

Christmas Ornament Display Structure

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Overview

- Client Background
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- Design Constraints
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Client Background

- My Star of Bethlehem LLC
- Online business
- Operates out of Sedona, AZ
- Import and sell decorative stars manufactured in Germany
- Market in Northern Arizona

Client Background Continued



Problem Statement

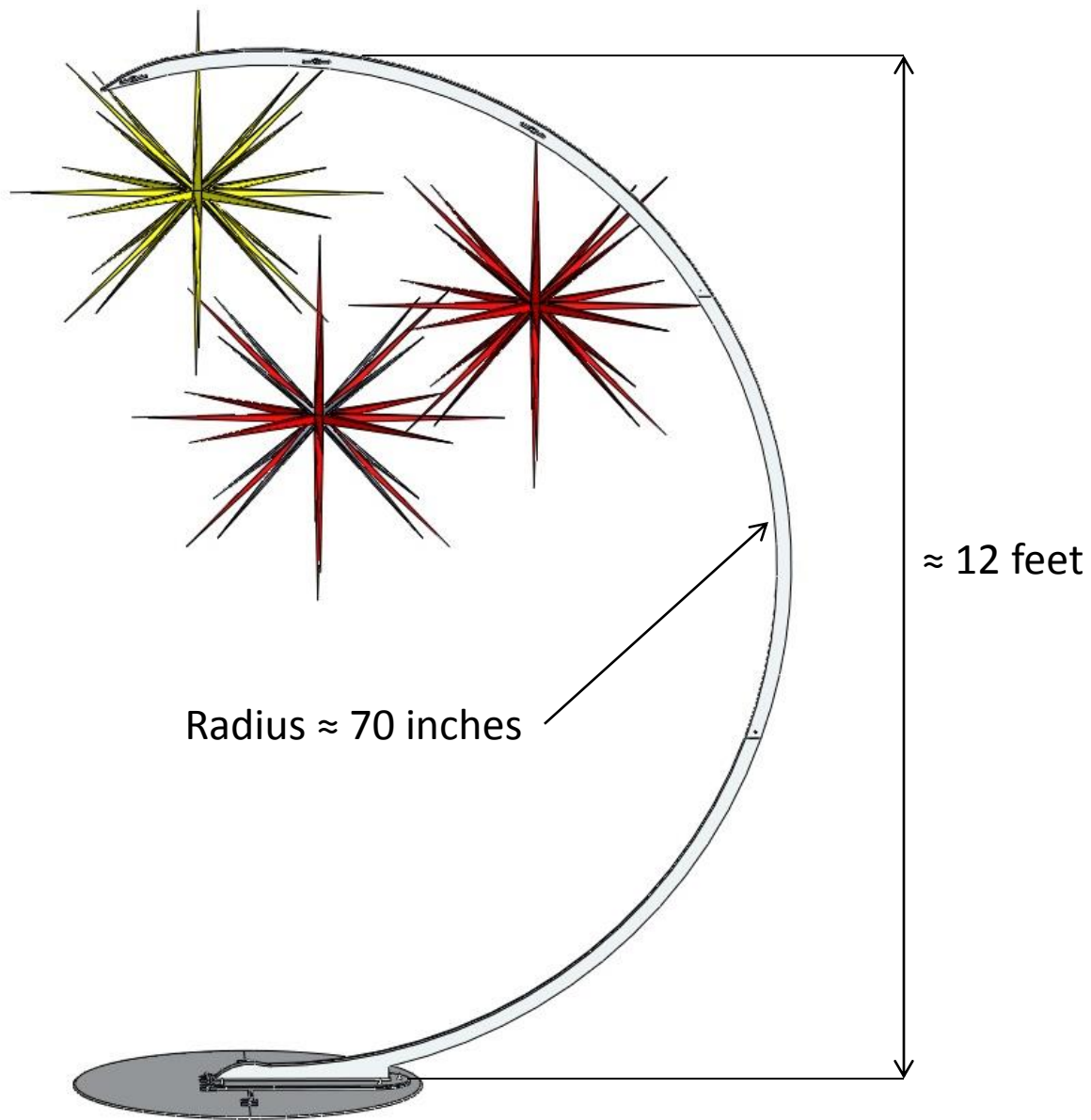
Need: The client did not have an aesthetically pleasing way to display their products when promoting at multiple venues.

Goal: Design and manufacture a display stand which will showcase the client's ornaments in a visually pleasing way to potential customers when marketing.

