

Problem 08

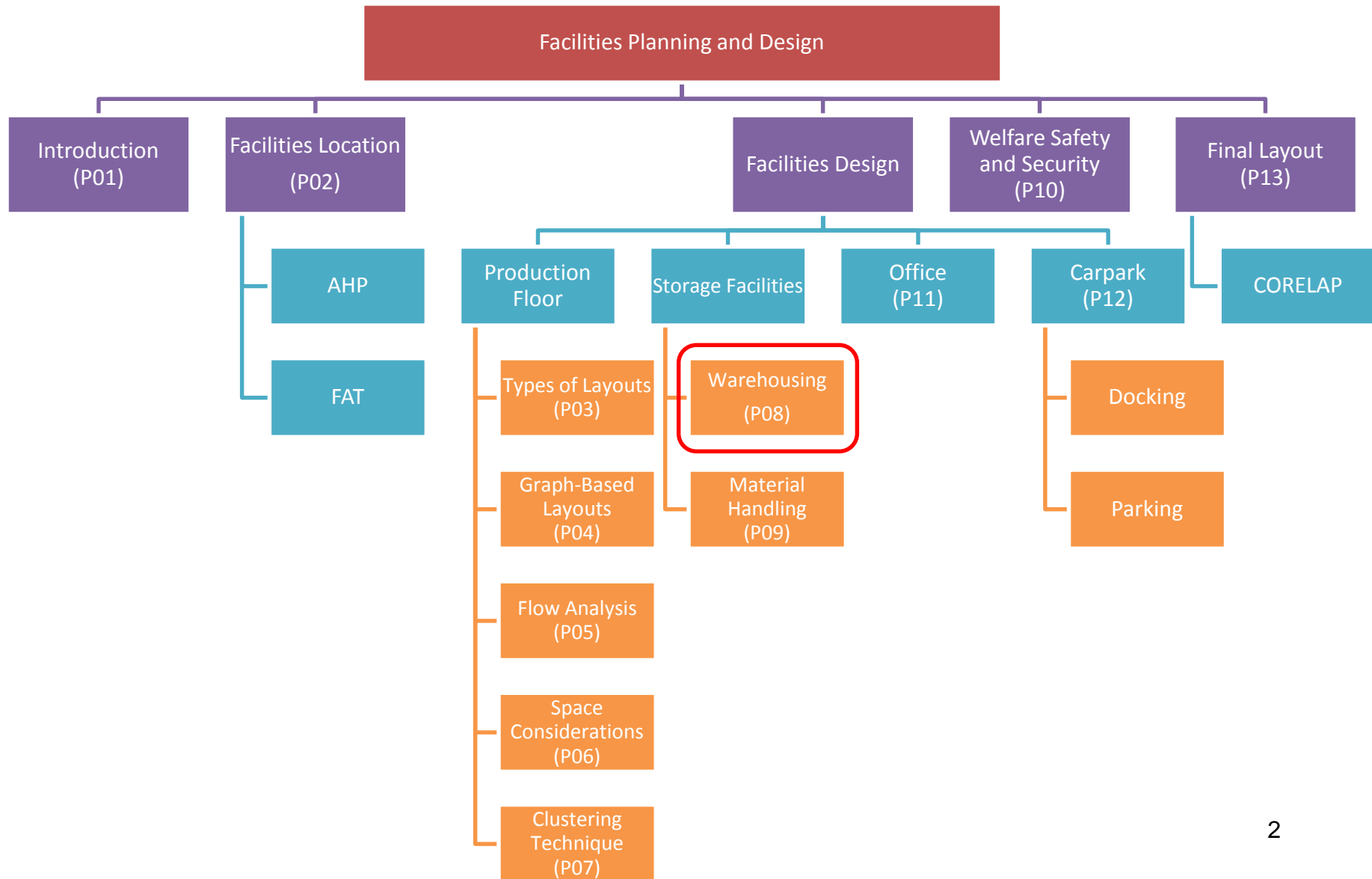
Storage and Warehouse

E212 – Facilities Planning and Design



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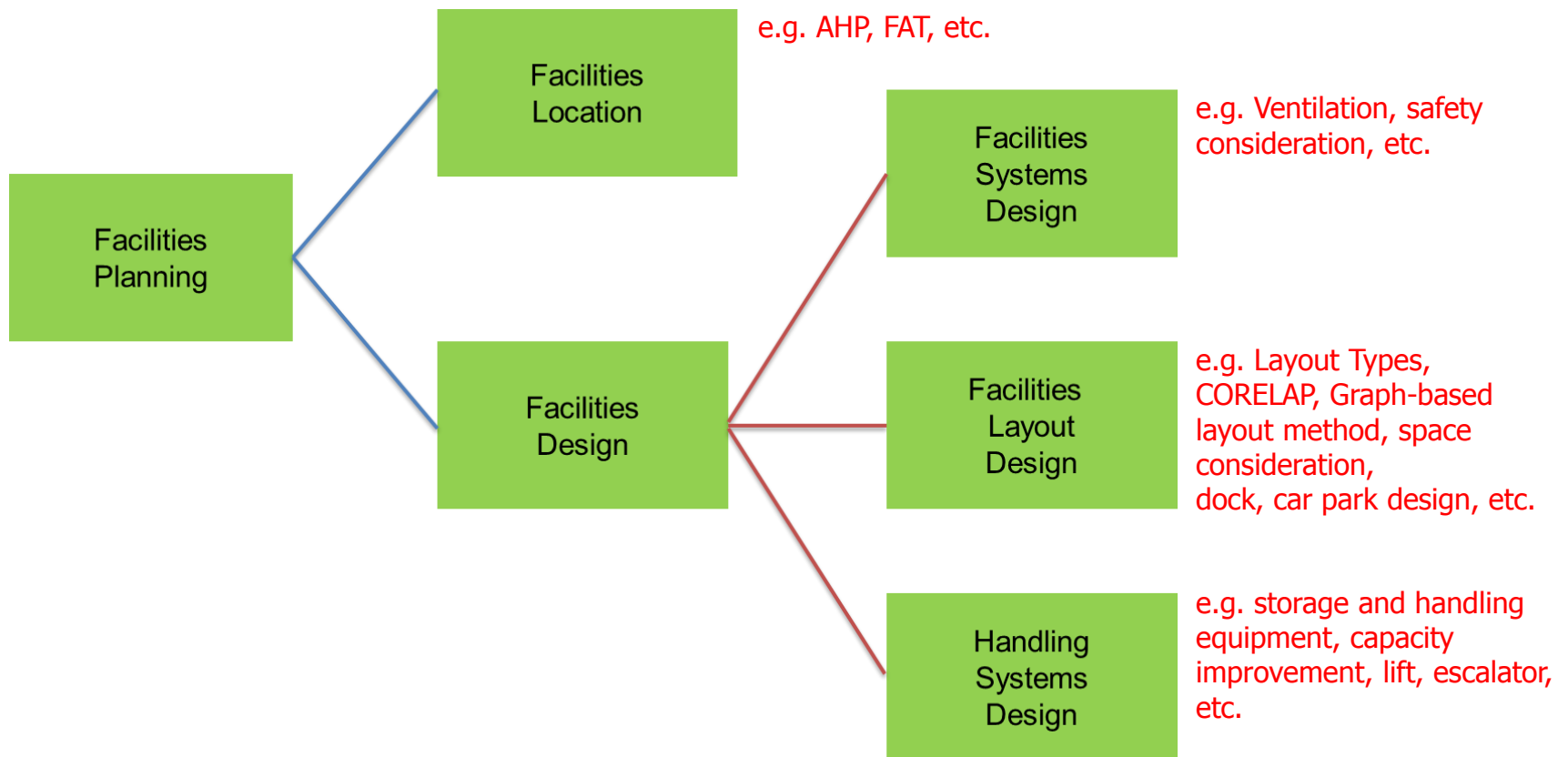
E212 Facilities Planning & Design - Topic Tree



Recall : Facilities Planning Hierarchy



Facilities planning covers both facilities location and facilities design.



Areas of Warehouse Operation



- The goal of warehouse layout design is to optimize your warehousing functions and achieve maximum efficiency and space utilization.
- A warehouse is typically divided into 5 areas to support daily processes. These areas include:
 1. Inbound (Goods in)
 2. Main store – reserve stock
 3. Order picking – forward stock
 4. Marshalling
 5. Outbound (Goods out)

Warehouse Storage



- Storage and warehousing resources are space, equipment and personnel.
- Objectives of designing storage and warehousing systems, it is desirable to maximize:
 - Space utilization (use space efficiently)
 - Equipment utilization (to allow efficient material handling)
 - Labor utilization (most economical storage in relation to costs of equipment, use of space, damage to material and handling labour)
 - Material accessibility (provide flexibility to meet changing storage and handling requirements)
 - Material protection
 - Good housekeeping

