Designing Warehouse for an Automobile Industry

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***Abstract*:** This study proposes improving the understanding of the main aspects involved in the design of warehouses by the construction of a framework that reveals the state-of-art. Normally, warehouses are designed and operated by third party logistics companies with tight margins. Therefore, there is increased pressure to design warehouses that are flexible and adaptable, even while the available information is incomplete. Working closely with available inputs in relation to production volumes, part specifications, bills of material and available budget, we here identified the key pieces of information and organized them in the form of object model, finally able to design and erect a world class warehouse facility which can support production of vehicles at an automobile plant in line to master production schedule (MPS).

Keywords – Design, Warehouse, MPS, Adaptable warehouses, Layout, Inventory Norms

I INTRODUCTION

Warehouses are facilities where inventories are sheltered. A warehouse is a planned space for the storage and handling of goods and material. Its main purpose is to keep the goods for the longer time and whenever there is a demand for the product, it will be supplied as fast as possible and reaches the user in its original position. Warehouses can be broadly classified into production warehouses and Distribution Centers.

This project is primarily dealing with designing and practical installation of warehouse facility for an Automobile Industry, which will ultimately be catering to manufacturing requirement of production line.

Warehouse design problems involve five groups of decisions: determination of the general structure of the warehouse (conceptual design); its sizing; layout calculation; warehousing equipment selection; and selection of its operational strategy. In addition, a warehouse project must also include definitions of policies about order fulfillment/picking, stocking, and stock rotation. In this project we will try to design and install stores considering above mentioned all decisions.

II LITERATURE REVIEW

Warehousing's roots go back to the creation of granaries to store food, which was historically available for purchase during times of famine. As European explorers began to create shipping-trade routes with other nations, both upstream & downstream warehouses grew in importance for the storage of products and commodities from afar. Industrialization revolution gave full throttle to think tanks to think about techniques and processes which will lead us to modern era of supply chain management where wastages can be reduced and efficiencies can be improved upon.

Ashayeri and Gelders (1985) compare two different approaches, analytical and simulation, for warehouse design problems. They conclude that, in general, neither a pure analytical approach nor an approach that uses only simulation will lead to a practical design method. They suggest a combination of the two approaches is likely to lead to a good design method. Cormier and Gunn (1992) present a survey on the throughput capacity models, storage capacity models and warehouse design models. Van den Berg (1999) presents a literature survey on methods and techniques for the planning and control of warehouse systems. Rouwenhorst et al. (2000) present a reference framework and a classification of warehouse design and control problems. An extensive review of the literature is also presented. They conclude that a majority of the papers are analysis oriented and provide some guidelines toward a more design-oriented research approach for warehousing problems. There are some publications concerning warehouse design methods. Gray et al. (1992) propose a hierarchical design method and describe the application of their method by an example design. Yoon and Sharp (1995, 1996) suggest an elaborate conceptual procedure for the design of an order picking system

III DEFINITION OF WAREHOUSING

A warehouse is a planned space for the storage and handling of goods and material. Its main purpose is to keep the goods for the longer time and whenever there is a demand for the product, it will be supplied as fast as possible and reaches the user in its original position.

During designing of warehouse we will be touching upon below mentioned aspects.

- Receipt and Inspection of Materials
- Put Away
- Line Feeding
- Bills of Material

- Master Production Schedule
- ABC Analysis
- Indirect Material
- Location & Layout of the Warehouse
- Warehouse Design Criteria

