Design and Improve Warehouse Operations
@ Nissan Rosslyn

By
CARLY VAN SCHIE
27262376

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Executive Summary

Schnellecke South Africa (“the Company”) serves as a third party logistics provider to Nissan Rosslyn (“the Client”); the duration of Schnellecke’s service is subject to a contractual agreement.

Nissan currently utilizes three warehouses (X90, X11 and D22 warehouses) which stocks all the parts for the production of various vehicle models; such as the Nissan Tida, Livina, NP 300, NP200 and Renault Sandero. Schnellecke is only contracted for one of the three warehouses, but present studies confirmed that 90% of the causes that stops the production line are the line feeding from the two warehouses which is controlled by Nissan. Nissan called on Schnellecke to improve the remaining warehouses’ operations and layouts.

The aim of this project is to improve the Warehouse operations and layout of the X11 warehouse; which include a proposed warehouse layout, capacity calculations that will assist the decision making progress on the storage facilities and assigning parts to specific locations.

Information has been gathered from Nissans’ SAP Warehouse Management system, which was analysed in order to formulate a solution methodology in the warehouse. The project outcome contains a new proposed layout, which indicates the storage type. Through capacity calculations, the part locations with reference to the line feed method strategy is obtained. The outcomes can be seen in Annexure B – D.

This project is currently implemented into the X11 warehouse and is planned to be completed by the end of 2010.
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1. INTRODUCTION AND BACKGROUND

Schnellecke South Africa ("the Company") serves as a third party logistics provider to Nissan Rosslyn ("the Client"); the duration of Schnellecke’s service is subject to a contractual agreement.

Nissan currently utilizes three warehouses (X90, X11 and D22 warehouses) which stocks all the parts for the production of various vehicle models; such as the Nissan Tida, Livina, NP300, NP200 and Renault Sandero. Schnellecke is only contracted for one of the three warehouses, but present studies confirmed that 90% of the causes that stops the production line are the line feeding from the two warehouses which is controlled by Nissan. Nissan called on Schnellecke to improve the remaining warehouses’ operation and layout.

The current function of Schnellecke for Nissans’ “X90 warehouse” include: (SA n.d.)

- Supply of Paint shop, Body shop, Assembly hall and Kitting area
- Line feeding for various Nissan and Renault models
- Devanning Containers
- Receiving CKD containers and local parts
- Deboxing/Downsizing into smaller production bins
- Line supply via JIT, KANBAN, Milk run, KIT-Supply and Sequential supply
- 10500m² warehouse space
- Line layouts, design and maintenance of facilities

The author of this report has been appointed by Schnellecke South Africa to assist in the planning department to improve the X11 warehouses by way of sound Industrial Engineering principles.
1.1 Company Profile – Schnellecke

In 1995 Schnellecke South Africa was founded as the Logistics Service Provider (LSP) for Volkswagen South Africa. Today they play a significantly role in the automotive industry for clients that include VWSA, FORD and NISSAN. Schnellecke supports the production environment of various vehicle models with an employee base of 1,775 and approximately 93,000m² of warehouse space.

The Schnellecke Group operates internationally in Europe, the Far East, South America and North America in all industries. As South Africa offers a mass of logistical opportunities, Schnellecke South Africa will pursue to increase their client base, with the help of their strong international logistics solutions and business partners. (SA n.d.)

Schnellecke South Africa currently provides the following services:

1. Warehousing of raw material and finished goods
2. Outbound services to local, national or international customers
3. Line feeding to automotive manufacturers
4. Assembly of automotive parts
1.2 Client Profile – Nissan Rosslyn

Nissan was established in 1914 by the Kwaishinsha Company who started production under the name Datsun, but was only registered in 1934 as Nissan Motors. In 1999 Nissan struggled with financial difficulties which lead to the alliance with the Renault Group. From 1914-2010 a total of 35 plants around the world are open for production of Nissan and Renault vehicles.

Nissan Rosslyn is South Africa’s only Nissan production plant, which is currently building the Nissan Tida, Livina, NP300, NP200 and the Renault Sandero. Their current production schedule totals to 40,000 vehicles annually which only exports within the African continent. (lifestyle 2004)

Figure 3 - World map of Nissan Production Plants (Just-AUTO 2009)
2. Project Aim

The aim of this project is to improve the Warehouse operations and layout of the X11 warehouse; which include a proposed warehouse layout, capacity calculations that will assist the decision making progress on the storage facilities and assigning parts to specific locations.

