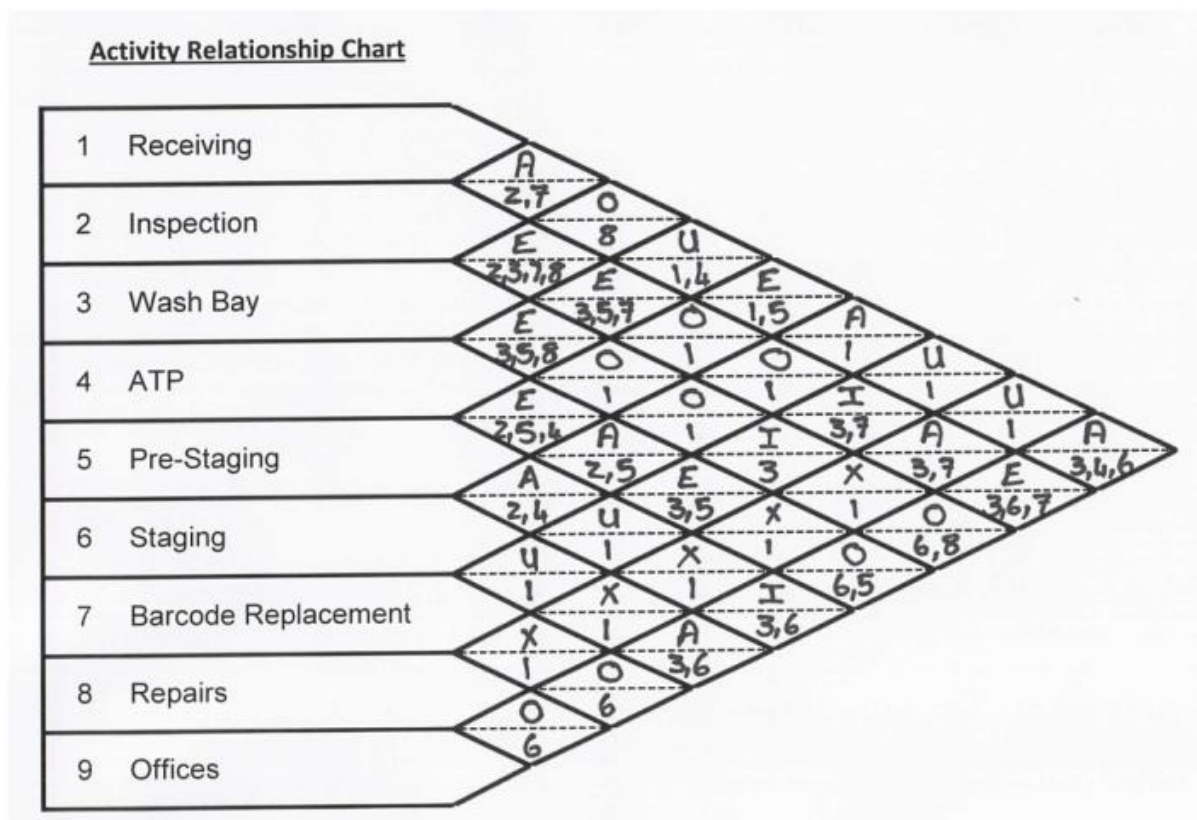
Schnellecke moves the empty reusable packaging to the onsite depot, where it is unloaded in receiving. The packaging then moves to inspection area to be checked to see how dirty the packaging is, if it needs barcode replacement or if the reusable packaging is damaged.

If the packaging is damaged, it is moved to repairs area; when the packaging is dirty it is moved to the wash bay; when any defects are found on the barcodes it is moved to barcode replacement area, e.g. if its barcodes are missing or damaged and when the packaging is none of the above, it is moved to ATP.

After packaging is repaired, washed or barcodes replaced, it is moved to ATP as well. In ATP, it is stored until it is needed to be dispatched to a supplier. When a supplier orders packaging, it is picked from a picking instruction and placed in supplier stacks in the pre-staging area. After its been scanned and linked to a skid label it is moved to the staging lanes where the DHL truck arrives and collect the empty reusable packaging and transports them to suppliers.

### Step 2: Activity Relationship Chart

The Activity Relationship chart measures the activities between areas and departments. Its looks at the closeness of departments and how they are connected to one another, if the departments are important to each other, it is better to try and place these departments in close proximity of each other and keep the flow between them unobstructed.



| Value | Closeness            |
|-------|----------------------|
| A     | Absolutely Necessary |
| E     | Especially Important |
| I     | Important            |
| O     | Ordinary Closeness   |
| U     | Unimportant          |
| X     | Undesirable          |

| Code | Reason             |
|------|--------------------|
| 1    | Same deck          |
| 2    | Flow of Material   |
| 3    | Service            |
| 4    | Convenience        |
| 5    | Inventory Control  |
| 6    | Communication      |
| 7    | Quality Management |
| 8    | Cleanliness        |

Figure 14: Activity Relationship Chart

The activity relationship chart for the onsite depot show that receiving and inspections should be in close range. Inspection should be near wash bay, repairs, barcode replacement and ATP.

The offices should be close to receiving, pre-staging and staging.

### Step 3: Relationship Diagram

Relationship diagram is a pictorial display that shows the process flow between departments or area's as well as the information flow.

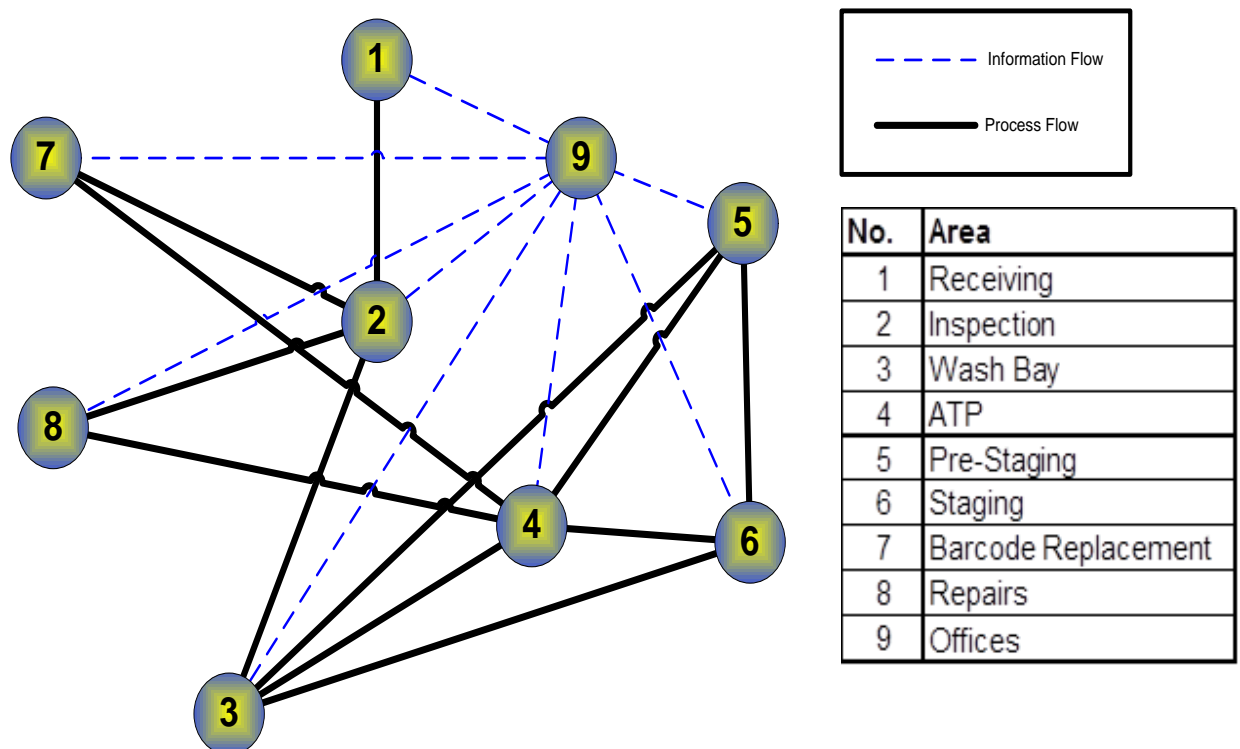


Figure 15: Flow of Materials and Information

#### Step 4: Space Requirements

| Area                            | Area (m <sup>2</sup> ) |             |             | Total         |
|---------------------------------|------------------------|-------------|-------------|---------------|
|                                 | TrenStar Equipment     | Interlayers | Specialized |               |
| Receiving                       | 27.19                  | 14.45       | 55.06       | 96.70         |
| Inspection                      | 43.85                  | 34.18       | 36.51       | 114.54        |
| Wash Bay                        | 24.79                  | 18.15       | 26.23       | 69.16         |
| ATP                             | 150.40                 | 53.14       | 144.74      | 348.29        |
| Pre Staging                     | 25.99                  | 19.54       | 26.23       | 71.76         |
| Staging                         | 25.99                  | 23.14       | 26.23       | 75.36         |
| Barcode Replacement             | 15.44                  | 6.32        | 13.14       | 34.89         |
| Repairs                         | 14.24                  | 6.32        | 13.14       | 33.69         |
| Offices                         | 32.00                  | 0.00        | 0.00        | 32.00         |
| <b>Total Depot Space needed</b> |                        |             |             | <b>876.38</b> |

Table 16: Space requirements for depot per area

Table 16 is a summarized table of all the space requirements worked out earlier. The table shows that the packaging needs 1323.42m<sup>2</sup>.