Terms used in Warehousing

1. **Receipt & Inspection of material:** Delivery of incoming material required for production is called receipt whereas checking of material on quality parameters is called inspection.
2. **Put Away:** It is the process of taking products off the receiving shipment and putting them into the most appropriate location.
3. **Line feeding:** Line feeding is the process of proving material to shop floor based on production plan.
4. **Bills of material:** A bill of materials or product structure is a list of the raw materials, sub-assemblies, intermediate assemblies, sub- components, parts, and the quantities of each.
5. **Master production schedule:** A master production schedule (MPS) is a plan for individual commodities to be produced in each time period such as production, staffing, inventory, etc. The MPS translates the customer demand (sales orders, PIR's), into a build plan using planned orders in a true component scheduling environment.
6. **Direct material:** Direct materials are those materials and supplies that are consumed during the manufacture of a product, and which are directly identified with that product. Items designated as direct materials are usually listed in the bill of materials file for a product.
7. **Indirect Material:** Indirect materials are defined as materials used in manufacturing processes that cannot be traced to an individual product or job. These materials, while consumed as part of the production process, are usually used in small amounts on a per-product basis and purchased in mass quantities.
8. **ABC Analysis:** In materials management, ABC analysis is an inventory categorization technique. ABC analysis divides an inventory into three categories—"A items" expensive ones with very tight control and accurate records, "B items" less expensive with less tightly controlled and good records, and "C items" least expensive with the simplest controls possible and minimal records.

IV STORES INFRASTRUCTURE

- **Selective Pallet Multi-tier Racking System:** Selective Pallet Racking is a simple, flexible, economical, and easy-to-use system that allows complete access and control of the inventory. Being highly versatile and extremely easy to install, we can say that the SPR system is undeniably the most popular solution for bulk storage of goods.
- **Mobile Compactors Storage System:** The choice depends on the requirements and space constraints. Our rail mounted racks are suitable for all kinds of storage requirements.
- **Mezzanine Catwalk Storage Space:** A warehouse mezzanine, which is an elevated platform that is installed between the floor and the ceiling, will increase space by utilizing the vertical space that already exists in the facility.
- **Material Handling Equipment(MHE):** Material handling equipment (MHE) are mechanical equipment used for the movement, storage, control and protection of materials, goods and products throughout the process of manufacturing, distribution, consumption and disposal.
- **Dock Leveler:** A dock leveler is used to bridge the difference in height and distance between the warehouse floor and vehicle in the most efficient way. It is a height-adjustable platform used to ensure smooth transition between dock and truck which helps prevent forklift accidents that can cause serious injuries and forklift damages. It is usually comprised of a simple metal plate that is raised from a stowed position and then lowered onto the back of the truck.

VI DATA COLLECTION, ANALYSIS, FORMULATION & CALCULATION

Data Collection: Information needs to be gathered from available resources like ERP and various departments, which needs to be analyzed in order to formulate and design warehouse. Gathered data includes below listed variables

- **Master production Schedule (MPS):** Master Production Schedule (MPS) is a production plan which indicates when, how many and which vehicles must be produced to attain the forecasted demand.
- **Bills of Material (BOM):** A Bill of Material is a list of assemblies, raw material, components, parts and quantities needed to manufacture the end product. Bill of Material defines the parts as they are built, known as "manufacturing bill of materials".
- **Two production variants** Vx and Mx yearly volume 12000 units with variant ratio of 60:40 respectively
- **Number of parts** to be stored 3926 numbers

Particulars	No. of Parts
Maintenance Spares	1513
Indirect Material	547
BOM Material	1766
Total Parts	3926

- **Parts Specification:** In order to decide storage type same were extracted from available R&D data.

Part Specification Tabulation:

Columns	Description
Part Number	Unique number assigned to a part
Description	Part Description
SUT	Size of part/box received; e.g. Crate, box, steel rack
SNP	Number of parts in a box
Material Type	Raw Material, Semi-finished
Length	Length of Part
Width	Width of Part
Height	Height of part
Box Footprint (m^2)	(Length x Width)/1000000
Box cubic (m^3)	(length x width x height)/ 1 000 000
GLT of KLT	if(box cubic>1, "GLT", "KLT"), used to specify if part should be block stacked or placed in the High Bay racks