3. Project Scope

The project scope is to improve the warehouse to NMUK (Nissan United Kingdom) standards; such as:

- Improve warehouse processes to shorten the time it takes for parts to be delivered to the manufacturing plant with use of appropriate Industrial Engineering techniques, tools and methods
- Improve the storage locations and type, so as to make efficient use of the warehouse space.
- Improve the warehouse layout; which includes the receiving area right through to the handover area.
- Improve the warehouse operations to make sure the right products are being delivered to the correct part of the production line in the right time, quantity and quality using logistics techniques
- Develop the warehouse layout according to the “Line Feed Method”

Figure 4 - NMUK warehouse
4. **Deliverables**

The deliverable of the project will include a presentation and industrial engineering techniques and methods that will be used to improve the warehouse operations and layout. The warehouse process improvements will focus on the; Information-, Process-, Materials Flows, and Warehouse Layout. By implementing IE methods, tools, techniques and software applications the following benefits will be obtained: (Supply chain Logistics - Consulting n.d.)

- Improved Material Flow
- Improved Warehouse Layout
- Improved Warehouse Design
- Reduced Inventory
- Reduced Lead-times
- Improved Process efficiency
- Reduced Capital costs
- Improved Service levels
- More efficient Warehouse operation
5. Literature Review

5.1 The Importance of Studying Literature

When formulating a project, a literature review is of great importance to inform the researcher of new knowledge or discovery. The main reasons why one should do a literature review is:

- It helps to identify any flaws in earlier researches
- Determine any opposing findings in previous studies
- It leads to further research and studies
- Adds background knowledge of the project environment

The research can also make one aware of any methods, tools, techniques and technologies that were used in previous projects to solve similar problems. By citing reliable authors’ work, in regards to the project topic, will build a stronger foundation for the paper.

The following are tools that have been used in the information gathering process:

- Library Resources
- Case Studies
- Discussions
- Journals
- Observations
- Internet
5.2 Warehouse Management System - SAP

The SAP Warehouse Management (WM) is an integrated software package for business applications. These applications provide flexible, automated support to assist you in processing all goods movements and in maintaining current stock inventories. (AG, SAP 2001)

Warehouse management supports warehousing processes by making it possible to:

- Define and supervise complex warehousing structures
- Optimize material flow
- Process goods receipts, goods issues and stock transfers quickly and easily

5.3 Warehouse operations with reference to a WMS

Warehouses are a critical component in any production operation. The main warehouse roles consist of:

- Buffering the material flow to allow the entire production network to deal efficiently with the systematic and random variation in the network operations.
- Serves as a Consolidation centre: It accumulates and consolidates products from various national – and international suppliers.
- Value-added-Processing (VAP)

![Figure 5 - Consolidation Centre](image-url)
The basic requirement in a warehouse are to receive stock from national- and international suppliers, store the stock, receive orders from the production line, pick and stage stock at the handover area. There are many concerns involved in designing a warehouse to meet these requirements. The resources that are needed among the warehouse functions are space, labour and equipment.

The Principles of the warehouse layout design must consider the:

- Unloading Area from national and international suppliers
- Storage Type
- Storage Section
- Picking Area
- Storage Bin
- Warehouse doors
- Staging Area
5.4  Capacity Planning

According to R. Anthony Inman, “Capacity planning is the process used to determine how much capacity is needed (and when) in order to manufacture greater product or begin production of a new product” (Inman n.d.)

5.4.1 Capacity management constraints

There are two capacity management constraints; namely:

1. **Time** - This can be a constraint where the operator requires a part at a specific time. Planners thus “plan backward”. This process can identify if there is sufficient time to meet the production demand

2. **Capacity** – If there is not sufficient time then the production capacity is a constraint. Decision must then be made to whether increase the capacity or not.

5.4.2 Capacity Planning strategies

- **Lead strategy**; capacity increases when an increase in demand is anticipated. Lead strategy is an aggressive strategy and has a disadvantage of resulting in excess inventory, this leads to unnecessary costs.

- **Lag strategy**; capacity is only added when production runs at full capacity. Lag strategy is more a conservative strategy which decreases the risk of waste, but could result in a decrease in customers.

- **Match strategy**; it is a moderate strategy which adds capacity in small amounts in reaction to demand
5.5 Available methods and tools: software

5.5.1 Microsoft Excel

Microsoft Excel® is the spreadsheet most commonly used in the industry. As SAP contains proprietary software components of other software vendors; such as the Microsoft Corporation (AG, SAP 2001), it easily interfaces with Microsoft Excel®. Excel® will thus be used to analyse the current data that was extracted from the SAP WMS.

