

Design of ECU Server Shelf

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Problem Definition

An engineering research group at CSU is developing a remote vehicle network test platform. Continuous operation of electronic control units (ECUs), computers, servers, and other electrical hardware is expected. An organized means of mounting ECU equipment in standard 19-inch racks (server racks) is desired.



Engine Control Module

Needs Analysis

Primary Function:

Support a vehicle ECU and its equipment on standard 19" racks

Secondary Function(s):

None

Timeline:

January 1st – January 30th 2021

Where:

Powerhouse Energy Institute Engine Control Room

Who:

SystemsCyber Research Group

Requirements

System Operational Requirements (SR)

- SR1 – System shall be securable to a standard 16U* 19" two-post server rack.
- SR2 – System height shall not exceed 3U.
- SR3 – System weight shall not exceed 52.5 lb. (15% of rack weight capacity).
- SR4 – At minimum, the system shall support an ECU, 12V power adapter, and an SSS2 unit.

*1U = 1.75 in.

Key Figures of Merit (FOMs):

Material Cost (Mc) – Dollars (\$)

Manufacturing Time (Mt) – Hours

Composite Failure Rate (λ) – Likelihood a shelf is not made according to design

Total Design Cost (TC) – Per Shelf

Design Alternatives

Alternative 1:

Acrylic-ABS Shelf and Display

Description: A desire for the shelf to doubly function as a project display board was considered but not included in the requirements. Alternative 1 attempts to satisfy this desire and the requirements by using laser cut 1/8" acrylic sheets, velcro, 3D-printed components, and available lab material.

Equipment Used:

Laser Cutter, 3D Printer, Power Drill

Alternative 2:

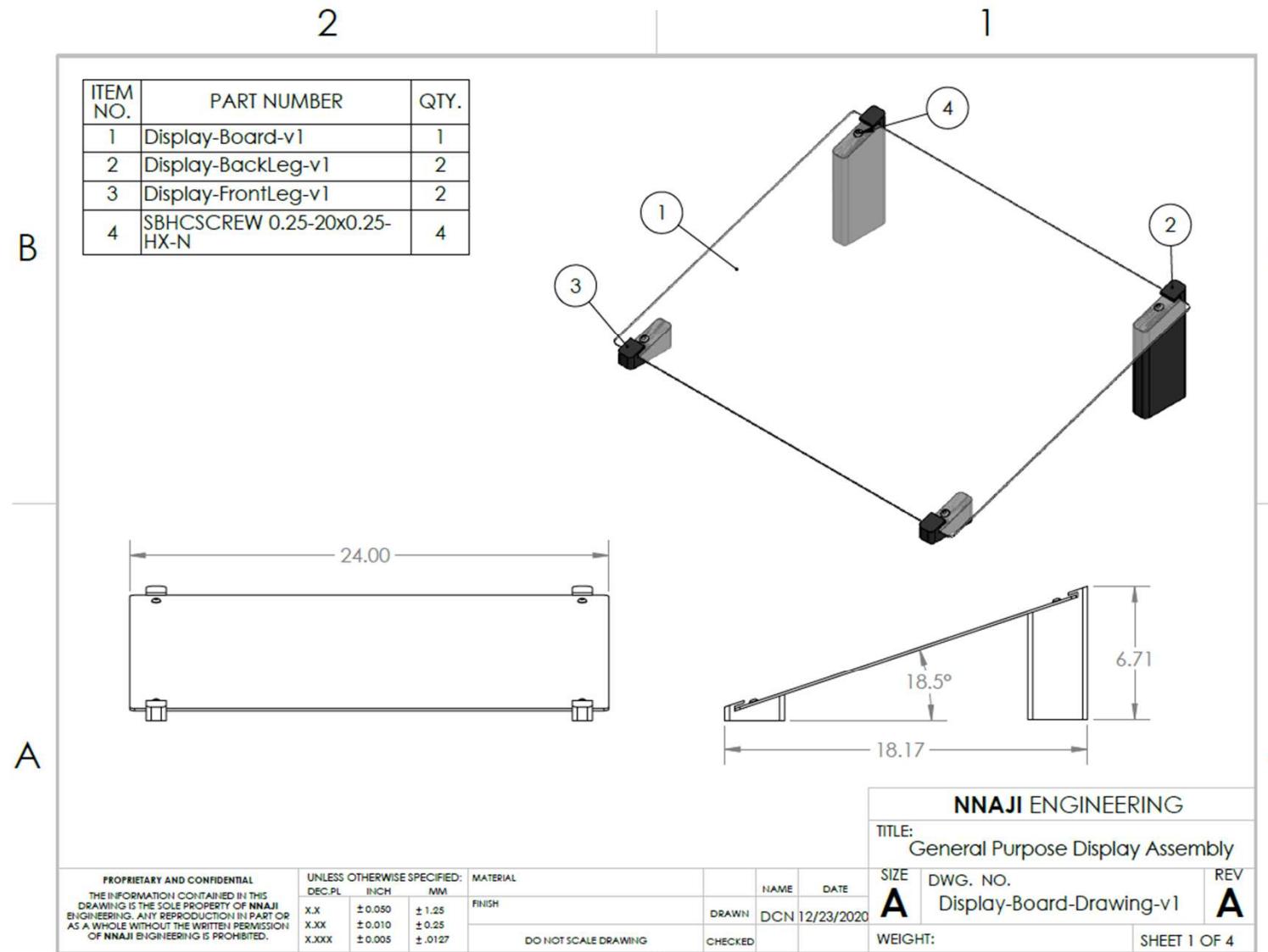
Wood-Steel Shelf

Description: Alternative 2 attempts to use welded 1/8 in. angle iron, screws, plywood, and available lab materials to satisfy the requirements.

Equipment Used:

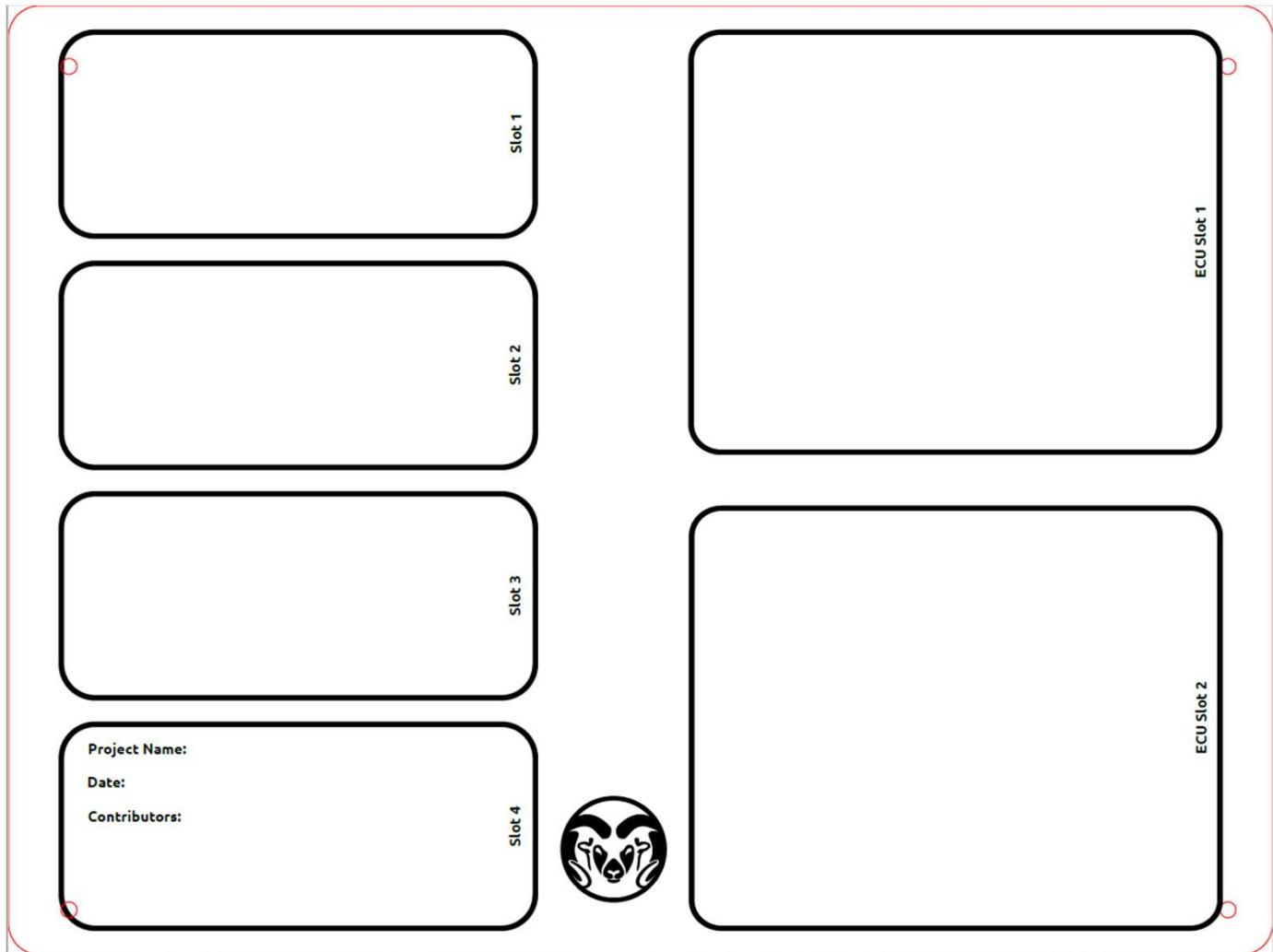
Mill, Welding Station, Metal Grinder, Horizontal Band Saw, Wood Saw, Power Drill