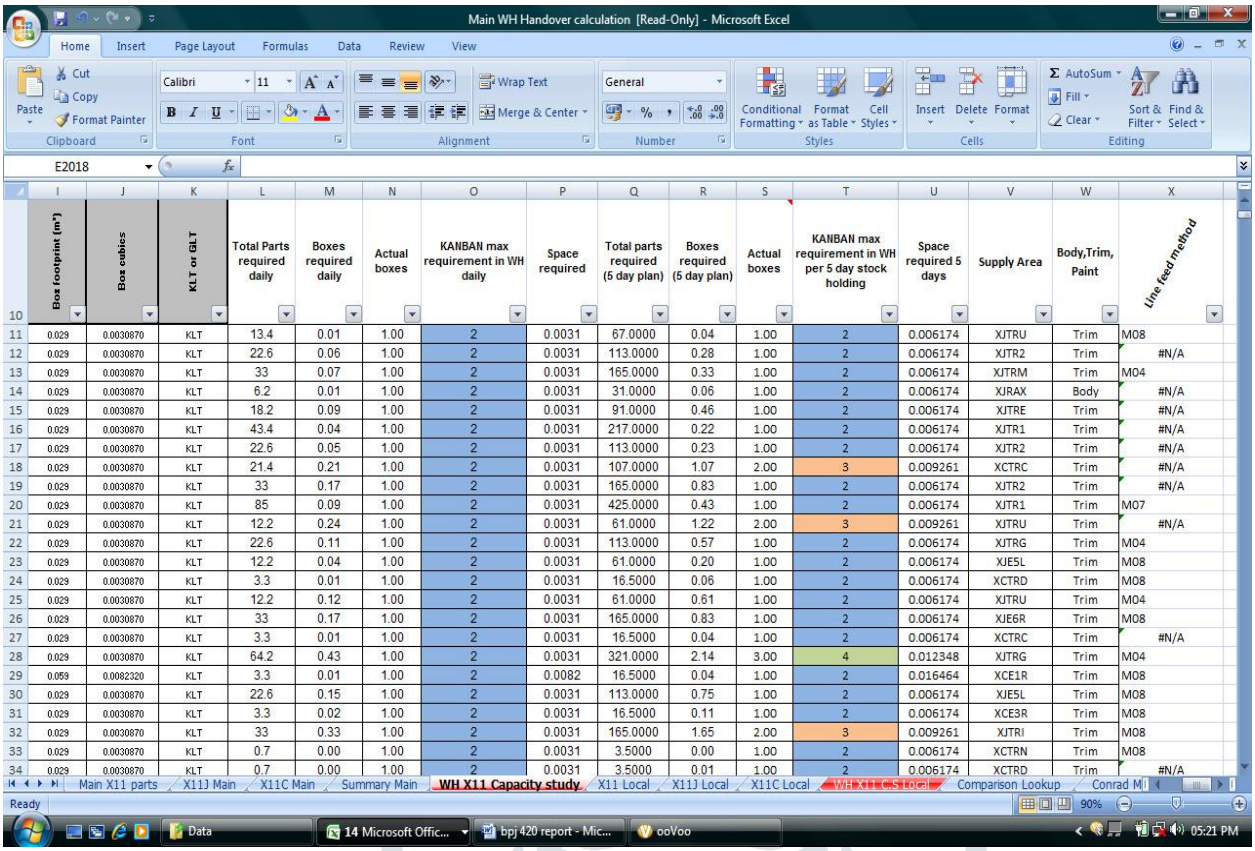
Data Analysis: Collected data is analyzed, formulated and is used for calculations purposes to decide size of stores.

- **Inventory Model –** ABC Analysis for direct material
  - A Category: 241 Parts – Inventory Norm 7 Days
  - B Category: 439 Parts – Inventory Norm 15 Days
  - C Category: 1263 Parts – Inventory Norm 30 Days