5.5.2 Microsoft Visio

Microsoft Visio® is a diagramming program from the vendor; Microsoft Corporation. New warehouse layouts will be drawn using Visio® drawing techniques and tools.

5.5.3 Microsoft One Note

Microsoft One Note® is a software application that creates one centralized resource for all ones’ ideas, manage information with tools that save time and simplify ones’ work.

One Note® will be used to keep track of the project and organize all paperwork, with regards to the execution of the project. The purpose of this planning procedure is to clearly define the process in which a planner executes he’s/hers’ operations when handling a project.
5.6 IE methods, techniques and tools

Some industrial engineering methods, techniques and tools are discussed that was used in other similar problems, but as the project develops more methods will be searched and used for the execution of the project.

5.6.1 Value Stream Mapping

Value Stream Mapping (VSM) also known as “material and information mapping”, is a lean manufacturing technique used to analyze the current flow of material and information within the warehouse. Future VSM can be draw by assessing the current VSM, in terms of creating flow by eliminating waste. Out of the seven VSM tools, Process Activity Mapping will be used.

The seven common accepted wastes in the Toyota production system, after assessing their current VSM was: (Ohno et al. 2000)

1. Overproduction
2. Waiting
3. Transport
4. Inappropriate processing
5. Unnecessary inventory
6. Unnecessary motion
7. Defects

5.6.1.1 Process Activity Mapping

Process Activity mapping is a well known process flow chart; with the origin of industrial engineering. Process charts helps also with the identification of wasteful actions, and documents the process completely. A Standard Operation Procedure (SOP) can thus be developed for each process.
5.6.2 Time Studies

The time and motion study is a business efficiency technique combining the Time Study work of Taylor and Motion Study of Gilbreth. It would be used to reduce the number of motions in performing a task (NetMBA 1999).
6. Data Gathering

Information has been gathered from Nissans’ SAP Warehouse Management system, which will be analysed in order to formulate a solution methodology in the warehouse. Through the literature study it can conclude that the warehouse layout can improve the warehouse operations, by considering the principles of a warehouse.

Gathering data was a big part of the project to assist with the design and improvements of the warehouse operations. The main objective of the project was to improve the warehouse according to NMUK (Nissan Manufacturing United Kingdom) standards.

6.1 Master Production Schedule (MPS)

Nissan’s Master Production Schedule (MPS) is a production plan which indicates when, how many and which vehicles must be produced to attain the forecasted demand. The project is based on the “X11 Warehouse”, which holds all the Nissan Livina and Nissan Tida parts.

These were the production data that was available for use:

1. Nissan Tida (aka X11C)

![Nissan Tida MPS (Screen shot)](image)
2. **Nissan Livina (aka X11J)**

![Forecasted Production Plan](image)

**Nissan Livina derivatives**

**Description of derivatives**

**NISSAN MPS**

Figure 7 - Nissan Livina MPS (Screen Shot)
6.2 Bill of Material (BOM)

A Bill of Material is a list of assemblies, raw material, components, parts and quantities needed to manufacture the end product. Nissan’s Bill of Material defines the parts as they are built, known as “manufacturing bill of materials”.

![Bill of Material: Pivot Table](image)

6.3 Part Specifications

Part Specification report was extracted from the Warehouse management system (SAP). It was used to calculate the footprint of the part, which will assist with decision of storage type for each part.
6.4 Stock on Hand (SOH)

Stock on Hand is also referred to as inventory. The SOH report was constructed from multiple data sources; such as Nissan’s Warehouse management system (SAP) and stock staking reports.

The SOH report was compared to the BOM parts. It identified any excess old parts that are not used and parts that are in excess.

6.5 Warehouse Layout

The author of the project used the current warehouse layout to understand the process activity flow.

See Annexure A for the current layout (A3 format)
7. Data Analysis

Before analysing data there must be a clear understanding of what must be achieved and what factors must be considered to achieve the project objectives. As before stated the main objective of the project is to transform the current X11 Warehouse so that it meets the NMUK standards. This includes:

- A successful order picking system; which impacts the storage type, sections and warehouse layout
- Utilization of the full cubic capacity

The factors that must be considered are:

- Within the X11 warehouse NSA (Nissan South Africa) will store Local and International (aka KD) parts.
- The X11 warehouse supplies to multiple destination. These destinations are:
  1. Production line (MML – Multi Model Line); the line includes the assembly line, paint shop, Engine Dress up area and Door line kitting.
  2. Body shop
- The Local and KD parts will be stored in different areas of the warehouse
- Parts must be stored according to the Linefeed Method
- An inventory of 5 days production must be kept in the warehouse
- High Racks are at 5 levels – each level is 1.4m high
- Block Stacking is at max 4 levels
- Aisles – 4m wide
7.1 Line Feed Method Summary

It is a storage method that was termed; Line feed Method, by Nissan and Schnellecke. With the help of Figure 9 - Line feed method explanation, the line feed method will be explained.

