

GROUP No: 20

**IA 2103 - Workshop Practice – Welding
Techniques**

Design for Manufacturability

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Foldable Tri-Level Perforated Rack

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1. Introduction

This document presents the design and manufacturing plan for a Foldable Tri-Level Perforated Rack. The product is engineered to provide a durable and space-efficient solution for drying or storing items, particularly in industrial and mechanical environments. The design integrates basic welding techniques and structural optimization, making it suitable for low-cost fabrication in workshop conditions.

2. Concept and Innovation

The core concept of the Foldable Tri-Level Perforated Rack is to allow users to access multiple levels of storage or drying surface with a foldable steel frame. Each level uses perforated sheet metal to provide ventilation and weight reduction. The rack's frame is built using standard steel square tubing, while the foldable mechanism allows the unit to be compact when not in use.

3. Design Description

The rack is designed with three perforated shelves supported by a triangular welded steel frame. The use of punched metal sheets ensures airflow and reduces material weight. The side frames are welded to provide structural rigidity, and the entire unit is designed for wall-mounting or floor standing based on user need.



Figure 1 - Full Assembly - Front Isometric View

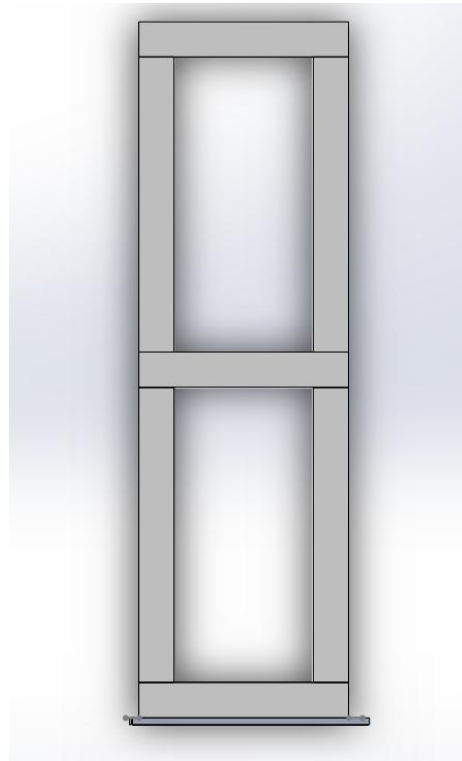


Figure 2 - Full Assembly - Rear Isometric View

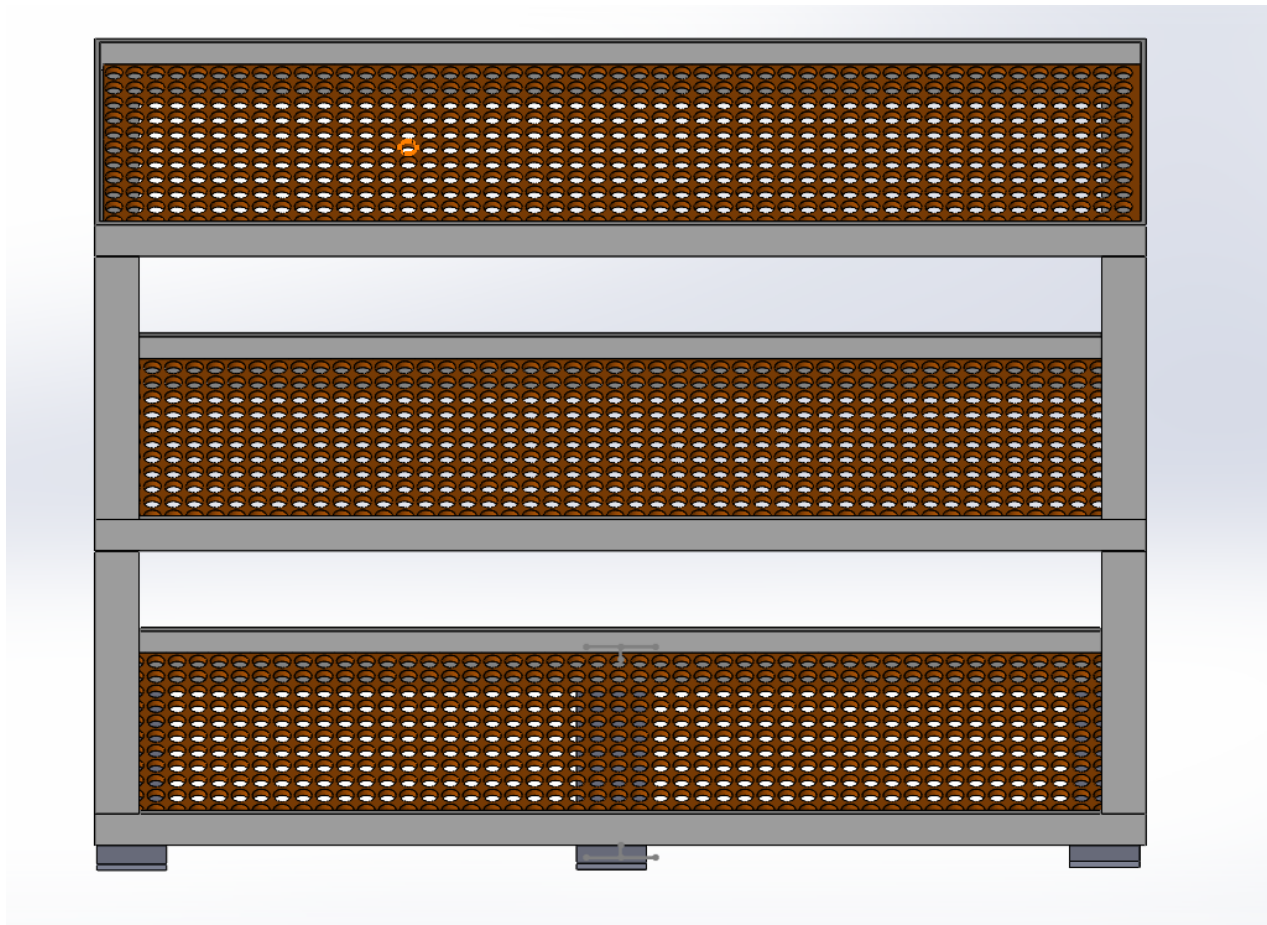


Figure 3 - Front View of Rack