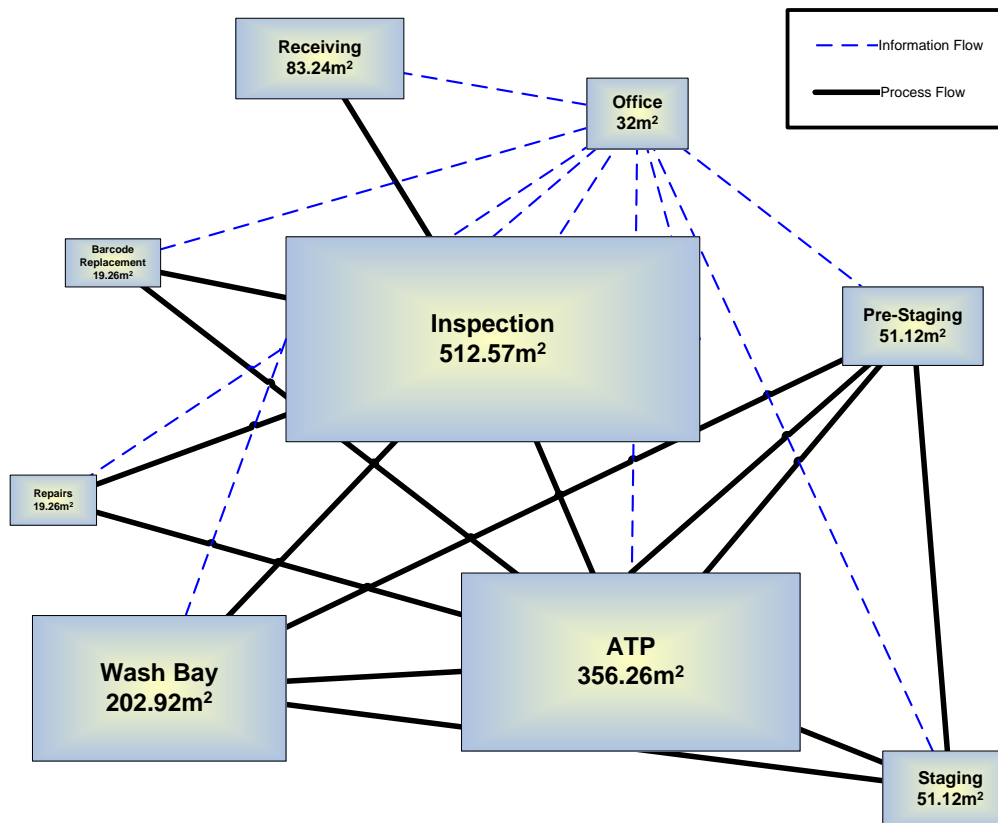
#### Step 5: Space Available

The space available to develop a new TrenStar onsite depot at Ford Motor Company is 2625m<sup>2</sup> (35m\*75m), this excludes the area required for staging. The wash bay has already been build and occupies 205m<sup>2</sup> of this available space.

The available area that can be used for staging, which can facilitate DHL trucks to load the empty reusable packaging for the suppliers, is 2340m<sup>2</sup>. Trucks turning diameter needs to be taken into account.

#### Step 6: Space relationship diagram

This is a pictorial view on the space difference between the different departments. It shows which areas space requires, the area that requires the most space, as well as the relationship between the departments.



**Figure 16: Space Relationship Diagram**

Inspection and ATP needs the most space and should be the area's to concentrate on. Staging is not important for the depot as it will be staged outside the depot and there are other aspects to look at, like truck space and truck turning diameter.

### Step 7: Modifying considerations

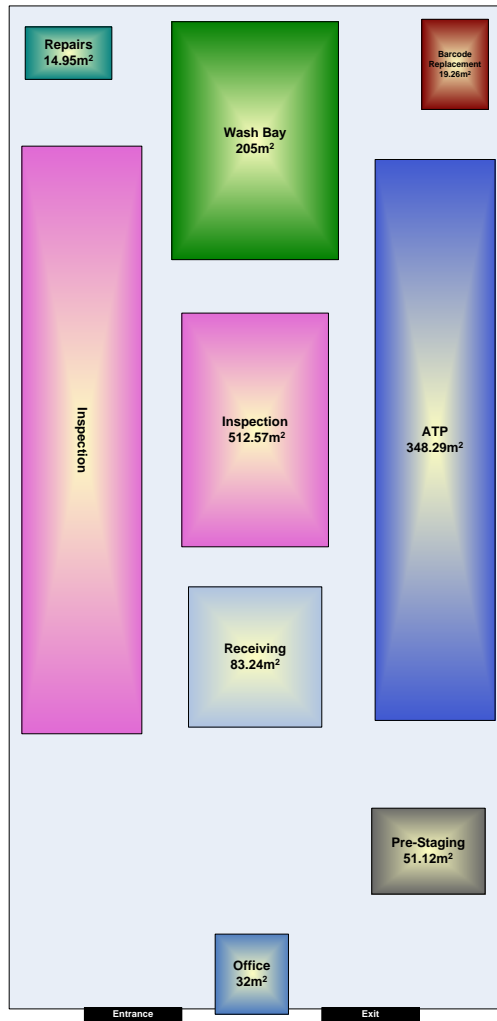
- Considerations should be taken for Schnellecke tow-truck to enter the onsite depot and exit; there should be ample turning space for five trailers.
- Space for the forklifts to operate between the areas is needed and ample space to turn or reversing. At least 3m is required but 5 m would be more practical, which will lessen the chance of bumping stacks.
- Considerations should be made for more space if Ford decides to make more units.

### Step 8: Practical limitations

- Washing bay is already built and thus it cannot be made bigger nor can it be moved. All the drains for the chemicals have been built to legal requirements and thus this is a limitation to the design.
- Another limitation is that the offices have already been placed next to the gates. Electricity has been provided and thus it is not seen practical to move the offices.
- 0.6m space is required from the boundaries, standards set by Ford safety department.

## Step 9: Develop layout Alternatives

### Alternative A



### Alternative B

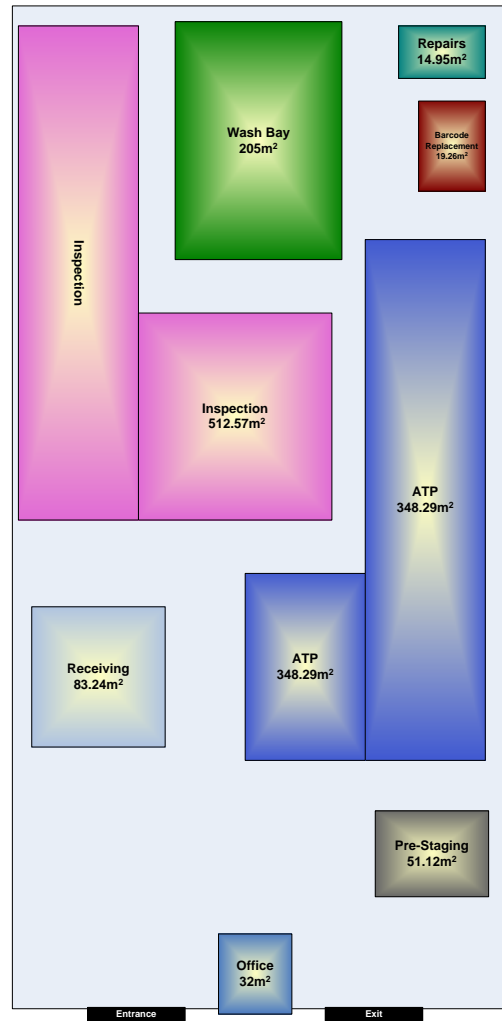
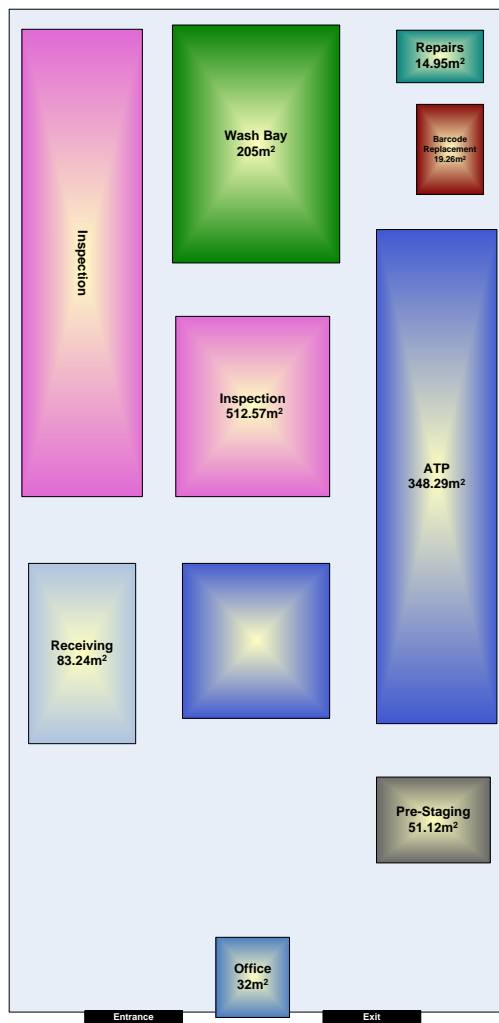


Figure 17: Alternative A and Alternative B

### Alternative C



### Alternative D

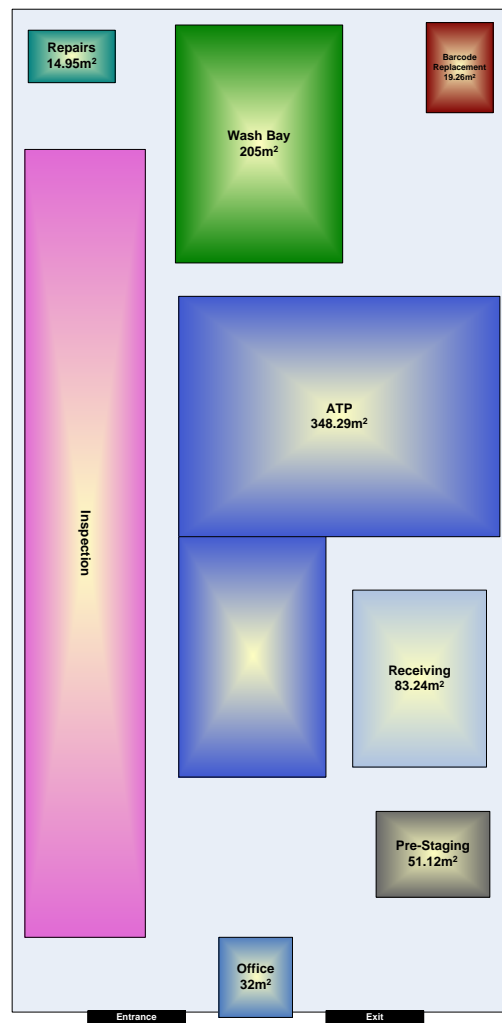


Figure 18: Alternative C and Alternative D

## Step 10: Evaluation

### Listing Advantages and Disadvantages

#### Alternative A

Advantages:

- There is room for expansion
- Inspection flows into the wash bay and ATP, the two main areas.
- ATP is next to the wash bay and makes access easy.
- Enough space for Schnellecke tow-truck to move through.
- Forklifts can move all over.

Disadvantages:

- Inspection is far from Barcode Replacement area.

### **Alternative B**

Advantages:

- There is room for expansion
- Inspection flows into the wash bay and ATP, the two main areas.
- ATP is next to the wash bay and makes access easy.
- Enough space for Schnellecke tow-truck to move through.

Disadvantages:

- Inspection is far from Barcode Replacement area.
- No direct flow for forklift to move to repairs will need to go around inspection if the packaging is inspected at the office side.