In the production plant, the line is divided into zones and named; e.g. 1, 2, 3, etc. To complete the activities at each zone, the operator needs the appropriate parts at the right time, quantity, quality and place.

E.g. At the production zone 1 the car doors are assembled onto the vehicle frame, thus in the storage layout row 1 are all the parts necessary to complete the job. These parts are also placed at a handover area that is marked “1”.

The warehouse storage layout will thus be developed into sections that correspond to the supplied area.

This helps that the different operators that pick, stage and deliver the parts to the production line are at the right time, quantity, place and parts.

The following table identifies the supplied area and their assigned warehouse zone code;
<table>
<thead>
<tr>
<th>Area/Zone (Range of Stations)</th>
<th>Warehouse Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone 1 – <em>Station 1-17 of production line</em></td>
<td>M01</td>
</tr>
<tr>
<td>Zone 2 – Station 18 – 34 of production line</td>
<td>M02</td>
</tr>
<tr>
<td>Zone 1 &amp; 2</td>
<td>M03</td>
</tr>
<tr>
<td>Zone 3 – <em>Station 39 – 53 of production line</em></td>
<td>M04</td>
</tr>
<tr>
<td>Zone 4 – <em>Engine Dress 1 &amp; 2</em></td>
<td>M05</td>
</tr>
<tr>
<td>Zone 5 – <em>Station 54 – 74 of production line</em></td>
<td>M06</td>
</tr>
<tr>
<td>Paint shop &amp; Painted body storage</td>
<td>M08</td>
</tr>
<tr>
<td>CPM &amp; Door line</td>
<td>M09</td>
</tr>
<tr>
<td>Mechanical subs &amp; Door line Kitting</td>
<td>M10</td>
</tr>
<tr>
<td>For future use only</td>
<td>M11</td>
</tr>
<tr>
<td>For future use only</td>
<td>M12</td>
</tr>
<tr>
<td>Body shop 1 &amp; 2, respectively</td>
<td>B01 &amp; B02</td>
</tr>
<tr>
<td>Local 1 &amp; 2, respectively</td>
<td>L01 &amp; L02</td>
</tr>
</tbody>
</table>

*Table 1- Assignment of Warehouse Zones*
7.2 Capacity Calculations

See clause 7.2.1
Figure 11 - Capacity Study Sheet (2)

See clause 7.2.2
The Master Production Schedule, Bill of Material and Parts Specifications reports were used to construct a capacity study. The gathered data was compared and linked by using the unique part number, all the information on the shown sheet in figure 10 & 11 about the parts will be discussed below in clause 7.2.1 & 7.2.2.

### 7.2.1 Part Specification

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part number</td>
<td>Unique number assigned to a part</td>
</tr>
<tr>
<td>Description</td>
<td>Part Description</td>
</tr>
<tr>
<td>SUT</td>
<td>Size of part/box received; e.g. Crate, box, steel rack</td>
</tr>
<tr>
<td>SNP</td>
<td>Number of parts in a box</td>
</tr>
<tr>
<td>Material type</td>
<td>e.g. raw material</td>
</tr>
<tr>
<td>Length</td>
<td>Length of part</td>
</tr>
<tr>
<td>Width</td>
<td>Width of part</td>
</tr>
<tr>
<td>Height</td>
<td>Height of part</td>
</tr>
<tr>
<td>Box footprint (m²)</td>
<td>= (length x width)/1 000 000</td>
</tr>
<tr>
<td>Box cubic (m³)</td>
<td>= (length x width x height)/ 1 000 000</td>
</tr>
<tr>
<td>GLT of KLT</td>
<td>( if(box\ cubic&gt;1, \text{“GLT&quot;}, \text{“KLT&quot;}) ), used to specify if part should be block stacked or placed in the High Bay racks</td>
</tr>
</tbody>
</table>

Table 2 - Capacity Study Description (1)
## 7.2.2 Capacity requirement calculations