Space Planning for Storage Activities



1. Defining the materials to be stored
2. Choosing a storage philosophy
3. Space requirements for alternative storage methods

Warehouse Storage



1. Defining the Materials to be stored

Example of a Storage Analysis Chart used in calculating space requirements

Date <u>September 14, 1997</u>					Raw Materials <u>X</u>								
In-Process Goods _____													
Company <u>J.D.S., Inc.</u>													
Prepared by <u>B. Hudock</u>					Sheet <u>1</u> of <u>1</u>		Plant Supplies _____						
Finished Goods _____													
Unit Loads					Quantity of Unit Loads					Stores		Storage	
Space _____													
Description (1)	Type (2)	Capacity (3)	Size (4)	Weight (5)	Maximum (6)	Average (7)	Planned (8)	Method (9)	Specs (10)	Area ft ² (11)	Ceiling Height Required ft (12)		
Aluminum rails, three runner 288'	Bundles	50 pcs.	18" x 28' x 288'	1250 lbs.	14	5	12	Cantilever rack	Four-arm dual rack, 4' x 12' x 6'	192	24		
Glass, 1/4" thick, 8' x 4' sheets	Racks	4 sheets	8' x 4' x 4'	400 lbs.	20	13	15	Pallet rack	4' x 4' x 22' (4 levels)	240	24		
Rubber Stripping 1/8" square	Cartons	500 feet	12' x 4' x 12'	20 lbs.	20	12	8	Industrial Shelving	5 level 42" x 18" shelves	12	9		

Columns 1-5: define what materials are to be stored

Columns 6-8 : how much is to be stored

Columns 9-12: how the materials are to be stored

Warehouse Storage



2. There are 2 major material storage philosophies:

- **Fixed (assigned) location storage**
 - each individual stock-keeping unit (*SKU) is stored in a specific location
 - no other SKU may be stored there, even though the location may be empty
- **Random (floating) location storage**
 - any SKU may be assigned to any available storage location
 - a SKU stored in location 1 might be stored in location 2 the following month and a different SKU stored in location 1
- The amount of space planned for a SKU is directly related to the method of assigning space.

***SKU is a specific number or code used to identify each unique product for sale**

Warehouse Storage



3. Determine Alternative Storage Method Space Requirements:

- The space requirements are directly related to the volume of materials to be stored, and
- The use-of-space characteristics of the alternative
 - Aisle Allowance
 - Honeycombing allowance

A space standard is the volume requirement per unit load stored to include allocated space for aisles and non-usable space.

Total Warehouse Volume

= Storage space + Aisle way space + Non-usable space

Space standard = $\frac{\text{Total warehouse volume}}{\text{Total unit load quantity}}$