### **Alternative C**

Advantages:

- There is room for expansion
- Inspection flows into the wash bay and ATP, the two main areas.
- ATP is next to the wash bay and makes access easy.
- Enough space for Schnellecke tow-truck to move through.
- Forklifts can move all over.

Disadvantages:

- Inspection is far from Barcode Replacement area.
- Inspection is far from Repairs.

### **Alternative D**

Advantages:

- Inspection flows into the wash bay and ATP, the two main areas.
- ATP is next to the wash bay and makes access easy.
- Enough space for Schnellecke tow-truck to move through.
- ATP and Inspection has been increased in size for later expansion.

Disadvantages:

- Inspection is far from Barcode Replacement area.
- Not enough space for Schnellecke tow-truck to move through.
- No direct flow for forklift to move to repairs will need to go around inspection if the packaging is inspected at the office side.
- Other areas don't have much room for expansion.
- Receiving not close to entrance

### Criteria Ranking Matrix

|   |           |
|---|-----------|
| 1 | Very Poor |
| 2 | Poor      |
| 3 | Good      |
| 4 | Very Good |
| 5 | Excellent |

| No           | Criteria List                                    | Imporance | Alternative A |       | Alternative B |       | Alternative C |       | Alternative D |       |
|--------------|--|-----------|---------------|-------|---------------|-------|---------------|-------|---------------|-------|
|              |  |           | Rating        | Total | Rating        | Total | Rating        | Total | Rating        | Total |
| 1            | Packaging flow                                   | 20        | 4             | 80    | 3             | 60    | 5             | 100   | 2             | 40    |
| 2            | Room for expansion                               | 25        | 5             | 125   | 4             | 100   | 5             | 125   | 1             | 25    |
| 3            | Manovering space for Forklift                    | 15        | 5             | 75    | 2             | 30    | 5             | 75    | 2             | 30    |
| 4            | Inspection connected to ATP and Washbay          | 10        | 5             | 50    | 5             | 50    | 5             | 50    | 5             | 50    |
| 5            | Inspection connected to repair area              | 8         | 5             | 40    | 2             | 16    | 2             | 16    | 5             | 40    |
| 7            | Inspection connected to Barcode replacement area | 8         | 2             | 16    | 2             | 16    | 2             | 16    | 1             | 8     |
| 8            | Receiving near entrance                          | 4         | 5             | 20    | 5             | 20    | 5             | 20    | 2             | 8     |
| 9            | Space for tow-truck to move                      | 10        | 4             | 40    | 4             | 40    | 5             | 50    | 1             | 10    |
| <b>Total</b> |  | 100       | 35            | 446   | 27            | 332   | 34            | 452   | 19            | 211   |

Figure 19: Criteria Ranking Matrix

From the above matrix, alternative C would be the best layout, as it scored the highest points out of all the layouts. The next alternative that could be considered is Alternative A because the difference in score is not so far apart from each other. Therefore the advantages and disadvantages list must be studies and Alternative A is the best solution as the repair area is in contact with Inspection area.

### 3.2. Detail Design of TrenStar onsite depot

After the results have been shown to TrenStar management, the alternatives and evaluation of advantages and disadvantages; criteria ranking matrix, **Alternative A** was chosen as the solution for the layout design. Below is a detailed design for the onsite depot, but extra area was used for receiving with request from TrenStar management, as no schedule can be received from Schnellecke:

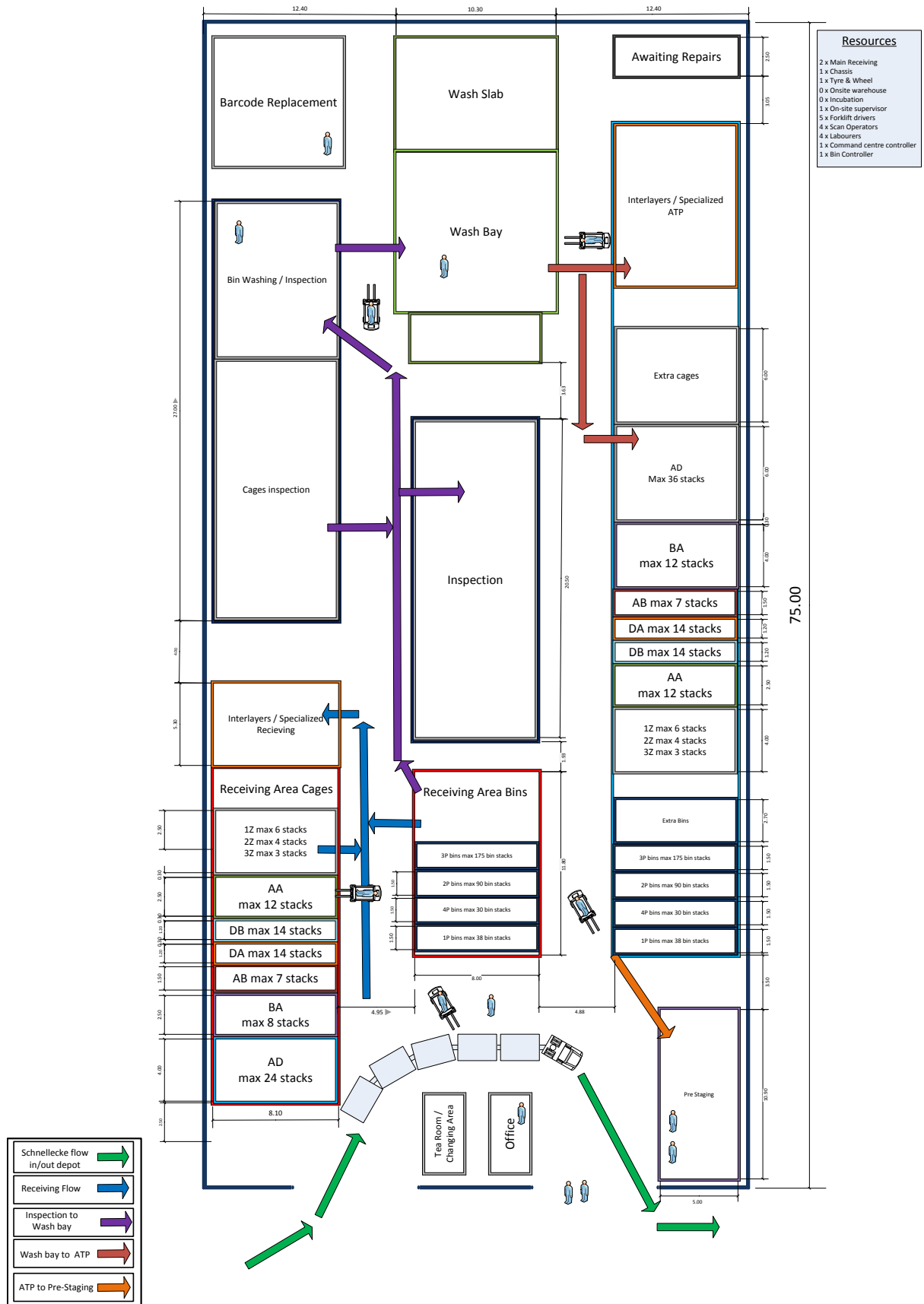


Figure 20: Detail design for TrenStar onsite depot with flow

### 3.3. Staging Layout

#### *DHL Truck Arrival Schedule*

DHL trucks arrive at the TrenStar onsite depot on a milk-run schedule each day which is about 8.5 hour. This schedule has been received from DHL and is fixed times that the trucks should arrive if no disruption occur. There are different types of trucks; interlinks which has two trailers and is 18 m in length, 8 tons that are 6 m in length and 12 m trucks.

The DHL schedule indicates that there will be at most four trucks at the onsite depot for collection at a specific time. Thus TrenStar onsite depot requires four loading bays with four staging areas.

In *table 17* below is a schedule of the arrival of trucks and which loading area it should stop at. TrenStar would like to stage, if possible before the truck arrives, this has been depicted in the *table 17* below as well. The amount of trucks in the loading/staging area per time slot is shown in the second column and amount of trucks arriving and leaving in the 7<sup>th</sup> and 8<sup>th</sup> column. The last column shows the amount of forklifts needed per time slot. A maximum of 4 forklifts are needed between 13:15 and 14:00.

| DHL Truck Arrival Time | Total Amt. of Trucks | Load Area 1 | Load Area 2 | Load Area 3 | Load Area 4 | Total Amt. of Trucks Arrive | Total Amt. of Trucks Leave | Amount of Forklifts Req. |
|------------------------|----------------------|-------------|-------------|-------------|-------------|-----------------------------|----------------------------|--------------------------|
| 07:00                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |
| 07:15                  | 0                    | Stage       |             |             |             | 0                           | 0                          | 1                        |
| 07:30                  | 0                    |             | Stage       |             |             | 0                           | 0                          | 1                        |
| 07:45                  | 2                    | 8 ton       | 8 ton       |             | Stage       | 2                           | 0                          | 3                        |
| 08:00                  | 2                    |             |             | Stage       |             | 0                           | 2                          | 3                        |
| 08:15                  | 2                    | Stage       |             | Link        | Link        | 2                           | 0                          | 3                        |
| 08:30                  | 3                    | Link        |             |             |             | 1                           | 2                          | 3                        |
| 08:45                  | 1                    |             | Stage       |             |             | 0                           | 1                          | 3                        |
| 09:00                  | 0                    |             |             | Stage       |             | 0                           | 0                          | 1                        |
| 09:15                  | 2                    |             | Link        | Link        |             | 2                           | 0                          | 2                        |
| 09:30                  | 2                    |             |             |             | Stage       | 0                           | 2                          | 3                        |
| 09:45                  | 1                    | Stage       |             |             | 12m         | 1                           | 0                          | 2                        |
| 10:00                  | 1                    |             | Stage       |             |             | 0                           | 1                          | 2                        |
| 10:15                  | 2                    | Link        | Link        |             |             | 2                           | 0                          | 2                        |
| 10:30                  | 2                    |             |             |             |             | 0                           | 2                          | 2                        |
| 10:45                  | 0                    |             |             | Stage       |             | 0                           | 0                          | 1                        |
| 11:00                  | 1                    |             |             | Link        | Stage       | 1                           | 0                          | 2                        |
| 11:15                  | 2                    |             |             |             | Link        | 1                           | 1                          | 2                        |
| 11:30                  | 1                    |             |             |             |             | 0                           | 1                          | 1                        |
| 11:45                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |
| 12:00                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |
| 12:15                  | 0                    | Stage       |             |             |             | 0                           | 0                          | 1                        |
| 12:30                  | 0                    |             | Stage       |             |             | 0                           | 0                          | 1                        |
| 12:45                  | 1                    | 12m         |             | Stage       |             | 1                           | 0                          | 2                        |
| 13:00                  | 2                    |             | Link        |             | Stage       | 1                           | 1                          | 3                        |
| 13:15                  | 3                    | Stage       |             | Link        | 8 Ton       | 2                           | 1                          | 4                        |
| 13:30                  | 3                    | 8 Ton       | Stage       |             |             | 1                           | 2                          | 4                        |
| 13:45                  | 3                    |             | Link        | 12m         | Stage       | 2                           | 1                          | 4                        |
| 14:00                  | 4                    | Link        |             |             | 8 Ton       | 2                           | 2                          | 4                        |
| 14:15                  | 3                    |             | Link        |             |             | 1                           | 2                          | 3                        |
| 14:30                  | 1                    | Stage       |             | Stage       |             | 0                           | 1                          | 3                        |
| 14:45                  | 0                    |             | Stage       |             |             | 0                           | 0                          | 1                        |
| 15:00                  | 2                    | Link        |             | Link        | Stage       | 2                           | 0                          | 3                        |
| 15:15                  | 3                    |             |             |             | Link        | 1                           | 2                          | 3                        |
| 15:30                  | 2                    |             | 8 Ton       |             |             | 1                           | 1                          | 2                        |
| 15:45                  | 1                    |             |             |             |             | 0                           | 1                          | 1                        |
| 16:00                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |
| 16:15                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |
| 16:30                  | 0                    |             |             |             |             | 0                           | 0                          | 0                        |