### Columns Description

<table>
<thead>
<tr>
<th>Columns</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Parts Required daily</td>
<td>From the BOM, the total parts that are required daily were calculated.</td>
</tr>
<tr>
<td>Boxes required daily</td>
<td>= Total parts required daily / SNP</td>
</tr>
<tr>
<td>Actual boxes</td>
<td>=roundup(Boxes required daily,0)</td>
</tr>
<tr>
<td>KANBAN max</td>
<td>=Actual boxes +1; According to the KANBAN maximum requirements, there should be one extra box</td>
</tr>
<tr>
<td>Space required</td>
<td>= Box cubic x Actual boxes</td>
</tr>
<tr>
<td>Total parts required (5 day plan)</td>
<td>=Total parts required daily x 5;</td>
</tr>
<tr>
<td>Boxes required (5 day plan)</td>
<td>= Total parts required (5 day plan) / SNP</td>
</tr>
<tr>
<td>Actual boxes</td>
<td>=roundup(Boxes required(5 day plan),0)</td>
</tr>
<tr>
<td>KANBAN max (5 day plan)</td>
<td>=Actual boxes +1; According to the KANBAN maximum requirement in the warehouse, an extra box must be kept per 5 day stock holding</td>
</tr>
<tr>
<td>Space required (5 day plan)</td>
<td>=Box cubic x KANBAN max (5 day plan)</td>
</tr>
<tr>
<td>Supply Area/ Body, Trim, Paint</td>
<td>Coded area to which part must be supplied to</td>
</tr>
<tr>
<td>Line feed Method</td>
<td>It is the identified area which part must be binned. See clause 7.1 that explains the codes. The areas which shows a “N/A”, identifies the parts that is not used anymore for production.</td>
</tr>
</tbody>
</table>

Table 3 - Capacity Study Description (2)
7.3 Identification of excess SOH

Figure 12 - SOH calculation

The stock on hand reports were analyzed to obtain the number of stock on hand in days. This was obtained by dividing the daily required stock (capacity calculation, clause 7.2) into the number of parts in stock. A diagram was constructed that identifies the stock on hand in the X11 warehouse, e.g. there are 248 parts in stock for 10-19 days. This is an indication that there is no control on the stock within the warehouse and the ordering system of parts, which is causing unnecessary holding costs.

Figure 13 - Nr of parts in stock Diagram
8. Design and Solutions

8.1 Proposed Warehouse Layout
After understanding the process activity flow from the current warehouse layout, waste areas were identified; such as:

1. Confusion in the offloading area
2. Unnecessary inventory
3. Unnecessary handling
4. Handover areas
5. Picking Schedule
6. Inappropriate use of warehouse capacity

The capacity calculations and the factors (discussed in clause 7) that must be considered in the new layout played a significant role in the proposed layout.

See Annexure B for the proposed warehouse layout (A3 format)

The following changes was made in the layout

- All the parts underneath the outside canopies are moved inside the warehouse.
- Local and KD receiving area are separated
- 4 high bay racks are removed and replaced with a block stacking area
- Moved the current block stacking aisles to accommodate 4m aisles
- All High Bay racks are converted from 6 levels to 5 levels
- Local and KD marshalling areas are separated
- Local and KD parts are kept separate (see clause 8.2)
8.2 Storage Type and Part location

See Annexure C & D, of the line feed method summary and part locations, respectively.
9. Conclusion and Future task

The current state of the X11 warehouse is that of an inefficient warehouse operation. This project's main aim is to improve the warehouse operations and layout; considering the warehouse principles and factors discussed in the project. With the help of Software application and IE methods, the main causes and waste was identified.

The project identified the excess stock on hand and lack of capacity utilization. This assisted with the design of a new warehouse layout, storage type and part locations.

The X11 warehouse is currently in the process of changing, the tasks include:

- All the parts underneath the outside canopies are moved inside the warehouse.
- Local and KD receiving area are separated
- 4 high bay racks are removed and replaced with a block stacking area
- Moved the current block stacking aisles to accommodate 4m aisles
- All High Bay racks are converted from 6 levels to 5 levels; each level is 1.4 m
- Local and KD marshalling areas are separated
- Parts are located according to the Line feed method
- Excess stock is removed
- Demarcation and visualization of all areas
9. Bibliography

Unsupported source type (InternetSite) for source Placeholder2.


Appendix A – Old Layout
Appendix B – Proposed Warehouse Layout
Appendix C – Line Feed Method Summary
Appendix D – Part Locations; with ref to Appendix C

1. Main Warehouse – KD H/Bay Racking Setup (4 pages)
2. Main Warehouse – KD Block Storage Setup (1 page)
3. Main Warehouse – Local H/Bay Racking Setup (1 page)
4. Main Warehouse – Local Block Storage Setup (1 page)