- **Capacity requirement calculations**

Capacity Calculation formulation

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

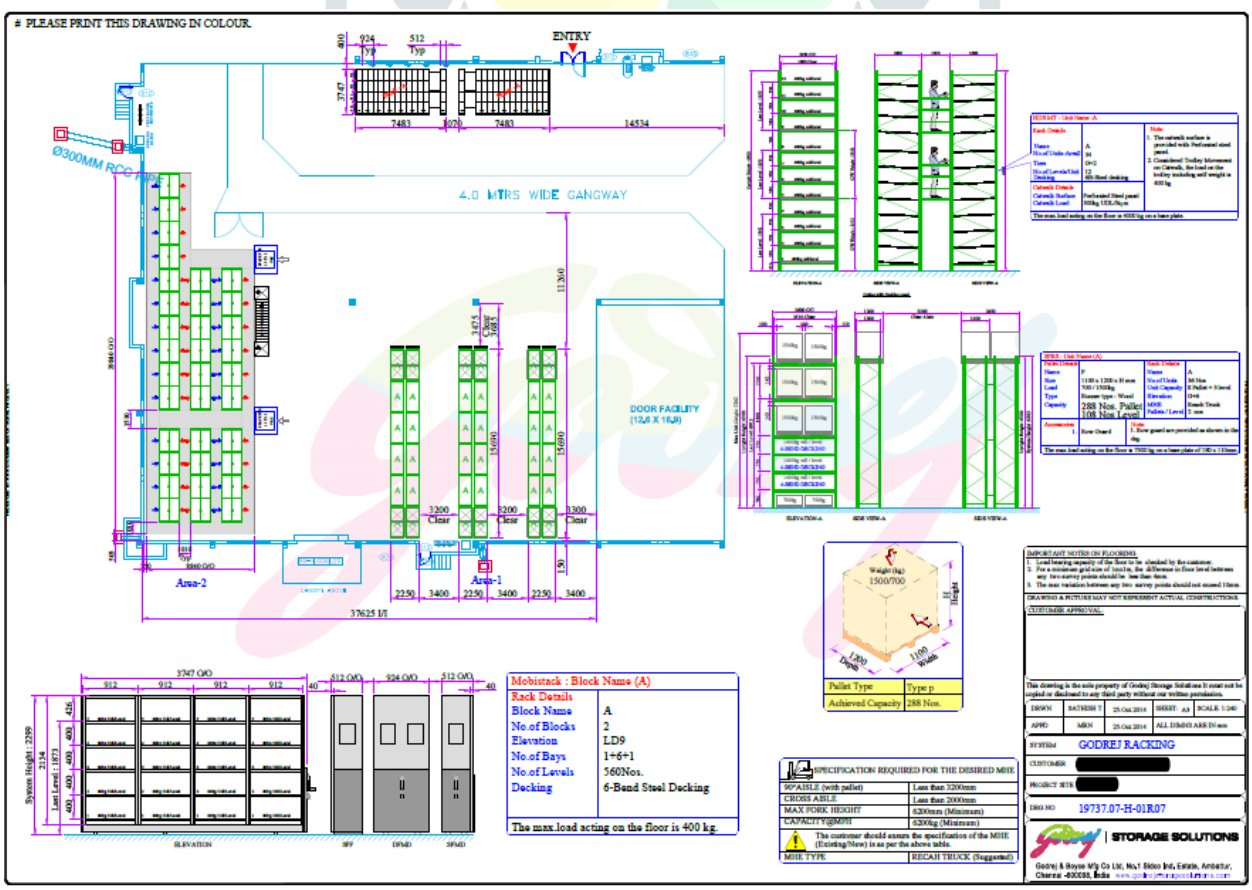


Main WH Handover calculation [Read-Only] - Microsoft Excel

Box footprint (m²)	Box cubics	KLT or GLT	Total Parts required daily	Boxes required daily	Actual boxes	KANBAN max requirement in WH daily	Space required	Total parts required (5 day plan)	Boxes required (5 day plan)	Actual boxes	KANBAN max requirement in WH per 5 day stock holding	Space required 5 days	Supply Area	Body,Trim, Paint	Line feed method
0.029	0.0030870	KLT	13.4	0.01	1.00	2	0.0031	67.0000	0.04	1.00	2	0.006174	XJTRU	Trim	M08
0.029	0.0030870	KLT	22.6	0.06	1.00	2	0.0031	113.0000	0.28	1.00	2	0.006174	XJTR2	Trim	#N/A
0.029	0.0030870	KLT	33	0.07	1.00	2	0.0031	165.0000	0.33	1.00	2	0.006174	XJTRM	Trim	M04
0.029	0.0030870	KLT	6.2	0.01	1.00	2	0.0031	31.0000	0.06	1.00	2	0.006174	XJRAX	Body	#N/A
0.029	0.0030870	KLT	18.2	0.09	1.00	2	0.0031	91.0000	0.46	1.00	2	0.006174	XJTRE	Trim	#N/A
0.029	0.0030870	KLT	43.4	0.04	1.00	2	0.0031	217.0000	0.22	1.00	2	0.006174	XJTR1	Trim	#N/A
0.029	0.0030870	KLT	22.6	0.05	1.00	2	0.0031	113.0000	0.23	1.00	2	0.006174	XJTR2	Trim	#N/A
0.029	0.0030870	KLT	21.4	0.21	1.00	2	0.0031	107.0000	1.07	2.00	3	0.009261	XCTRC	Trim	#N/A
0.029	0.0030870	KLT	33	0.17	1.00	2	0.0031	165.0000	0.83	1.00	2	0.006174	XJTR2	Trim	#N/A
0.029	0.0030870	KLT	85	0.09	1.00	2	0.0031	425.0000	0.43	1.00	2	0.006174	XJTR1	Trim	M07
0.029	0.0030870	KLT	12.2	0.24	1.00	2	0.0031	61.0000	1.22	2.00	3	0.009261	XJTRU	Trim	#N/A
0.029	0.0030870	KLT	22.6	0.11	1.00	2	0.0031	113.0000	0.57	1.00	2	0.006174	XJTRG	Trim	M04
0.029	0.0030870	KLT	12.2	0.04	1.00	2	0.0031	61.0000	0.20	1.00	2	0.006174	XJE5L	Trim	M08
0.029	0.0030870	KLT	3.3	0.01	1.00	2	0.0031	16.5000	0.06	1.00	2	0.006174	XCTRD	Trim	M08
0.029	0.0030870	KLT	12.2	0.12	1.00	2	0.0031	61.0000	0.61	1.00	2	0.006174	XJTRU	Trim	M04