Table 17: DHL trucks arriving at onsite depot

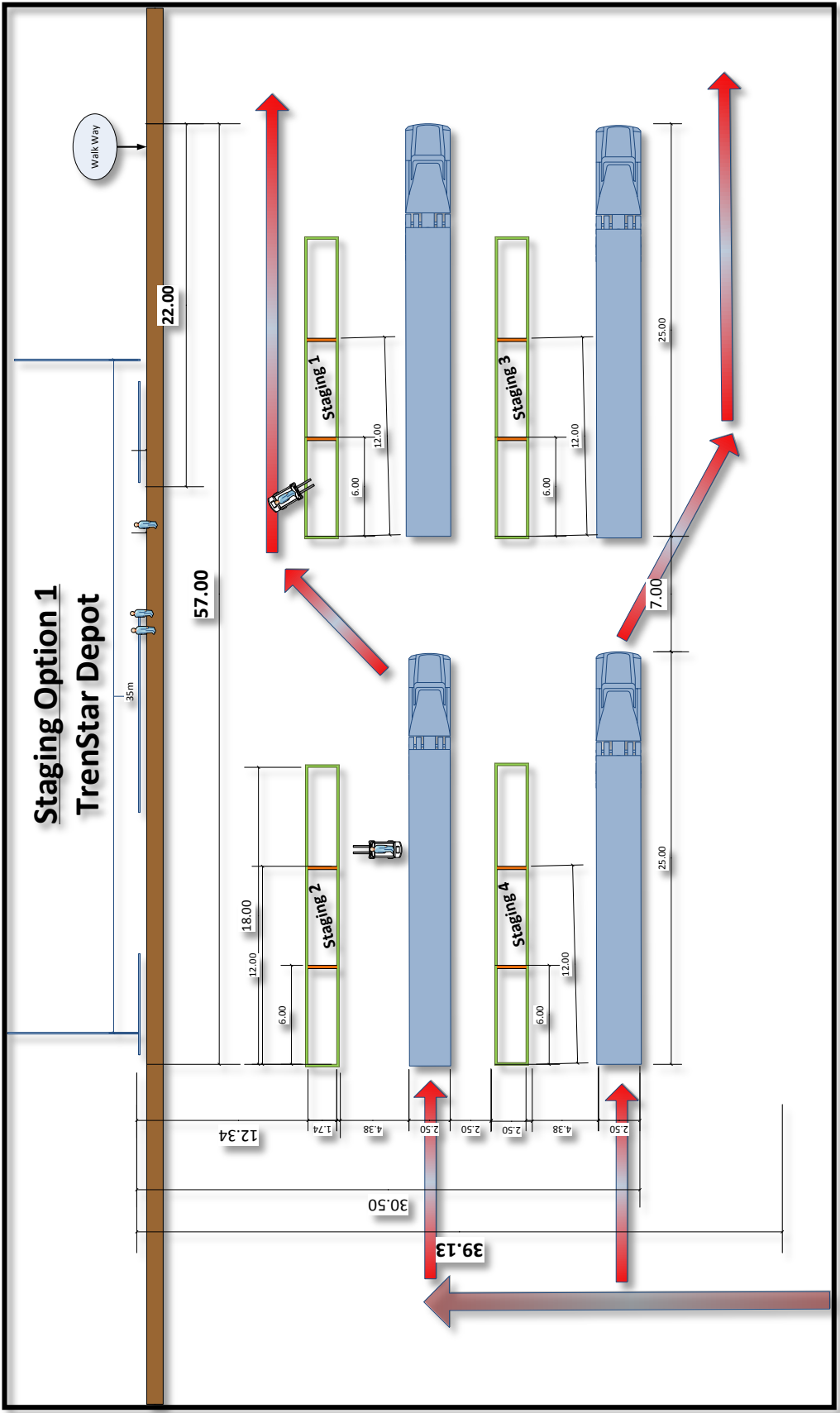


Figure 21: Staging option 1

Option 1 was chosen for the staging because it took up less space and was more practical for the trucks to get out of the loading bay.

- Option 1 = 2223m<sup>2</sup>
- Option 2 = 2535m<sup>2</sup> (Option 2 is shown in *appendix B*)

Trucks need a lot of turning area; therefore keeping the trucks driving in a straight line, would be the best option and minimise sharp turning.

#### 4. Tracking

To make tracking easier, RFID readers with antennas will be placed at the entrance and exit of the onsite depot. When reusable packaging arrives, the RFID reader will read all the tags on the packaging and will transfer the information to the middleware controller (computer) where it will be passed through to the information system (EAM).

This will log the packaging to the onsite depot. When packaging leaves the depot, a user will have to log on the system to what customer it is being dispatched to.

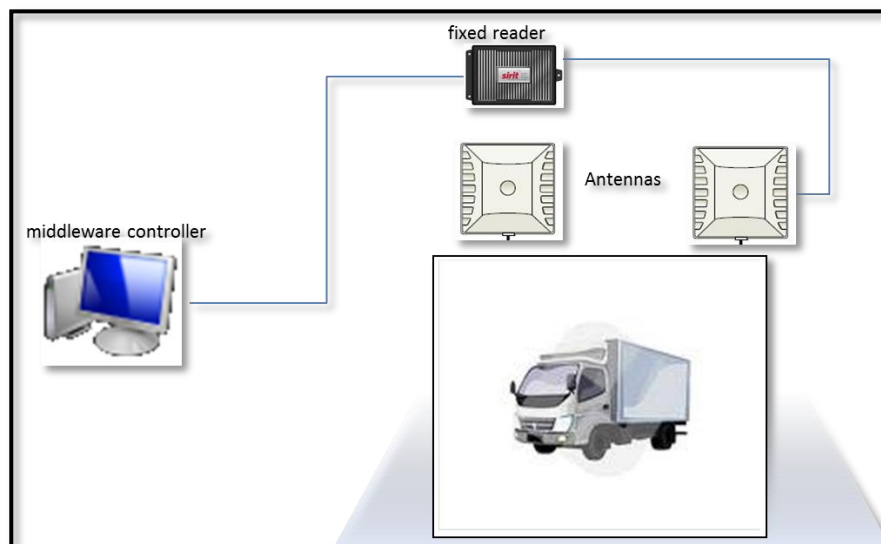


Figure 22: RFID process

The suppliers all have been issued with GPRS scanners and can scan the packaging as they receive them and dispatch them back to Ford.

Currently not all the packaging has RFID tags, thus the packaging entering the onsite depot will have to be scanned as well until all the packaging can be RFID tagged. When damage assessments need to be done, it is done via a scanner as well, where it logs on the system a job card and can specify what is wrong with the packaging.

## 5. Resources

The following resources to be used in the new depot were allocated by TrenStar Operational Manager and Ford Motor Company Management:

- 1 x onsite supervisor
- 5 x Forklifts
- 5 x Forklift drivers
- 4 x Scan Operators
- 4 x Labourers
- 1 x Bin co-ordinator
- 1 x Command centre controller

The following times to load an 18 m truck with forklift's are in *Table 18* below and these values are given by TrenStar depot employees that have loaded trucks in the past:

|            | Best case | Average case | Worse case | Total for 4 loading bays |
|------------|-----------|--------------|------------|--------------------------|
| 1 Forklift | 30 min    | 40 min       | 50 min     | 4 Forklift               |
| 2 Forklift | 15 min    | 25 min       | 35 min     | 8 Forklift               |

**Table 18: Number of forklifts needed**

Using one forklift to load a truck you need a best case scenario. This would be that the forklift is always loading and does not ever have to stop for anything; never has a break down, doesn't need repairs, refilling with petrol, or any other time consuming activity. Then the depot can use 1 forklift per staging lane.

In reality, the average case should be used. Two forklifts per staging lane should be used to load the truck. The truck will be loaded on average within 25 minutes.

Thus recommendation that eight forklifts be used to stage and load trucks. One forklift to offload in receiving area, another should be used within inspection and one in the wash bay area. The total amount of forklifts that should be used in the depot is eleven and thus eleven forklift drivers should be allocated as well.

## 6. Material Handling

### Forklift

Forklifts will be used to move the cages around the depot, to create stacks to store them and load the packaging on and off trucks. Forklifts will be the main material handling equipment as the cages are too heavy for manual lifting and trolleys will take too long.



**Figure 23: Forklift**

### **Pallets**

There will be three types of pallets at the onsite depot. The most common pallet is the wooden pallet which will be used to transport smaller items around in bulk. Bins will be placed nested on the pallets and moved to the area where they are needed, the bins will also be stored on pallets. The steel pallets are used for specialized equipment and will only be stored in the depot. The plastic pallet is used to transport Polyethylene bins that are also a specialized bin for a supplier.

## **7. Processes for the Onsite depot**

Schnellecke takes empty packaging from the Ford factory to the TrenStar onsite depot on a small tow-truck with no more than five trailers. Schnellecke will park within the depot at Receiving and waits for TrenStar yard operators to offload with a forklift.

### **Receiving Area**

A TrenStar must offload Schnellecke tow-truck using a forklift and place the packaging in the prescribed receiving area. Another TrenStar yard operator needs to scan all of the offloaded packaging that is brought to receiving area.