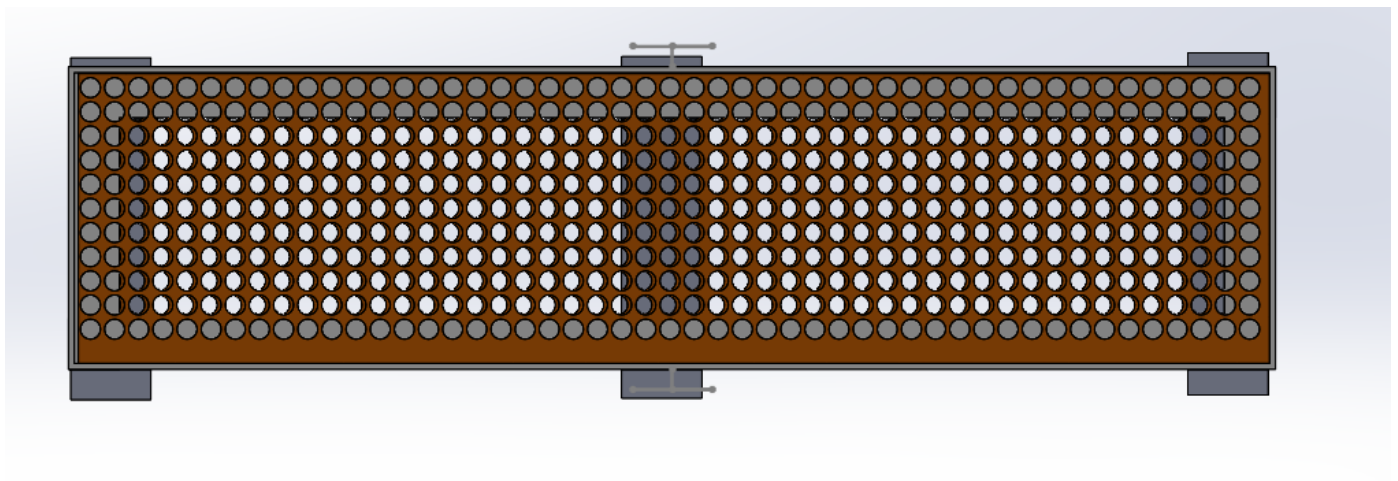


Figure 4 - Top View of Rack

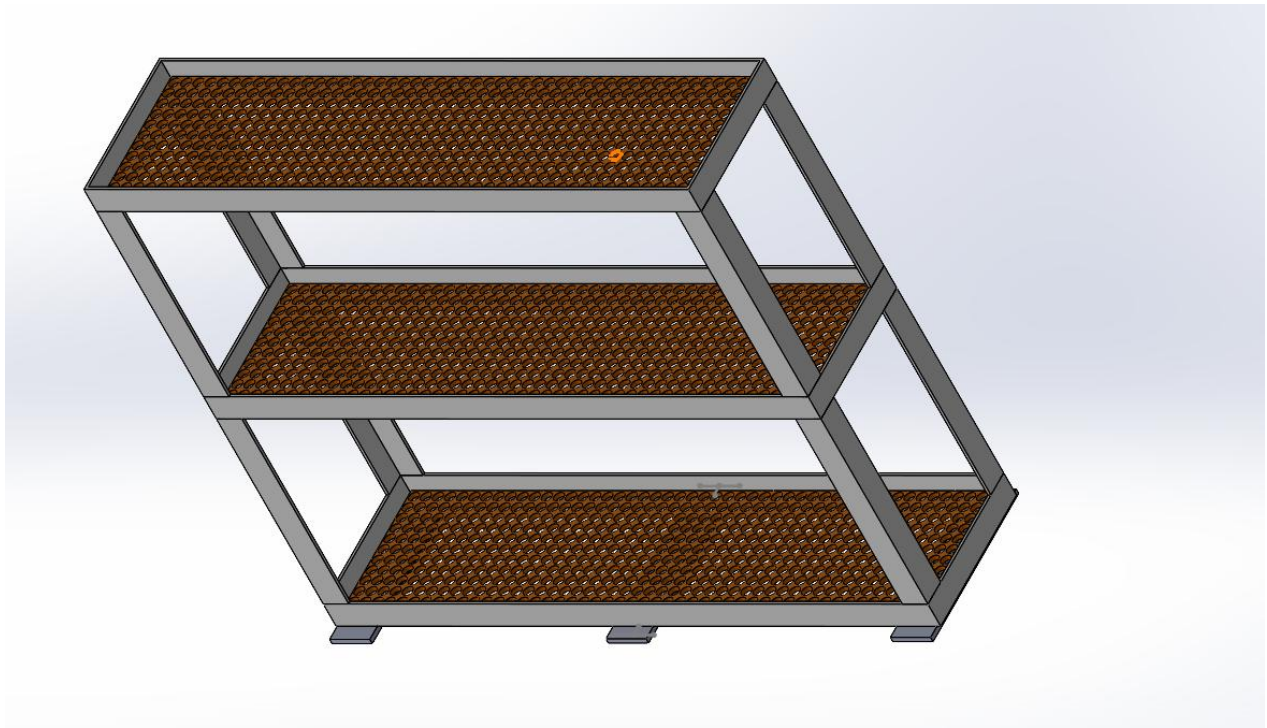


Figure 5 - Folded Position - Side Isometric

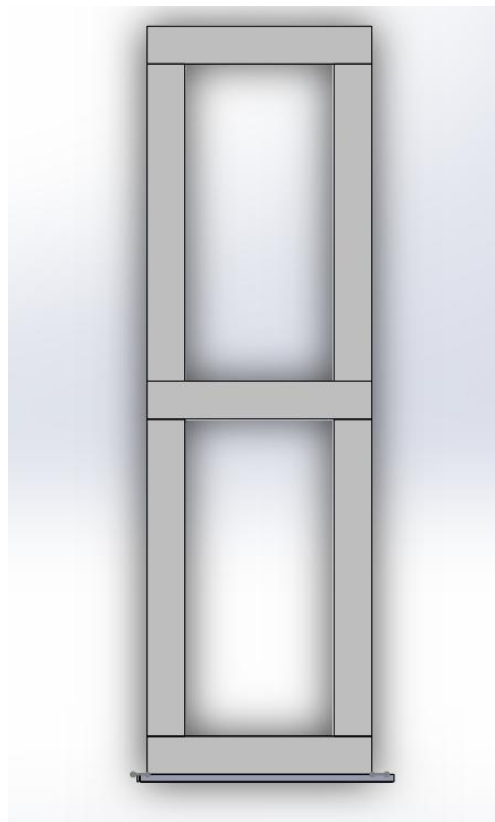


Figure 6 - Folded View - Side Frame

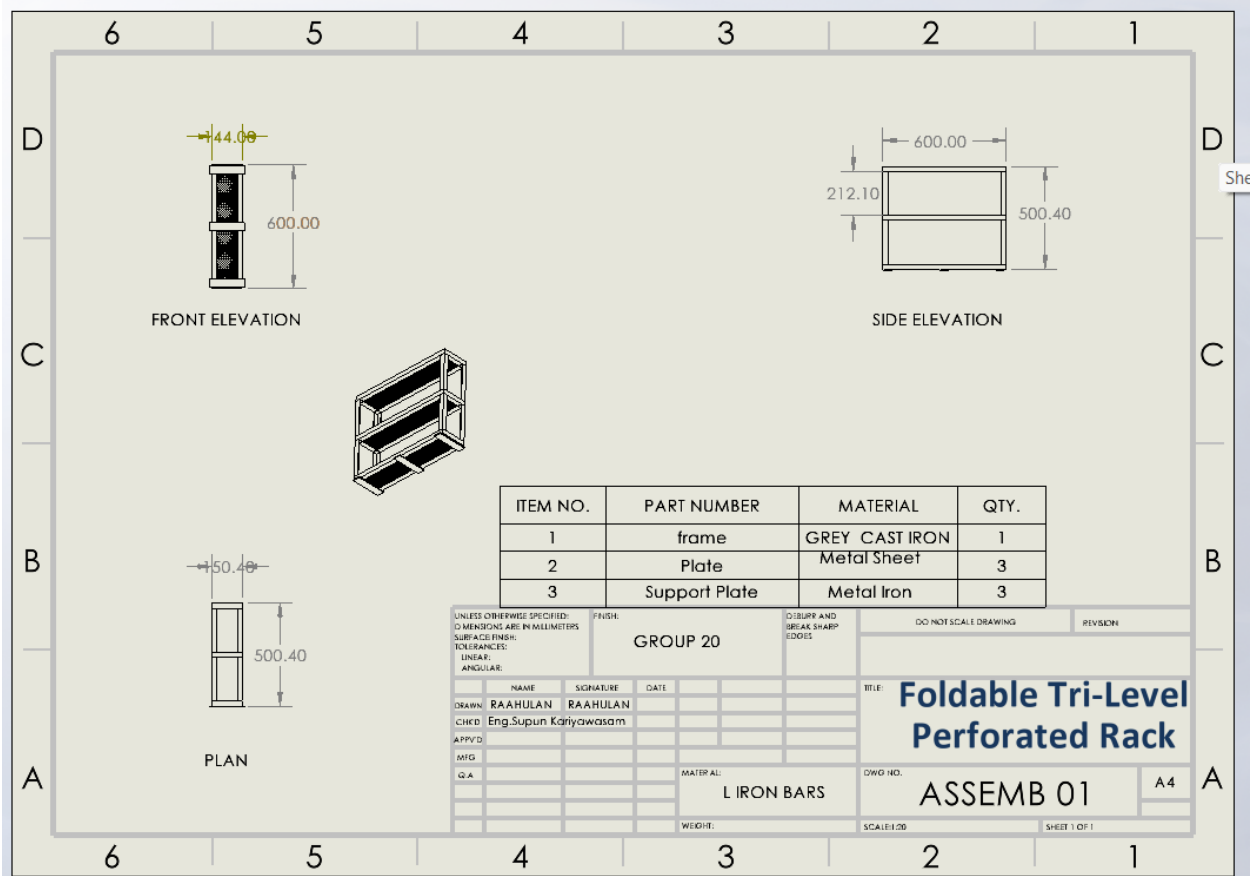


Figure 7 - Engineering Drawing Sheet



Figure 8 - SolidWorks Isometric Model

4. Fabrication Process

- **Step 1: Material Preparation**

All required materials, including square steel tubes (20x20 mm) and perforated sheet metal, are selected based on the Bill of Materials.