Prototype CAD Drawing Alternative 1



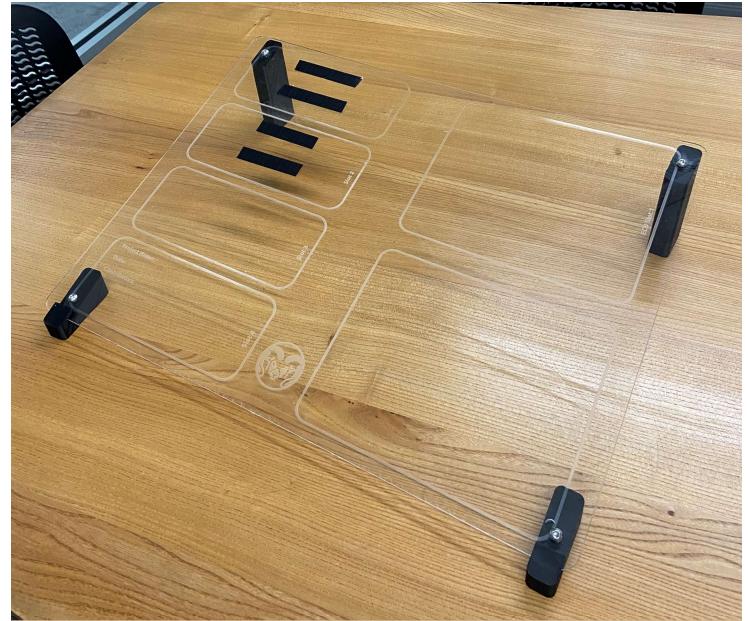
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Prototype Laser Design Alternative 1