### **Inspection Area**

TrenStar forklift driver needs to move stock that is in the Receiving area to the inspection area. The equipment must be packed out next to each other and packaging that has been collapsed must be extended. An Inspection must be carried out on all the containers to see whether the containers are damaged or dirty. The inspection is carried out with the scanner to log on the system the results of the inspection. This keeps record of the inspection.

If the packaging is damaged it must be moved to repairs area, when the packaging is dirty, it is moved to the washing area and if it is neither then it is moved to ATP area.

### **Washing Area**

All the packaging is scanned into the wash bay area, to log the equipment's position. The washing area has been divided into two areas, chemical washing area and normal washing area. Both washing areas has a drainage system that is linked to a chemical drain; to ensure that no water that is contaminated enters the storm water drains.

When a packaging type needs to be washed with chemicals to remove oil, grease or tough dirt, it is washed with chemicals, high pressure (HP) water or steam in the enclosed area. The enclosed area has a roof and Polyethylene Terephthalate (PET) curtains, to ensure that no spillage from spraying fall outside the prescribed area and all the chemicals run down the chemical drain.

The other outside washing area is for packaging that is dirty from dirt, mud or non-toxic substances. This area is an open area; built on a slab with a drain in the center.



**Figure 24: Washing cages**

TrenStar barcode quality is checked and if it is in good quality the packaging is moved to the ATP area. If the barcode quality is not good, then the packaging is moved to the barcode replacement area.

### **Repair Area**

In the repair area, TrenStar onsite depot supervisor assesses the damage of the packaging. If the damage is fair wear and tear then a damage assessment is done with the scanner, which in turn logs a job card notification automatically onto the system and the packaging waits to be moved to Wadeville depot.

When the damage is not normal wear and tear, then TrenStar supervisor and Ford personnel does the damage assessment together to asses if it is Ford liability or supplier liability. The damage assessment is done with the scanner and a damage notification is sent to the guilty party. TrenStar will charge this party with the cost to repair or replace the packaging. When this is done, the

packaging wait to be moved to Wadeville depot, when there is enough packaging to fill a truck, it is transported to Wadeville depot for repairs.



**Figure 25: Repairing Cages**

### ***Barcode replacement Area***

In the barcode replacement area, the packaging that requires new barcode is moved there. A receive scan is done on the packaging to verify on the system that it is in this area. Then a Notification is loaded for a new Barcode. The Barcode is printed at Head Office, where it is then brought onto site to be replaced on the packaging. Then the packaging will be moved to ATP area.

### ***ATP Area***

This is the main storage area for the packaging. The onsite depot needs to carry a one day's stock plus 15% of reusable packaging for the suppliers and Ford. All the stock that has been inspected or cleaned is moved to this area. Every type of packaging has a specific prescribed area to be stored, so that when it is needed for pre-staging, it can be easily found. The cages are stacked collapsed and not more than 10 cages high. The bins are stored on pallets and are stacked 20 nested into each other. Specialized equipment like Interlayers are also stored on pallets but the height varies depending on safety.

Each packaging that is moved to this area must be scanned.

### ***Pre-Staging Area***

Each day the onsite supervisor receives a picking instruction from the Bin coordinator, which was compiled from the online ordering. This picking instruction gives the type and amount of packaging for each supplier that DHL will collect on its milk run schedule.

A forklift driver will move the items on the picking instruction to the pre-staging area for a specific supplier. The packaging will be scanned and linked to a skid label.

## *Staging*

Before the DHL truck arrives, a forklift driver can move all the equipment for a truck to the prescribed staging area. There can be two to three suppliers' packaging in one staging area. When the truck arrives, the skid label is scanned out to the customer and the packaging is logged on the system. The forklift driver will load the DHL truck. Two scan notifications will be attached to the waybill and the truck will leave on its milk run delivery schedule after the truck is loaded.

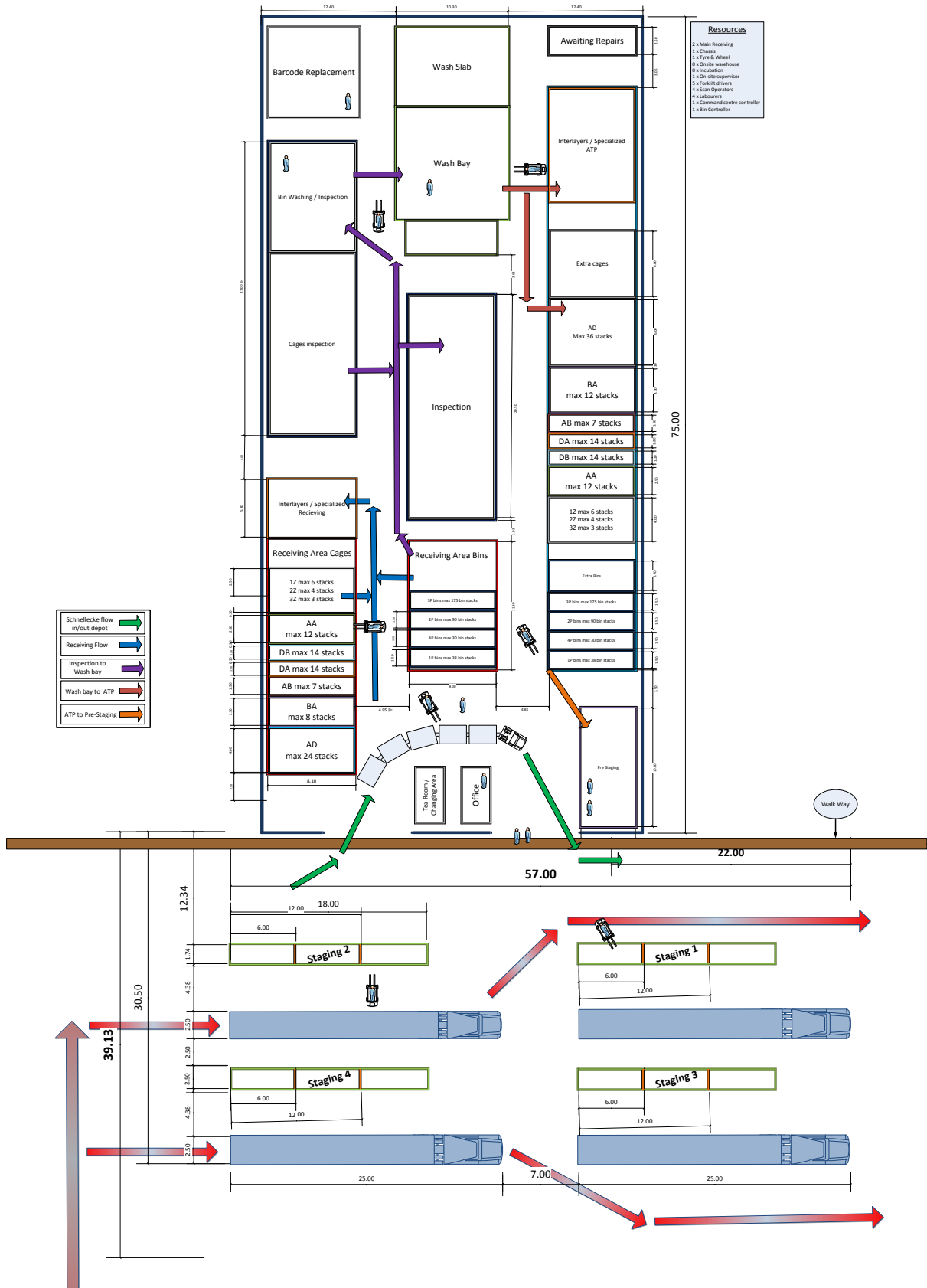
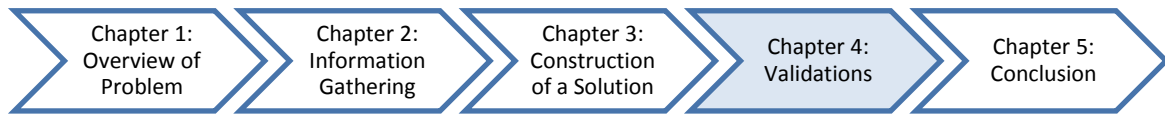


Figure 26: Depot and Staging area

## Chapter 4: Validations



### 1. Validation

The success of this project can only be verified once Ford starts full production of the T6 Ford Ranger and the depot design is correctly laid out. The criteria that will determine if this project is successful will be:

- The demarcated areas can handle the volumes.
- The capacity has been correctly worked out with a variance of 15%.
- There is expansion for growth.
- The DHL trucks can be loaded within 30 min and the schedule of pre-staging and staging is kept.

### 2. What-if analysis

What-if analysis is a method of brainstorming to determine what things can happen when values and situation changes and the effects are of those changes. This can help plan for the future, if the situation changes or help design the depot in a way to handle these changes if they do occur.

#### 2.1. Volume Change:

The first what-if analysis that was done, was if the units produced by Ford increased to 300 and then to 400 units per day. Changes in the volume was done on the excel model and the quantity of packaging for the new volume was updated.

The reusable packaging volumes for 300 units is displayed in the table below:

| TrenStar Packaging |                                  |                             |
|--------------------|----------------------------------|-----------------------------|
| Packaging Type     | Total # of Packaging for max day | Total Packaging with Buffer |
| 1A                 | 52                               | 60                          |
| 1Z                 | 93                               | 107                         |
| 2Z                 | 84                               | 97                          |
| 3Z                 | 40                               | 46                          |
| 1P                 | 190                              | 219                         |
| 2P                 | 80                               | 92                          |
| 3P                 | 106                              | 122                         |
| 4P                 | 508                              | 584                         |
| AD                 | 690                              | 794                         |
| DA                 | 41                               | 47                          |
| BA                 | 262                              | 301                         |
| DB                 | 22                               | 25                          |
| AB                 | 64                               | 74                          |
| <b>Totals</b>      | <b>2232</b>                      | <b>2567</b>                 |

| Interlayers     |                                    |                               |
|-----------------|------------------------------------|-------------------------------|
| Interlayer Code | Total # of Interlayers for max day | Total Interlayers with Buffer |
| AD              | 837                                | 962                           |
| BA              | 260                                | 299                           |
| LV              | 228                                | 262                           |
| MG              | 128                                | 147                           |
| Shurlock        | 51                                 | 59                            |
| <b>Totals</b>   | <b>1504</b>                        | <b>1730</b>                   |

| Specialized      |                                    |                               |
|------------------|------------------------------------|-------------------------------|
| Specialized Code | Total # of Specialized for max day | Total Specialized with Buffer |
| MS               | 4                                  | 5                             |
| MG               | 51                                 | 59                            |
| GR               | 34                                 | 39                            |
| GS               | 24                                 | 28                            |
| GF               | 102                                | 117                           |
| GH               | 102                                | 117                           |
| GI               | 102                                | 117                           |
| GJ               | 51                                 | 59                            |
| GK               | 51                                 | 59                            |
| LV               | 29                                 | 33                            |
| <b>Totals</b>    | <b>550</b>                         | <b>633</b>                    |