Aisle Space Requirement

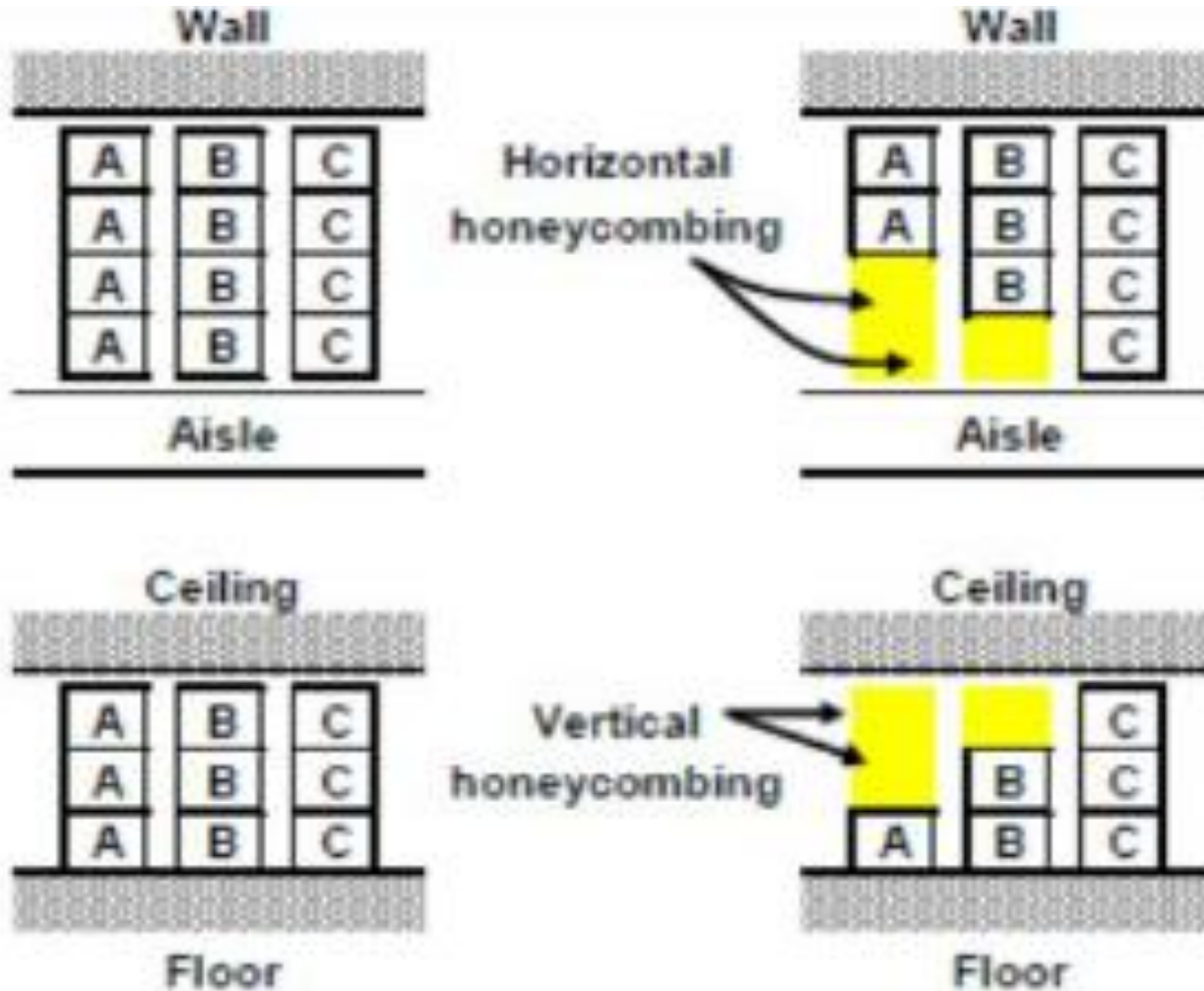


Dependent on the type of material handling equipment

Recommended aisle width for various types of flow

Types of Flow	Aisle Width (feet)	Aisle Width (metre)
Tractors	12	3.66
3-ton Forklift	11	3.35
2-ton Forklift	10	3.05
1-ton Forklift	9	2.74
Narrow aisle truck	6	1.83
Manual platform truck	5	1.52
Personnel	3	0.91
Personnel with doors opening in the aisle from one side	6	1.83
Personnel with doors opening in the aisle from two sides	8	2.44

Honeycombing Space



Storage Facilities Guidelines/References

- 1) Workplace Health and Safety Act -
Occupational Safety and Health
Administration (OSHA)
- 2) Singapore Fire Safety Act
- 3) Provision of Parking Places and Parking
Spaces Rules
- 4) Environmental Pollution Control Act

Considerations of Warehouse Layout Design

- A warehouse layout is more complicated when:
 - ☐ The different customer orders take into account a high number of references.
 - ☐ There are frequent orders of low number of units for the same product.
 - ✓ In this cases, the material handling costs for each roundtrip move would be excessively high.
 - ✓ Solutions for this problem: Aggregation of units for several orders, or establishment of optimal routes for each order.

Recall: Facilities Design



Facilities design consists of the facility systems, layout and handling system:

- o Facility systems – structural, atmospheric, enclosure, lighting, electrical, communications, safety and sanitation systems
- o Layout – equipment, machinery, furnishings and fittings within the facility envelope
- o Handling system – the mechanisms needed to satisfy the required movements within the facility

Recall: Space Requirement



- Determining the amount of space required in a facility is perhaps the most difficult determination in facilities planning
- Determine the space requirement based on workstation specifications for equipment, materials, and personnel and departmental specifications.
- Aisles has to be taken into account when doing space planning. Typical aisle space for personnel: 3 feet

Developing Storage/Warehouse Layout



The steps required to develop a scaled layout are:

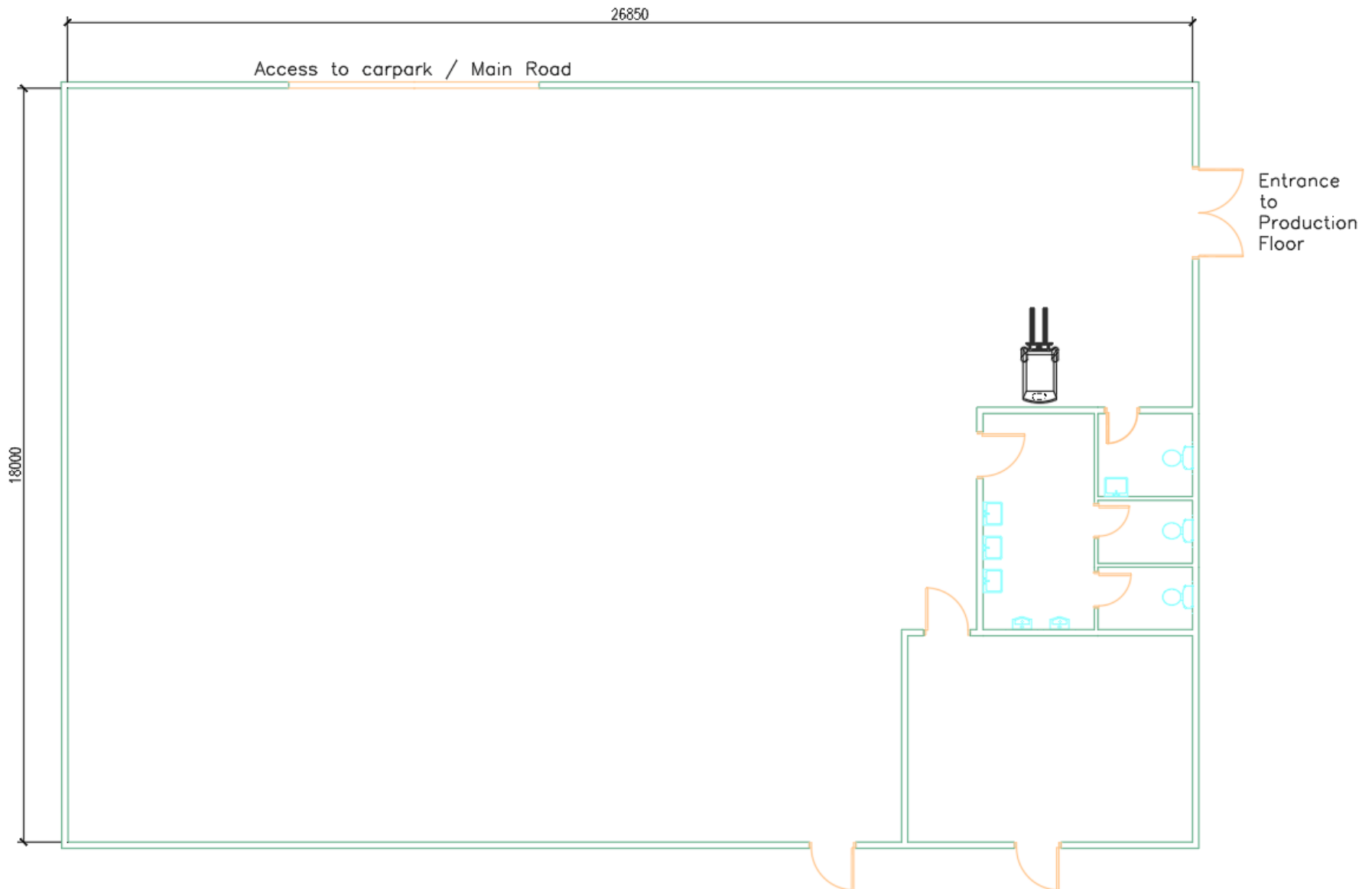
- Draw the overall area to scale
- Include all fixed obstacles, such as columns, elevators, stairs, plant services etc.
- Locate the receiving and shipping areas
- Locate the various types of storage
- Assign materials to storage locations