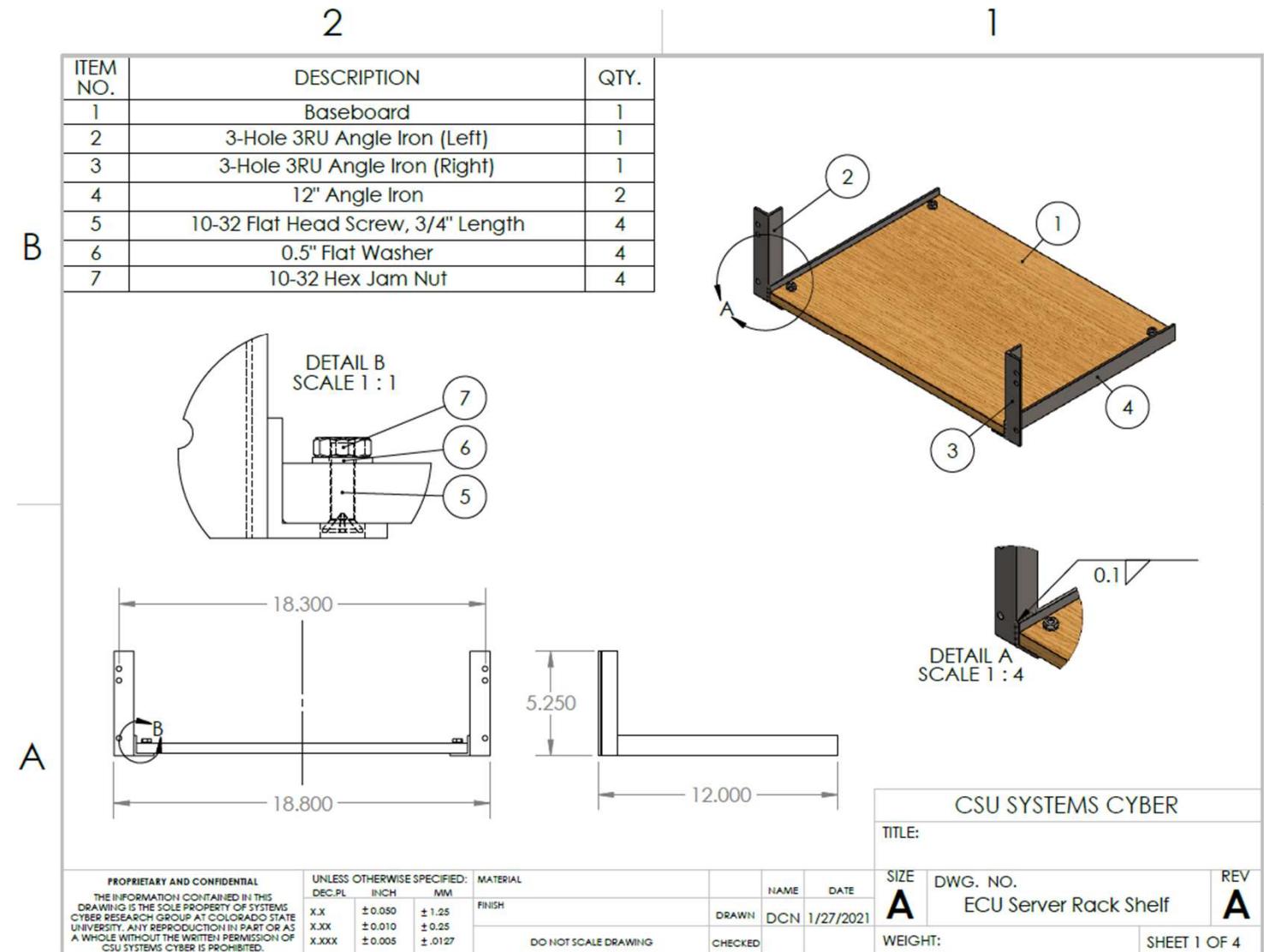


Issues: Alternative 1

- 3D printed components are difficult to reliably produce.
- 3D printed components require 2-7 hours each to produce.
- Significant acrylic deflection observed when ECU components are mounted.
- Acrylic to ABS fastening is relatively weak.