Table 19: Packaging volumes for 300 units

The reusable packaging volumes for 400 units is displayed in the table below:

| TrenStar Packaging |                                  |                             |
|--------------------|----------------------------------|-----------------------------|
| Packaging Type     | Total # of Packaging for max day | Total Packaging with Buffer |
| 1A                 | 51                               | 59                          |
| 1Z                 | 87                               | 100                         |
| 2Z                 | 96                               | 110                         |
| 3Z                 | 36                               | 41                          |
| 1P                 | 207                              | 238                         |
| 2P                 | 85                               | 98                          |
| 3P                 | 113                              | 130                         |
| 4P                 | 627                              | 721                         |
| AD                 | 781                              | 898                         |
| DA                 | 41                               | 47                          |
| BA                 | 322                              | 370                         |
| DB                 | 25                               | 29                          |
| AB                 | 66                               | 76                          |
| <b>Totals</b>      | <b>2537</b>                      | <b>2918</b>                 |

| Interlayers     |                                    |                               |
|-----------------|------------------------------------|-------------------------------|
| Interlayer Code | Total # of Interlayers for max day | Total Interlayers with Buffer |
| AD              | 1116                               | 1283                          |
| BA              | 347                                | 399                           |
| LV              | 304                                | 350                           |
| MG              | 171                                | 196                           |
| Shurlock        | 102                                | 117                           |
| <b>Totals</b>   | <b>2039</b>                        | <b>2345</b>                   |

| Specialized      |                                    |                               |
|------------------|------------------------------------|-------------------------------|
| Specialized Code | Total # of Specialized for max day | Total Specialized with Buffer |
| MS               | 8                                  | 9                             |
| MG               | 102                                | 117                           |
| GR               | 64                                 | 74                            |
| GS               | 48                                 | 55                            |
| GF               | 204                                | 235                           |
| GH               | 204                                | 235                           |
| GI               | 204                                | 235                           |
| GJ               | 102                                | 117                           |
| GK               | 102                                | 117                           |
| LV               | 58                                 | 67                            |
| <b>Totals</b>    | <b>1096</b>                        | <b>1260</b>                   |

Table 20: Packaging volumes for 400 units

The ratio to the volume change in the total volume is displayed below:

$$200 : 300 : 400$$

$$1 : 1.8 : 2.1$$

When these volumes are implemented into space requirements model, the following tables below display the different space required for the various areas in the depot.

| Area (300 units)                | Area (m <sup>2</sup> ) |             |             | Total          |
|---------------------------------|------------------------|-------------|-------------|----------------|
|                                 | TrenStar Equipment     | Interlayers | Specialized |                |
| Receiving                       | 41.12                  | 15.65       | 82.54       | 139.31         |
| Inspection                      | 696.31                 | 160.24      | 45.85       | 902.40         |
| Wash Bay                        | 174.08                 | 164.09      | 31.20       | 369.36         |
| ATP                             | 279.13                 | 111.12      | 238.14      | 628.40         |
| Pre Staging                     | 36.44                  | 17.79       | 31.20       | 85.43          |
| Staging                         | 36.44                  | 28.49       | 31.20       | 96.13          |
| Barcode Replacement             | 16.64                  | 7.52        | 13.64       | 37.79          |
| Repairs                         | 14.24                  | 6.32        | 13.64       | 34.19          |
| Offices                         | 32.00                  | 0.00        | 0.00        | 32.00          |
| <b>Total Depot Space needed</b> |                        |             |             | <b>2325.03</b> |

Table 21: Space requirements for 300 units

| Area (400 units)                | Area (m <sup>2</sup> ) |             |             | Total          |
|---------------------------------|------------------------|-------------|-------------|----------------|
|                                 | TrenStar Equipment     | Interlayers | Specialized |                |
| Receiving                       | 45.80                  | 20.36       | 110.12      | 176.28         |
| Inspection                      | 784.92                 | 185.95      | 157.99      | 1128.85        |
| Wash Bay                        | 196.23                 | 190.77      | 37.01       | 424.01         |
| ATP                             | 309.70                 | 131.70      | 314.79      | 756.19         |
| Pre Staging                     | 39.92                  | 17.79       | 37.01       | 94.72          |
| Staging                         | 39.92                  | 31.30       | 37.01       | 108.23         |
| Barcode Replacement             | 18.91                  | 7.52        | 13.64       | 40.07          |
| Repairs                         | 14.24                  | 6.32        | 13.64       | 34.19          |
| Offices                         | 32.00                  | 0.00        | 0.00        | 32.00          |
| <b>Total Depot Space needed</b> |                        |             |             | <b>2794.55</b> |

Table 22: Space requirements for 400 units

The tables above show that the depot won't be able to handle the volumes if Ford Motor Company decides to increase the volumes. The Wash Bay area can only handle 205 m<sup>2</sup> of packaging; therefore the Wash Bay area cannot handle the increased volumes.

The space requirements for 300 units is 2325.03m<sup>2</sup> and the available space for the new depot is 2625m<sup>2</sup>, which doesn't really leave any space for aisle, working and movement space, but it will be to take the volumes except in the wash bay, though it is impractical.

For 400 units, the space requirement is over the limit and thus the new depot won't be able to handle the volumes at all. The depot can look at automatic washers to increase turnaround time within the wash bay area or the washing of the extra packaging must be done on another premises, but this won't solve the space requirements problem.

In conclusion, if Ford Motor Company would like to increase their volumes to 300 or more units, Ford Motor Company will have to allocate more space and resources for the depot.

### 3. Health, Safety and Environmental Impact Recommendation

To have a depot that looks after environment and its employees, managers need to look at different factor, hazards in the work area:

- **Stacking heights** – If the stacks are too high, it can be easily blow over by the wind and fall on a person. Thus stacks should not be too high.
- **Walk/Drive aisle between stacks** – there should be enough spaces between the aisles so that the forklift can easily turn and manoeuvre all over the yard to ensure that it doesn't bump any stacks.
- **High pressure water system** – proper procedure needs to be in place to use the high pressure water to clean the containers and to ensure that no injuries occur with the high pressure water. Proper training needs to be given to employees on how to clean containers and use high pressure water.
- **Hazardous material** – All hazardous material needs to be identified before handled by employees. Instructions need to be made on how employees need to handle containers that have hazardous materials on it and how to use chemicals to clean containers. Employees need to be trained on what to do when they come in contact with hazardous materials. Proper drainage is also needed for hazardous material to prevent it from entering storm water drains.
- **Forklifts** – All forklift drivers need to be trained on how to drive a forklift and undergo a driving test to be certified to drive a forklift.
- **Electric connection** – All electric connections need to be

ISO 14001:2004 address various aspects of environmental management tools that enables one to identify and control environmental issues, improve environmental performance continually and implement a systematic approach to setting environmental objectives and targets to achieving these objectives. (International Organization for Standardization, 2011)

To achieve a safe working environment, on need to look at the following:

- All new employees that work on the site need to carry out safety induction training.
- Employee's needed to be issued with safety equipment, e.g., hard hat, overalls, safety shoes.
- Standard operating procedures need to be made to state how jobs in the depot must be carried out in a safe and ergonomically way. The hazards, dangers and safety equipment need to be stated on these standard operating procedures.
- Emergency plans need to be made on the different type of emergencies that can occur on the site. These action plans need to be practiced continuously.

- Ergonomics processes and tools that would reduce body stress and awkward positioning should be implemented.

## 2.1 Ergonomics

Ergonomics-related risk factors that employees are exposed to should be addressed and minimized; these are (Occupational Safety & Health Administration, 2008):

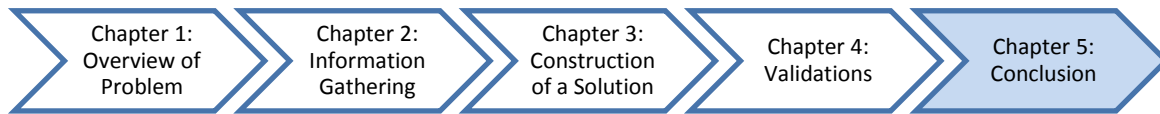
- Force
- Repetition
- Awkward and prolong static body posture
- Contact stress
- Vibration
- Cold Temperatures
- High noise exposure

Some yard ergonomic solutions that can be implemented in the depot are (Occupational Safety & Health Administration, 2008):

- Site-wide:
  - Lighting should be directly over a work area or equipment.
  - Point-of-Use Tool Boards and Rigging Racks are devices that position work between the knees and shoulders to make reach easier.
  - Standing Platforms or benches that can be help employee work in high areas and reduce the risk of employee using incorrect equipment to stand on.
- Material/Equipment handling:
  - Wheeled devices should be used to transport and carry material, e.g., forklifts, trolleys.
  - Drum Movers/Tilters should be used to easily lift and tilt heavy drums.
  - Overhead Cranes must be used to lift and transport heavy items
  - Hoists/Balancers are portable devices used to lift and position heavy objects and tools.
  - Conveyors or roller ball surfaces can ease manual transport of goods.
  - Movable containers that have wheels already attached to them.
  - Pulley System attached to tools or equipment that can assist in manual handling and positioning.
  - Automatic hose roller coils long hoses.
  - Cable Management System stores cables, hoses out of the way.
  - Racking and shelving
- Tools:
  - Tool extension handles

- Power tools to make manual work easier, should be made out of light-weight materials
- Low vibration tools
- Tool balancers are used to support and position tools.
- Personal Protective equipment:
  - Anti-vibration Gloves
  - Elbow Pads
  - Shoulder Pads
  - Kneeling Supports
  - Hard Hats
  - Overalls – chemical, fireproof, etc.
  - Safety glasses

## Chapter 5: Conclusion



TrenStar will be providing Ford Motor Company with a service to manage their reusable packaging at their factory. It is crucial that the new depot flows do not cause a bottleneck for Ford assembly line. To ensure this the depot must be able to supply good condition, clean reusable packaging to Ford's suppliers in time, so that in turn they can provide Ford with the parts needed to build the new T6 Ford Ranger.

The capacity of packaging that has been worked out in the model was used to calculate the space requirements. This showed that the area that Ford gave TrenStar to use for an onsite depot was adequate (2625m<sup>2</sup>). The reusable packaging area needed was 1323.42m<sup>2</sup> and the rest could be used for aisle space for the forklifts and can be used for later growth.

Muther's Systematic Layout Planning procedure was used to produce 4 layout designs for the depot. Alternative A and C was the best design and TrenStar decided Alternative A is the best layout design.