Problem 08

Suggested Solution



Goodle's Warehouse Floorplan



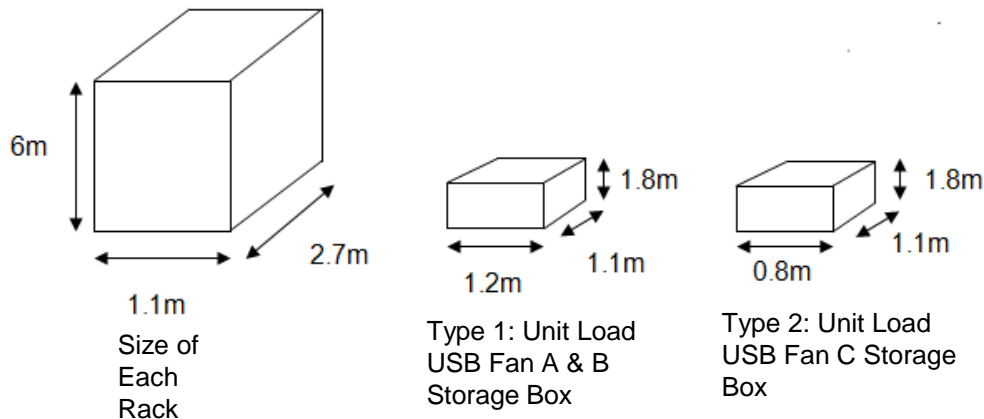
For Initial Warehouse Layout Design



Assumptions:

- (1) The office, toilet, receiving pallets area, outgoing pallet areas are non-usable space
- (2) Forklift can be parked at any aisle in the warehouse
- (3) Storage assignment is not location-specific
- (4) The receiving and outgoing pallets, racks, are stacked up to maximum warehouse height of 6m

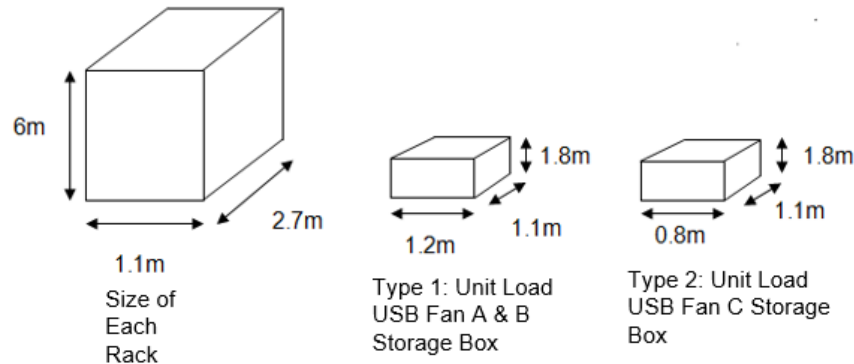
Given:



For Initial Warehouse Layout Design



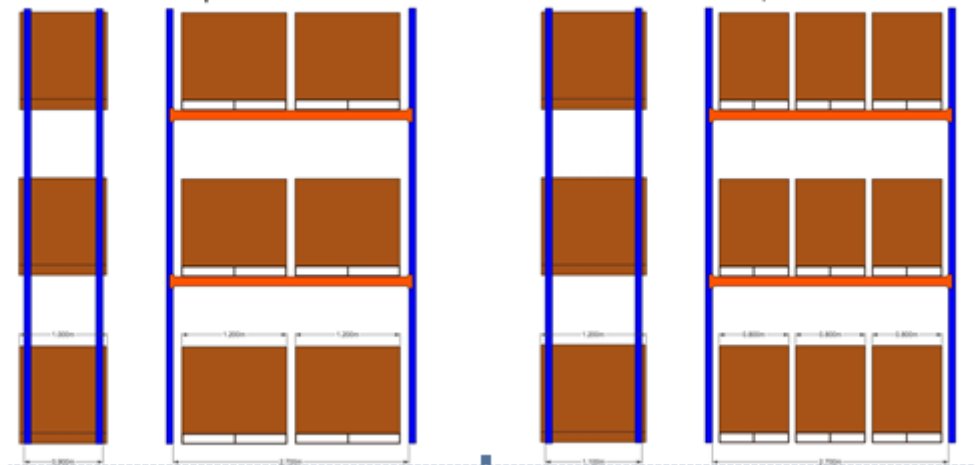
Given:



The number of loads that can be stored in one rack for Type 1 = $2 \times 3 = 6$ unit loads

For the number of loads that can be stored in one rack for Type 2 = $3 \times 3 = 9$ unit loads

Type A: For USB Fan 1.0 and 2.0 storage Type B: For USB Fan 3.0 Storage



For Initial Warehouse Layout Design



- Total warehouse space (based on 6m stack height)
= Length x Breadth x Height
= $26.85 \times 18 \times 6$
= 2899.8 m^3
- Total available rack storage space (based on 6m stack height)
= Individual rack volume x Number of racks
= $(6 \times 2.7 \times 1.1) \times 35 \text{ racks}$
= 634.7 m^3
- Total non-usable space (based on 6m maximum height)
= Toilet space + Office space + Pallet space
= $(5 \times 5.37 \times 6) + (6.8 \times 5 \times 6) + (4 \times 2.4) + (4 \times 2.4)$ 19.2+204+161.1
= $161.1 \text{ m}^3 + 204 \text{ m}^3 + 19.2 \text{ m}^3$
= 384.3 m^3