Tubes are measured and marked using a steel scale and scribe.

A metal chop saw is used to cut tubes precisely.

- **Step 2: Sheet Cutting and Finishing**

Sheets are cut using guillotine shear.

Edges are deburred using a bench grinder for safe handling.

- **Step 3: Drilling and Hinge Placement**

Mounting holes are drilled using a pedestal drill.

Clamps are used to ensure proper alignment.

- **Step 4: Welding and Frame Assembly**

Tack welds ensure alignment before full arc welds are done.

Special care is taken to maintain proper angles.

- **Step 5: Hinge and Stand Integration**

Hinges are bolted for foldability.

Supports are tested for motion and locking.

- **Step 6: Surface Treatment**

Frame cleaned with degreasing solution.

Coated with primer and enamel paint for corrosion resistance.

- **Step 7: Final Assembly and Testing**

Complete system is assembled and tested for load.

Folding and locking mechanisms are checked thoroughly.

5. Materials Used

- Square steel tubing (20x20 mm)
- Perforated sheet metal
- Welding electrodes
- Hinges and fasteners
- Anti-rust primer and paint

6. Cost Analysis (Estimated - Sri Lankan Market)

Component	Description	Estimated Cost (LKR)
Square Steel Tubes (20x20 mm)	6 meters @ ~LKR 450/meter	2,700
Perforated Sheet Metal	2 sheets @ ~LKR 1,000/sheet (1.5ft x 3ft, 1mm thick)	2,000
Welding Electrodes	10 rods @ ~LKR 30/rod	300
Hinges and Fasteners	Hinges, bolts, washers, nuts	800
Grinding & Cutting Discs	1 disc each for cutting & smoothing	500
Surface Preparation & Paint	Primer + Enamel paint	1,500
Electricity + Labor Cost	Estimated 3 hours @ LKR 250/hour	750
Total Estimated Cost		8,550

7. Bill of Materials (BOM)

Item	Material / Component	Dimensions	Quantity
1	Square Steel Tube	20mm x 20mm x 2mm, 1000mm length	6 pcs
2	Perforated Sheet Metal	3ft x 1.5ft x 1mm	2 sheets
3	Mild Steel Hinges	2" x 1.5"	3 pcs
4	Hex Bolts + Nuts + Washers	M6 x 20mm	12 sets
5	Welding Electrodes	E6013, 2.5mm	10 rods
6	Paint & Primer	Standard Enamel & Rust Primer	As required
7	Grinding Disc	4-inch	1 pc
8	Cutting Disc	4-inch	1 pc

8. Cost Analysis and Pricing

Component-wise cost estimation:

Component	Description	Estimated Cost (LKR)
Square Steel Tubes	6m @ 450	2,700
Perforated Sheet Metal	2 sheets @ 1000	2,000
Welding Electrodes	10 rods @ 30	300
Hinges/Fasteners	Bolts, nuts, hinges	800
Grinding/Cutting Discs	1 each	500
Surface Paint	Primer + Enamel	1,500
Labor + Electricity	3 hrs @ 250/hr	750
Total		8,550

Pricing Strategy:

- Wholesale Price: LKR 10,000
- Retail Price: LKR 11,500

9. Contribution of Group Members

Index Number	Name	Contribution (%)
2022t01340	THARUSHA RAJAPAKSHA	25%
2022t01341	S.PUVANITHAN	25%
2022t01342	M.RAAHULAN	25%
2022t01343	THARINDU	25%

10. References

- ✓ Kalpakjian, S., & Schmid, S. R. (2014). Manufacturing Engineering and Technology.
- ✓ Groover, M. P. (2015). Fundamentals of Modern Manufacturing.
- ✓ SolidWorks User Manual - Dassault Systèmes
- ✓ <https://www.wcwelding.com/welding-techniques.html>
- ✓ <https://bnshardware.lk/>
- ✓ Using SOLIDWORKS_2020_Premium

11. Conclusion

The **Foldable Tri-Level Perforated Rack** is a practical product designed for ease of manufacturing, cost-efficiency, and structural reliability. Its design supports scalability for commercial applications and meets the coursework requirement for welded assembly in a real-world context.