0.029	0.0030870	KLT	33	0.17	1.00	2	0.0031	165.0000	0.83	1.00	2	0.006174	XJE6R	Trim	M08
0.029	0.0030870	KLT	3.3	0.01	1.00	2	0.0031	16.5000	0.04	1.00	2	0.006174	XCTRC	Trim	#N/A
0.029	0.0030870	KLT	64.2	0.43	1.00	2	0.0031	321.0000	2.14	3.00	4	0.012348	XJTRG	Trim	M04
0.059	0.0082320	KLT	3.3	0.01	1.00	2	0.0082	16.5000	0.04	1.00	2	0.016464	XCE1R	Trim	M08
0.029	0.0030870	KLT	22.6	0.15	1.00	2	0.0031	113.0000	0.75	1.00	2	0.006174	XJE5L	Trim	M08
0.029	0.0030870	KLT	3.3	0.02	1.00	2	0.0031	16.5000	0.11	1.00	2	0.006174	XCE3R	Trim	M08
0.029	0.0030870	KLT	33	0.33	1.00	2	0.0031	165.0000	1.65	2.00	3	0.009261	XJTRI	Trim	M08
0.029	0.0030870	KLT	0.7	0.00	1.00	2	0.0031	3.5000	0.00	1.00	2	0.006174	XCTRN	Trim	M08
0.029	0.0030870	KLT	0.7	0.00	1.00	2	0.0031	3.5000	0.01	1.00	2	0.006174	XCTRD	Trim	#N/A

VII RESULTS

After applying Industrial engineering techniques we were able to finalize final design of stores with three particular infrastructural
facilities. i) Multitier shelving system ii) Mezzanine iii) Compactors



VIII CONCLUSION

The current state of the warehouse is sufficient enough to support production requirement 12000 vehicles per annum @ 40 vehicles per day. The designed infrastructure is tabulated below.

Header	**Area In Square Meters**	**Parts Storage in Nos.**
Special Pallet racking system	623.51	396
Compactors	212	560
Catwalk Mezzanine Storage System	523	2000
Super market Trolley Area	173	
Receipt Area	242	
Weld Super market	525	226
Tire Paint Storage	493	84
Trolley super market yard	660	660
Total Stores area	**3451.75**	**3926**

- Total Bins 18600 for storage of 3926 parts.
- With this infrastructure it is ensured that all material is stored inside the shed, for ease of working frequently required and heavy parts are stored on the lower racks.

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