For Initial Warehouse Layout Design



- The maximum average stock level for Type 1 (USB Fan A and USB Fan B) = 110 units
- Number of racks needed for Type 1 (USB Fan A and USB Fan B)
 $= 110/6 = 18.33 \sim 19$ racks
- The maximum average stock level for Type 2 (USB Fan C)
 $= 140$ units
- Number of racks needed for Type 2 (USB Fan C)
 $= 140/9 = 15.55 \sim 16$ racks
- Total number of storage racks needed = **19+16 = 35 racks**
- Maximum number of unit loads that can be stored in warehouse
 $= 6 \text{ unit loads/rack} \times 19 \text{ racks} + 9 \text{ unit loads/rack} \times 16 \text{ racks}$
= 258 unit loads

For Initial Warehouse Layout Design



- **Total warehouse space (based on 6m stack height)**
 - = Length x Breadth x Height
 - = $26.85 \times 18 \times 6$
 - = 2899.8 m^3
- **Total available finished product rack storage space (based on 6m stack height)**
 - = Individual rack volume x Number of racks
 - = $(2.7 \times 1.1 \times 6) \times 35 \text{ racks}$
- = $17.82 \times 35 = 623.7 \text{ m}^3$
- **Total available Raw Materials rack storage space (based on 6m stack height)**
- = Individual rack volume x Number of racks
- = $(2.7 \times 1.1 \times 6) \times 1 + (6 \times 1.1 \times 6) \times 1 + (1.3 \times 1.1 \times 6) \times 2 + (2.7 \times 1.1 \times 6) \times 1 + (1.1 \times 0.6 \times 6) \times 2$
- = 84.48 m^3

For Initial Warehouse Layout Design



- **Total non-usable space (based on 6 m maximum height)**
= Toilet space + Office space + Pallet space + Forklift parking area
= $(5.15 \times 5.31 \times 6) + (6.945 \times 5.075 \times 6) + (4 \times 0.8 \times 1.2 \times 6) + (2.4 \times 1.2 \times 6)$
= $164.08\text{m}^3 + 211.48\text{m}^3 + 23.04\text{m}^3 + 17.28\text{m}^3$
= 415.88m^3
- **Total space allocated to aisles**
= Total warehouse space – Total available storage space – Total non-usable space
= $2899.8 - 623.7 - 84.48 - 415.88$
= 1775.74m^3
- **Percentage loss in space utilization due to aisles**
= $[\text{Total space allocated to aisles} / \text{Total warehouse space}] \times 100\%$
= $[1775.74 / 2899.8] \times 100\%$
= 61.24%