Design Constraints

- Highest ornament elevated a minimum of 6-8 ft from the stand base
- Can fit in a compact sedan when disassembled
- Ornament(s) must be hung or mounted
- Assembly time cannot exceed 30 minutes
- Stand must support 2 different sized ornaments
 - Medium Size: 2.29 ft diameter, 2.94 lb weight
 - Large Size: 4.27 ft diameter, 7.19 lb weight
- Freestanding
- Lightweight
 - Individual components can be carried by one adult
- Collapsible
- Budget must stay within the low thousands of dollars

Final Design



Public Display



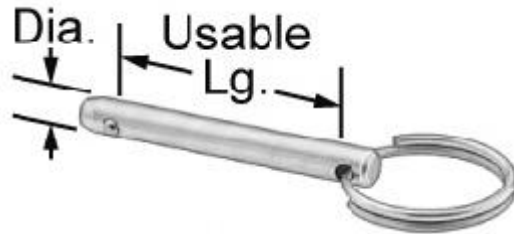
Exploded Views



Dock Cleat

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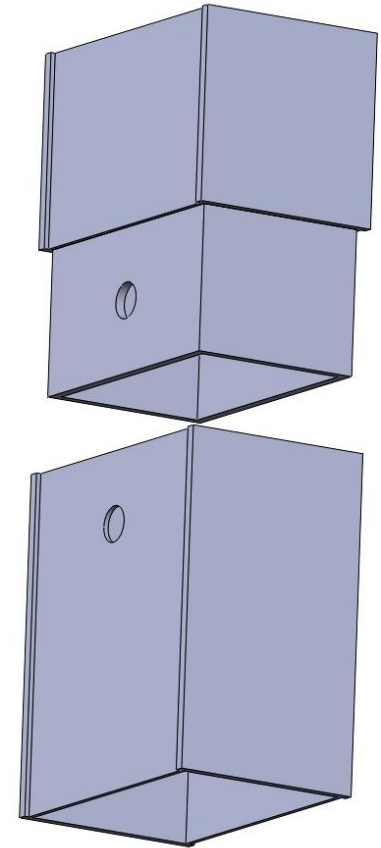
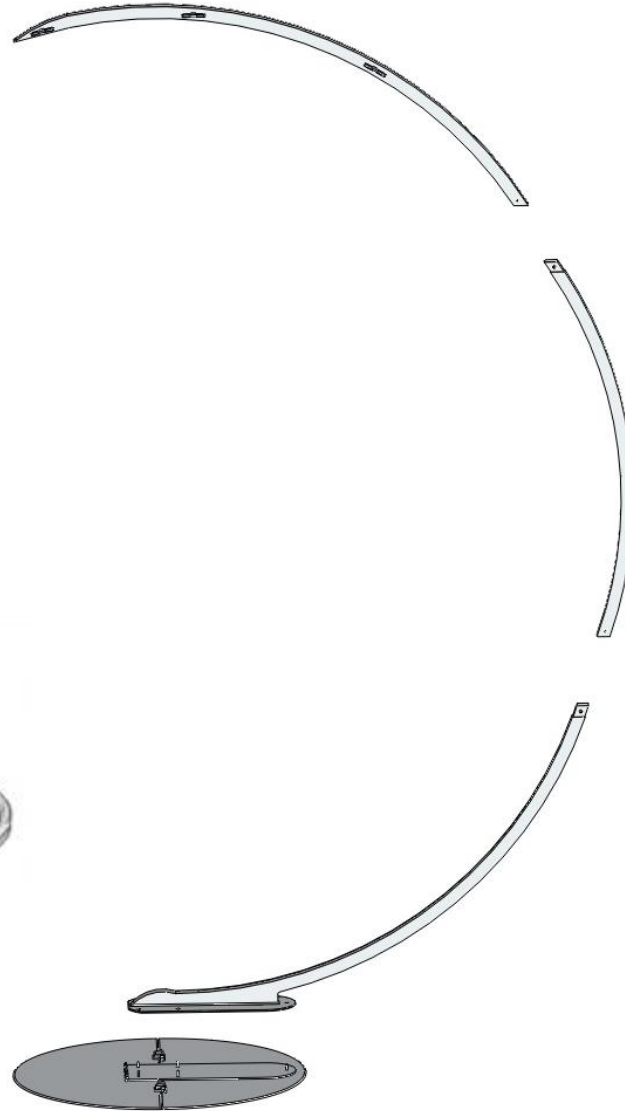
www.mcmastercarr.com/#