The staging area available for the DHL trucks is 2340m<sup>2</sup> and two designs were made for the loading and staging bays. Design 1 was selected as it was the most practical for the trucks, to minimise turning and reversing of the trucks out of the loading bays.

The processes for the depot were described in this report and final designs made to present to Ford Motor Company. Health, safety and environmental aspects have been discussed as well as ergonomic-related risk factors. The success factors that will determine if this project is successful after the implementation of the final designs were also briefly discussed.

Therefore the objectives for the projects have been adequately met and a design was developed to cater for the volumes that are anticipated for new T6 Ford Ranger, staging area design was made to support DHL milk run schedule.

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## Acronyms

ATP – Available to Promise

EAM – Enterprise asset management system

ERP – Enterprise resource planning

GPRS - General Packet Radio Services

GSM – Global system for mobile

HP – High Pressure

PFEP – Plan for every part (bill of materials)

RFID – Radio Frequency IDentification

SLP - Systematic Layout Planning

SMS – Short message service

TMS – Time management system

WMS – Warehouse management system

YMS - Yard management system

## Appendix A – TrenStar Demarcated Site

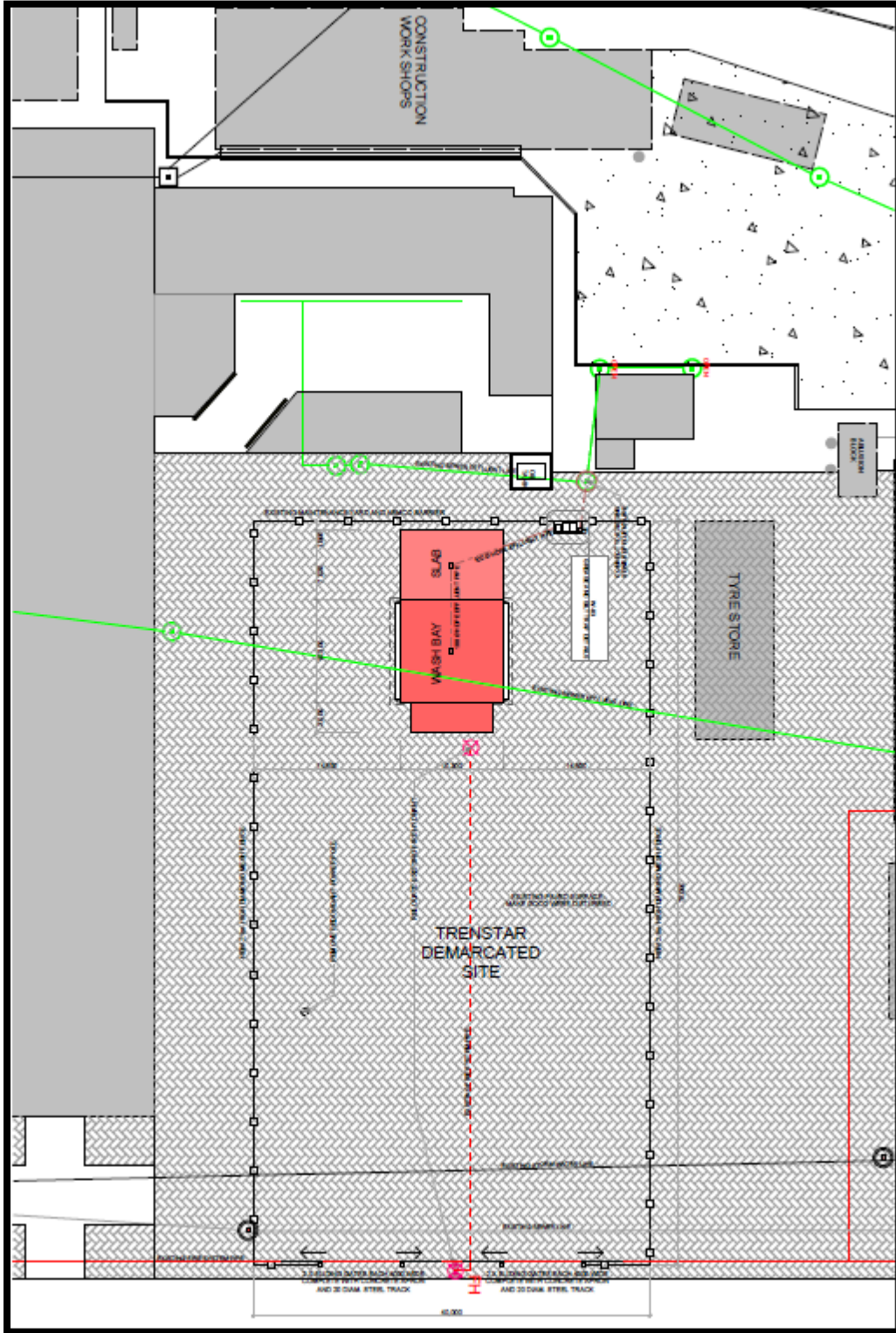


Figure 27: TrenStar demarcated Site

## Appendix B – Staging Option 2

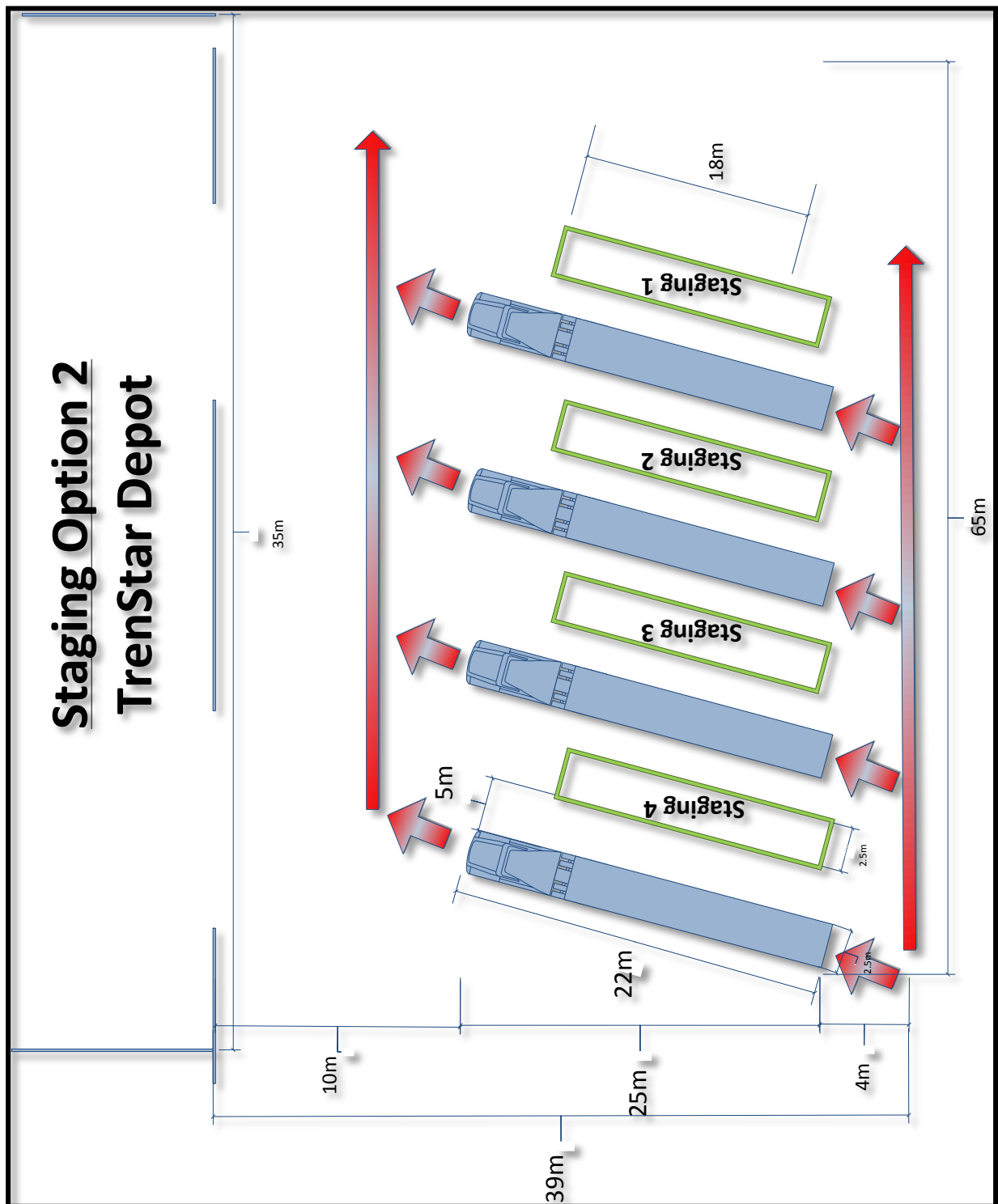


Figure 28: Staging option 2

## Appendix C - TrenStar Packaging

| TYPE 1P                  |                    | TYPE 3P                  |                    |
|--------------------------|--------------------|--------------------------|--------------------|
| SPECIFICATIONS           |                    | SPECIFICATIONS           |                    |
| External top dimensions  | 594 x 396 x 315 mm | External top dimensions  | 300 x 200 x 182 mm |
| Internal base dimensions | 510 x 338 x 280 mm | Internal base dimensions | 250 x 155 x 157 mm |
| Volume                   | 55 litres          | Volume                   | 6.4 litres         |
| Load Capacity            | 160 kg             | Load Capacity            | 75 kg              |
| Weight                   | 3.3 kg             | Weight                   | 0.7 kg             |
| Stack                    | 295 mm             | Stack                    | 167 mm             |
| Nest                     | 117 mm             | Nest                     | 110 mm             |

| TYPE 2P                  |                    | TYPE 4P                  |                    |
|--------------------------|--------------------|--------------------------|--------------------|
| SPECIFICATIONS           |                    | SPECIFICATIONS           |                    |
| External top dimensions  | 400 x 297x 315 mm  | External top dimensions  | 714 x 465 x 356 mm |
| Internal base dimensions | 342 x 235 x 280 mm | Internal base dimensions | 598 x 375 x 307 mm |
| Volume                   | 26 litres          | Volume                   | 75 litres          |
| Load Capacity            | 160 kg             | Load Capacity            | 200 kg             |
| Weight                   | 1.7 kg             | Weight                   | 4.6 kg             |
| Stack                    | 300 mm             | Stack                    | 331 mm             |
| Nest                     | 115 mm             | Nest                     | 78 mm              |