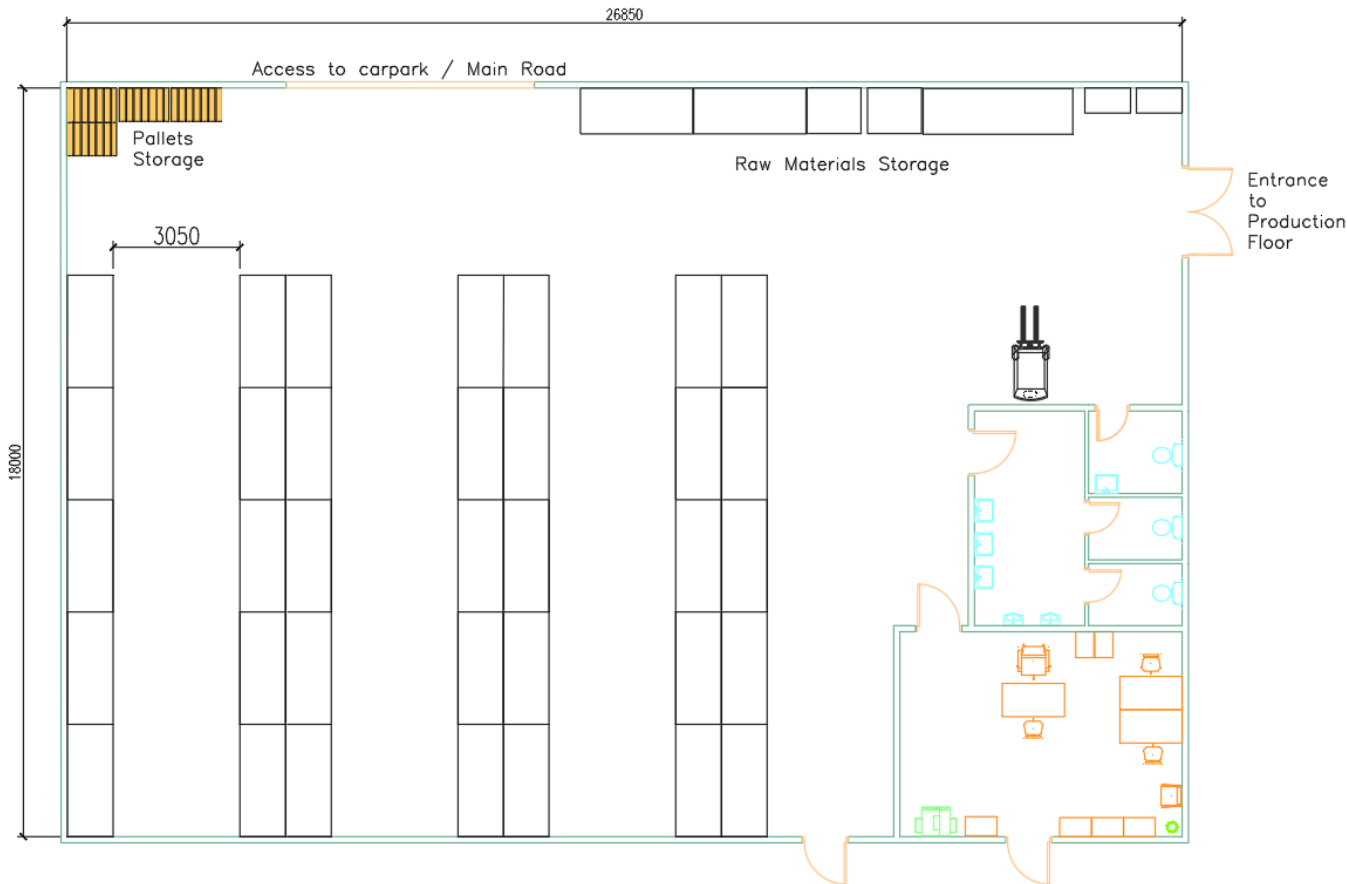
For Initial Warehouse Layout Design



- Space standard can be interpreted as the volume requirement per unit load stored. The space standard of the initial warehouse layout is calculated as follows:
- **Space Standard = Total warehouse space / Total number of unit load**
= 2899.8 / 258
= 11.24 m³ / unit load

The space standard of the current warehouse layout has **met the company's requirements of $\leq 12\text{m}^3$ / unit load**

Warehouse Floorplan Layout



Use 2-ton forklift

The aisle width between racks (3.05m) which is the recommended width of 3.05m.

Total of 35 racks used.

Factors Affect Warehouse Layout



Layout factors that support fulfilling of space standard:

1. Use of 2 Ton forklift, resulting in lower loss in space utilization
2. Minimal or no wasted spaces
3. Increasing the number of storage racks within the same space, leading to higher capacity

Note that these factors are inter-related.

Facility Plan of Storage & Warehouse



Strengths:

- Ample storage capacity that can handle current goods.
- Ample space for incoming good to break bulk.
- Material handling equipment for additional space for moving
- Sufficient space for loading/unloading (for equipment, material, pallet etc).

Weakness:

- 1. Need to relook into the flow of human traffic and material flow during re-layout..
- 2. Lack of safety features – floor zoning to show where personnel can walk on
- 3. Need to consider safety aspect in the facilities. E.g. first aid kit etc.

Facility Plan of Storage & Warehouse



Potential Area for Improvement:

- Clear signage to guide traffic flow to storage location.
- Set up rest area within the facility.
- Better/clearer signage to direct visitor to office.

Other Areas for consideration:

- Maintenance Plan for material handling equipment
- Safety and Security – Evacuation Procedure
- Car Traffic Control
- Barrier-free access for handicapped / people with strollers

Learning Objectives



- Perform the storage area profiling based on storage capacity required and types of unit load.
- Define and measure warehouse storage efficiency by applying Space Standard.
- Perform facilities layout to plan and design warehouse storage capacity without the needs of floor area expansion.

Overview of E212 Facilities Planning and Design