Preliminary CAD Drawing Alternative 2



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1

B

A

Prototype for Wood

Manufacturing Processes

Metal Cutting

Metal Grinding

Milling

Wood Cutting

Welding

Finishing

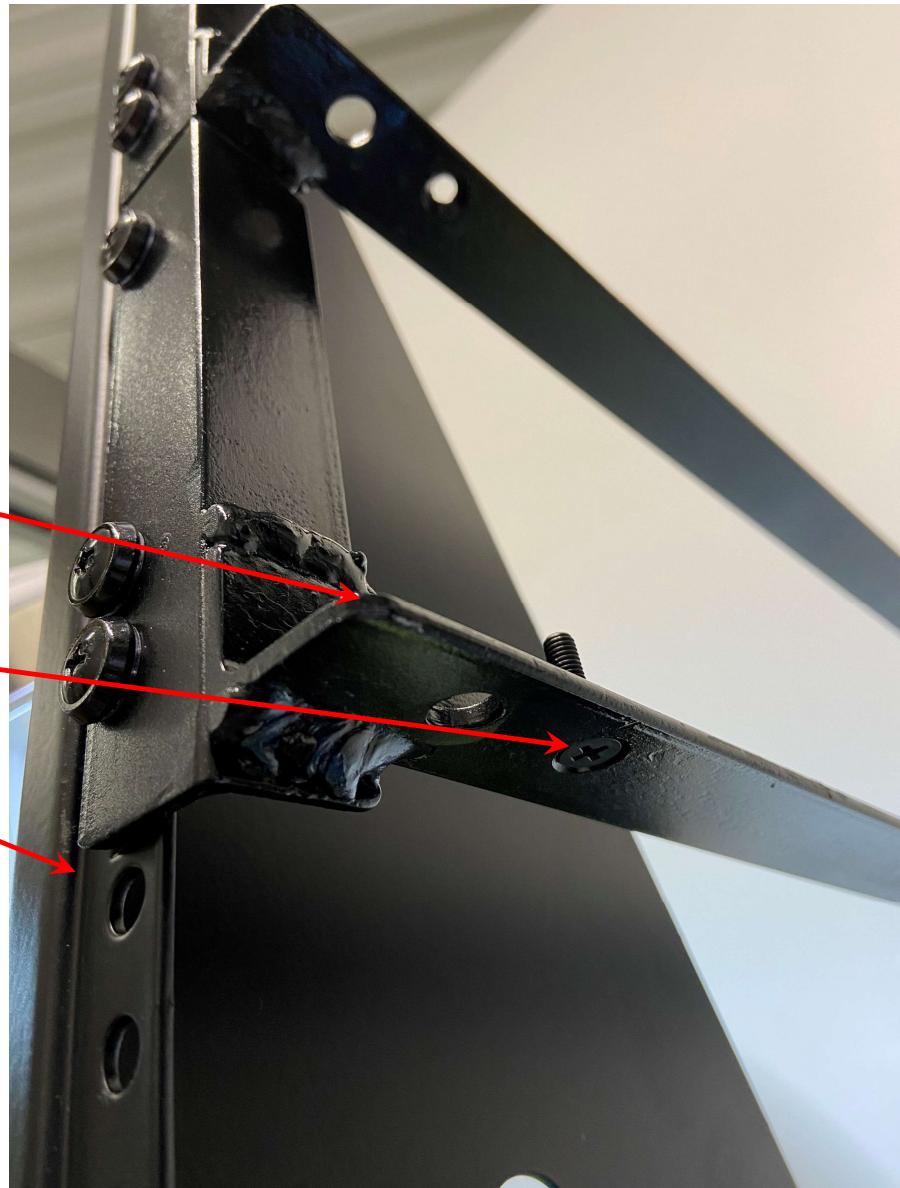
Painting

Assembly

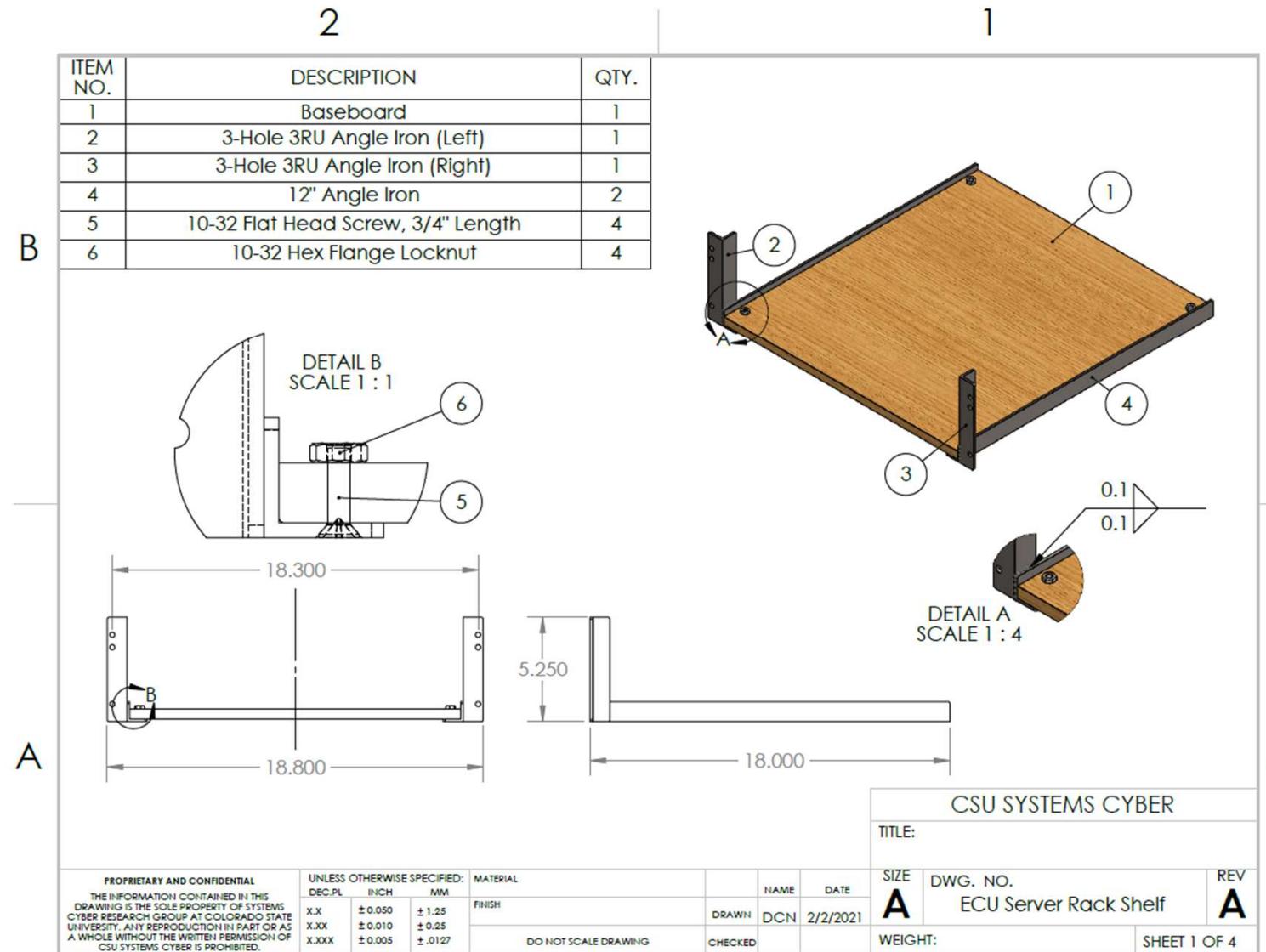


Issues: Alternative 2

- Preliminary Design length was changed from 12" to 18"
- Preliminary Design did not include fillet features
- Preliminary design did not include countersink for long angle iron holes.
- Preliminary Design did not account for server ear shape
- Hole spacing and sizes were adjusted for multiple components.
- Washer nut replaced with flange locknut.



Design-as-Built Drawing Alternative 2



Trade-Off Study

*Engineering Cost (ENGC): \$30/hr
Manufacturing Cost (MC): \$15/hr*

Alternative 1

Material Cost

19x24 Acrylic, \$13.29
136g of PLA, \$3.50
#10x0.75 Screw 50 Pack, \$9.00
Total: \$16.79

Total Design Cost

\$16.79 + 9h*ENGC + 17*MC= **\$542**

Manufacturing Time

Laser Cut/Engraving, 0.5h
3D-Prining, 16h
Assembly, 0.5h

Failure Rate

Baseboard, 0.05
Black legs, 0.4
Front legs, 0.2
Composite: 54.4%

Alternative 2

Material Cost

½" 19x18" Plywood, \$4.00
Paint, \$1
48" 1x1 Angle Iron from 10', \$7.20
#10x0.75 Fasteners 50 pack, \$16.16
Total: \$35.56

Total Design Cost

\$28.36 + 20h*ENGC + 9.1*MC= **\$764**

Manufacturing Time

Metal Cutting, 0.5h
Metal Grinding, 0.3h
Milling, 2h
Wood Cutting, 1h
Welding, 1h
Finishing, 1h
Painting, 3h

Assembly, 0.3h

Failure Rate

Shelf Angle Iron, 0.15
Mount Angle Iron, 0.1
Baseboard, 0.05
Composite: 27.3%

COTS

Save time, money and energy