Figure 29: TrenStar Bins

| TYPE 1A   | TYPE 1Z  | TYPE 2Z   | TYPE 3Z   | TYPE 5Z   |
|---|--|---|---|---|
| SPECIFICATIONS  | SPECIFICATIONS   | SPECIFICATIONS  | SPECIFICATIONS  | SPECIFICATIONS  |
| <b>Base</b>   | <b>Base</b>  | <b>Base</b>   | <b>Base</b>   | <b>Base</b>   |
| Dimensions 1200x1000mm  | Dimensions 1200x1000mm   | Dimensions 1630 x 1200mm  | Dimensions 2580 x 1400mm  | Dimensions 1000 x 595 mm  |
| Internal Dimensions 1100 x 900mm  | Internal Dimensions 1100 x 900mm   | Internal Dimensions 1530 x 1100mm   | Internal Dimensions 2410 x 1300mm   | Internal Dimensions 910 x 515 mm  |
| <b>Height</b>   | <b>Height</b>  | <b>Height</b>   | <b>Height</b>   | <b>Height</b>   |
| Overall 550mm   | Overall 860mm  | Overall 890mm   | Overall 1280mm  | Overall 664mm   |
| Internal 350mm  | Internal 660mm   | Internal 690mm  | Internal 1080mm   | Internal 480mm  |
| Collapsed 320mm   | Collapsed 345mm  | Collapsed 345mm   | Collapsed 345mm   | Collapsed 345mm   |
| <b>Volume</b>   | <b>Volume</b>  | <b>Volume</b>   | <b>Volume</b>   | <b>Volume</b>   |
| Outside 0.66 m <sup>3</sup>   | Outside 1.03 m <sup>3</sup>  | Outside 1.74 m <sup>3</sup>   | Outside 4.62 m <sup>3</sup>   | Outside 0.40 m <sup>3</sup>   |
| Inside 0.35 m <sup>3</sup>  | Inside 0.65 m <sup>3</sup>   | Inside 1.16 m <sup>3</sup>  | Inside 3.38 m <sup>3</sup>  | Inside 0.23 m <sup>3</sup>  |
| Collapsed 0.38 m <sup>3</sup>   | Collapsed 0.42 m <sup>3</sup>  | Collapsed 0.68 m <sup>3</sup>   | Collapsed 1.25 m <sup>3</sup>   | Collapsed 0.21 m <sup>3</sup>   |
| <b>Mass</b>   | <b>Mass</b>  | <b>Mass</b>   | <b>Mass</b>   | <b>Mass</b>   |
| Nett 81 kg  | Nett 84 kg   | Nett 118 kg   | Nett 227 kg   | Nett 55 kg  |
| Gross 1681 kg   | Gross 1684 kg  | Gross 1681 kg   | Gross 1656 kg   | Gross 1655 kg   |
| <b>Features</b>   | <b>Features</b>  | <b>Features</b>   | <b>Features</b>   | <b>Features</b>   |
| <ul style="list-style-type: none"> <li>High tensile steel chassis and frame construction</li> <li>Pressed hot rolled steel deck</li> <li>Expanded metal cladding</li> <li>Lockable lid</li> <li>Collapsible</li> <li>Unique number and logo identification</li> <li>Bar coded for tracking</li> <li>Stacks and stores easily</li> </ul> | <ul style="list-style-type: none"> <li>High tensile steel chassis and frame construction</li> <li>Pressed hot rolled steel deck</li> <li>Expanded metal cladding</li> <li>Lockable lid</li> <li>Collapsible</li> <li>Half drop down front gate</li> <li>Unique number and logo identification</li> <li>Bar coded for tracking</li> <li>Stacks and stores easily</li> </ul> | <ul style="list-style-type: none"> <li>High tensile steel chassis with tubular frame construction</li> <li>Pressed hot rolled steel deck</li> <li>Expanded metal cladding</li> <li>Lockable lid</li> <li>Collapsible</li> <li>Half drop down front gate</li> <li>Unique number and logo identification</li> <li>Bar coded for tracking</li> <li>Stacks and stores easily</li> </ul> | <ul style="list-style-type: none"> <li>High tensile steel chassis with tubular frame construction</li> <li>Pressed hot rolled steel deck</li> <li>Expanded metal cladding</li> <li>Lockable lid</li> <li>Collapsible</li> <li>Half drop down front gate</li> <li>Unique number and logo identification</li> <li>Bar coded for tracking</li> <li>Stacks and stores easily</li> </ul> | <ul style="list-style-type: none"> <li>High tensile steel chassis frame construction</li> <li>Pressed steel deck</li> <li>Expanded metal cladding</li> <li>Lockable lid</li> <li>Collapsible</li> <li>Half drop down front gate</li> <li>Unique number and logo identification</li> <li>Bar coded for tracking</li> <li>Stacks and stores easily</li> </ul> |
| Finish: Hot dip galvanised  | Finish: Hot dip galvanised   | Finish: Hot dip galvanised  | Finish: Hot dip galvanised  | Finish: Hot dip galvanised  |
| Full load stackable quantity; 4 high in transit, 8 high static  | Full load stackable quantity; 3 high in transit, 5 high static   | Full load stackable quantity; 3 high in transit, 4 high static  | Full load stackable quantity; 2 high in transit, 3 high static  | Full load stackable quantity; 4 high in transit, 6 high static  |

Figure 30: TrenStar Mesh Cages

| TYPE AD<br>SPECIFICATIONS   | TYPE AB<br>SPECIFICATIONS   | TYPE BA<br>SPECIFICATIONS   | TYPE DA<br>SPECIFICATIONS  | TYPE DB<br>SPECIFICATIONS  |
|---|---|---|--|--|
| <b>Base</b><br>Dimensions 1200x1000mm<br><b>Internal Dimensions</b><br>1100 x 900mm<br><b>Height</b><br>Overall 855mm<br>Internal 700mm<br>Collapsed 345mm<br><b>Volume</b><br>Outside 1.03 m <sup>3</sup><br>Inside 0.69 m <sup>3</sup><br>Collapsed 0.41 m <sup>3</sup><br><b>Mass</b><br>Nett 45 kg<br>Gross 1050 kg<br><b>Features</b> <ul style="list-style-type: none"> <li>• High tensile chassis construction</li> <li>• Flat steel deck</li> <li>• Corrugated plastic cladded frames and lid (polypropylene material)</li> <li>• Lockable lid</li> <li>• Collapsible</li> <li>• Half drop down gate positioned on front of unit</li> <li>• Stack and stores easily</li> <li>• Unique number and logo identification</li> <li>• Bar-coded for tracking</li> </ul> <b>Finish:</b> Hot dip galvanized<br>Full load stackable quantity; 3 high in transit, 5 high static | <b>Base</b><br>Dimensions 1200x1000mm<br><b>Internal Dimensions</b><br>1100 x 900mm<br><b>Height</b><br>Overall 620mm<br>Internal 460mm<br>Collapsed 315mm<br><b>Volume</b><br>Outside 0.74 m <sup>3</sup><br>Inside 0.46 m <sup>3</sup><br>Collapsed 0.38 m <sup>3</sup><br><b>Mass</b><br>Nett 68 kg<br>Gross 1068 kg<br><b>Features</b> <ul style="list-style-type: none"> <li>• High tensile chassis construction</li> <li>• Flat steel deck</li> <li>• Corrugated plastic cladded frames and lid (polypropylene material)</li> <li>• Lockable lid</li> <li>• Collapsible</li> <li>• Half drop down gate positioned on front of unit</li> <li>• Stack and stores easily</li> <li>• Unique number and logo identification</li> <li>• Bar-coded for tracking</li> </ul> <b>Finish:</b> Hot dip galvanized<br>Full load stackable quantity; 4 high in transit, 6 high static | <b>Base</b><br>Dimensions 1620 x 1200mm<br><b>Internal Dimensions</b><br>1520 x 1100mm<br><b>Height</b><br>Overall 900mm<br>Internal 720mm<br>Collapsed 320mm<br><b>Volume</b><br>External 1.75 m <sup>3</sup><br>Inside 1.20 m <sup>3</sup><br>Collapsed 0.62 m <sup>3</sup><br><b>Mass</b><br>Nett 118 kg<br>Gross 1118 kg<br><b>Features</b> <ul style="list-style-type: none"> <li>• Chassis from High Tensile steel outer with tubular inner braces</li> <li>• Flat hot rolled steel deck</li> <li>• Corrugated plastic cladded frames and lid (polypropylene material)</li> <li>• Half drop down gate on front for easy access, loading and unloading</li> <li>• Lockable lids for safety of your cargo</li> <li>• Unique number and logo identification</li> <li>• Bar-coded for tracking</li> </ul> <b>Finish:</b> Hot dip galvanized<br>Full load stackable quantity; 3 high in transit, 5 high static | <b>Base</b><br>Dimensions 1000 x 595 mm<br><b>Internal Dimensions</b><br>900 x 500 mm<br><b>Height</b><br>Overall 625mm<br>Internal 460mm<br>Collapsed 300mm<br><b>Volume</b><br>Outside 0.37 m <sup>3</sup><br>Inside 0.21 m <sup>3</sup><br>Collapsed 0.18 m <sup>3</sup><br><b>Mass</b><br>Nett 41 kg<br>Gross 541 kg<br><b>Features</b> <ul style="list-style-type: none"> <li>• High tensile chassis construction</li> <li>• Flat steel deck</li> <li>• Corrugated plastic cladded frames and lid (polypropylene material)</li> <li>• Lockable lid</li> <li>• Collapsible</li> <li>• Half drop down gate positioned on front of unit</li> <li>• Stack and stores easily</li> <li>• Unique number and logo identification</li> <li>• Bar-coded for tracking</li> </ul> <b>Finish:</b> Hot dip galvanized<br>Full load stackable quantity; 4 high in transit, 6 high static | <b>Base</b><br>Dimensions 1000 x 595 mm<br><b>Internal Dimensions</b><br>915 x 515 mm<br><b>Height</b><br>Overall 410mm<br>Internal 250mm<br>Collapsed 265mm<br><b>Volume</b><br>Outside 0.24 m <sup>3</sup><br>Inside 0.12 m <sup>3</sup><br>Collapsed 0.16 m <sup>3</sup><br><b>Mass</b><br>Nett 31 kg<br>Gross 541 kg<br><b>Features</b> <ul style="list-style-type: none"> <li>• High tensile chassis construction</li> <li>• Multiple plastic "tile" deck plate (polypropylene material)</li> <li>• Corrugated plastic cladded frames and lid (polypropylene material)</li> <li>• Lockable lid</li> <li>• Unique number and logo identification</li> <li>• Bar-coded for tracking</li> </ul> <b>Finish:</b> Hot dip galvanized<br>Full load stackable quantity; 6 high in transit, 10 high static |

Figure 31: TrenStar Solid Cages



Figure 32: TrenStar Specialised