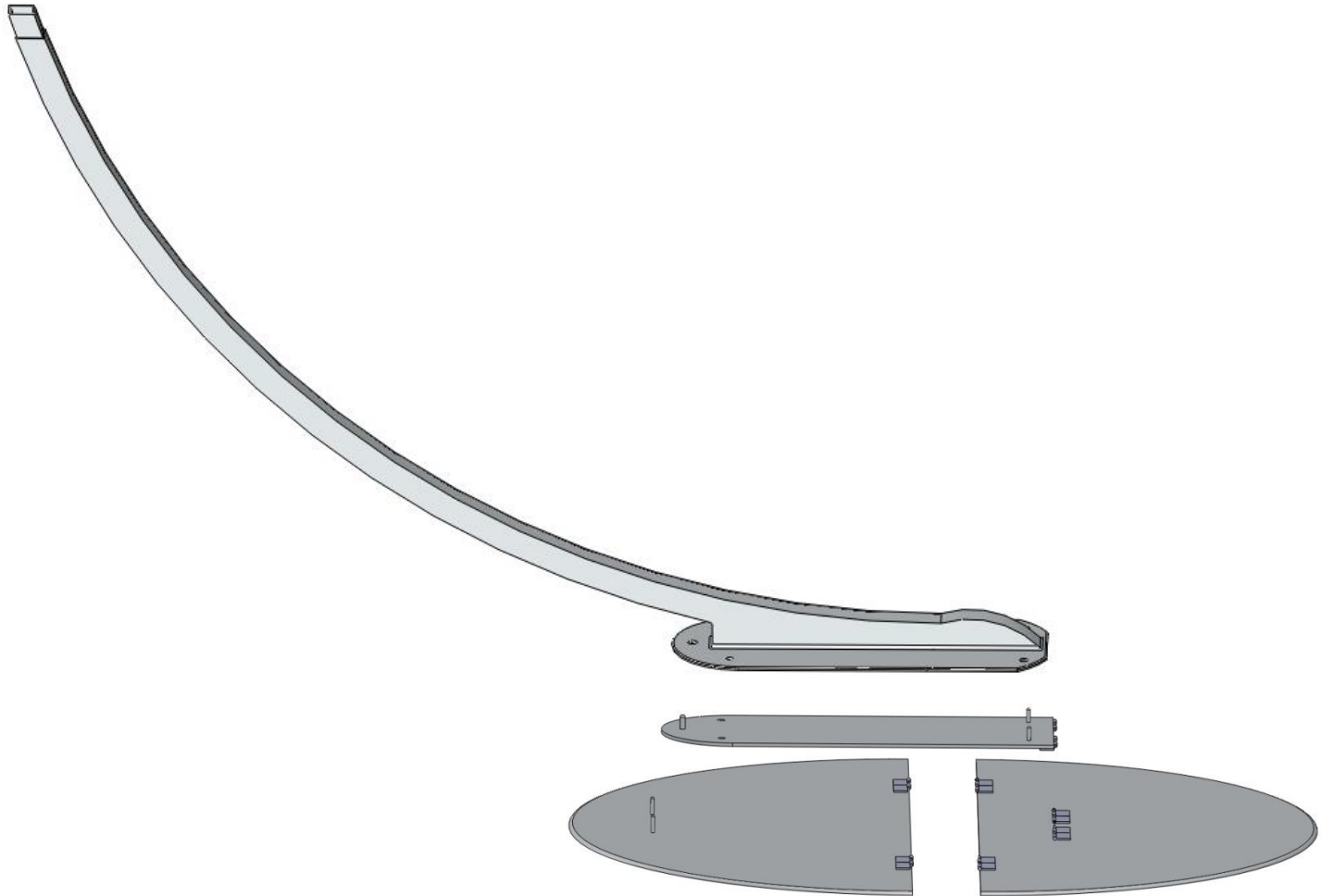
Quick-Release Pin

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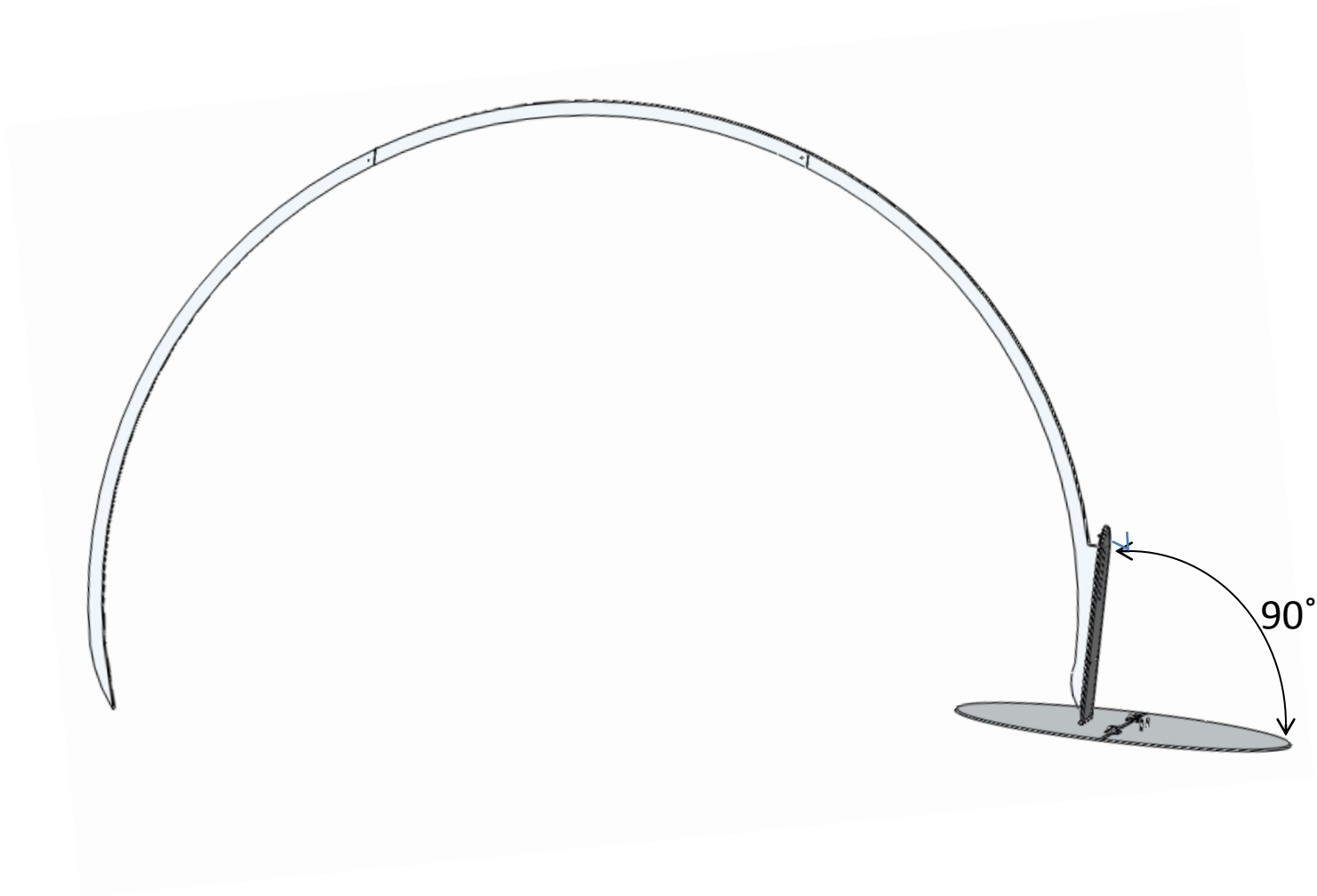
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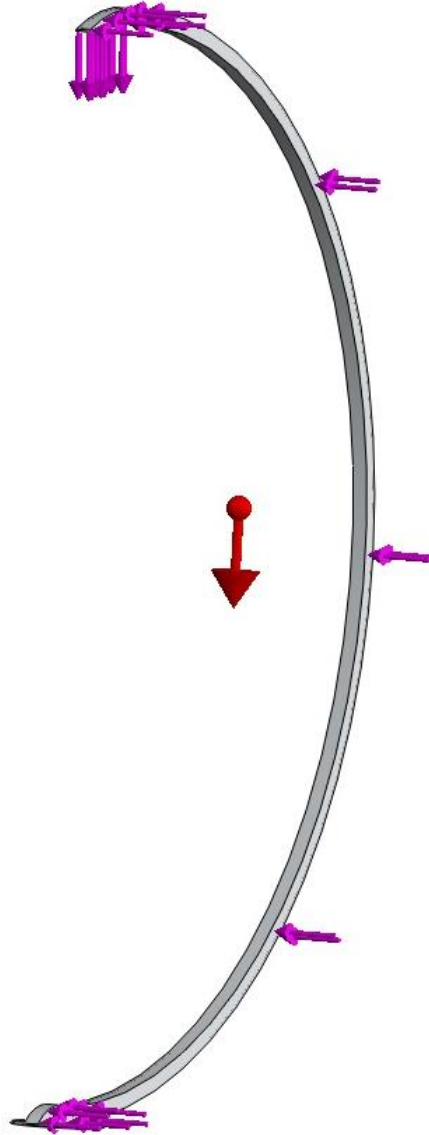
Base & Hinge Plate



Assembly Position



Force Analysis



- Wind Force $\approx 35 \text{ lb}_f$
- Wind Speed $\approx 50 \text{ mph}$ [4]
- Combined weight of 3 largest ornaments $\approx 22 \text{ lb}_f$

The equation used to analyze the wind force is:

$$F_w = A \cdot P \cdot C_d$$

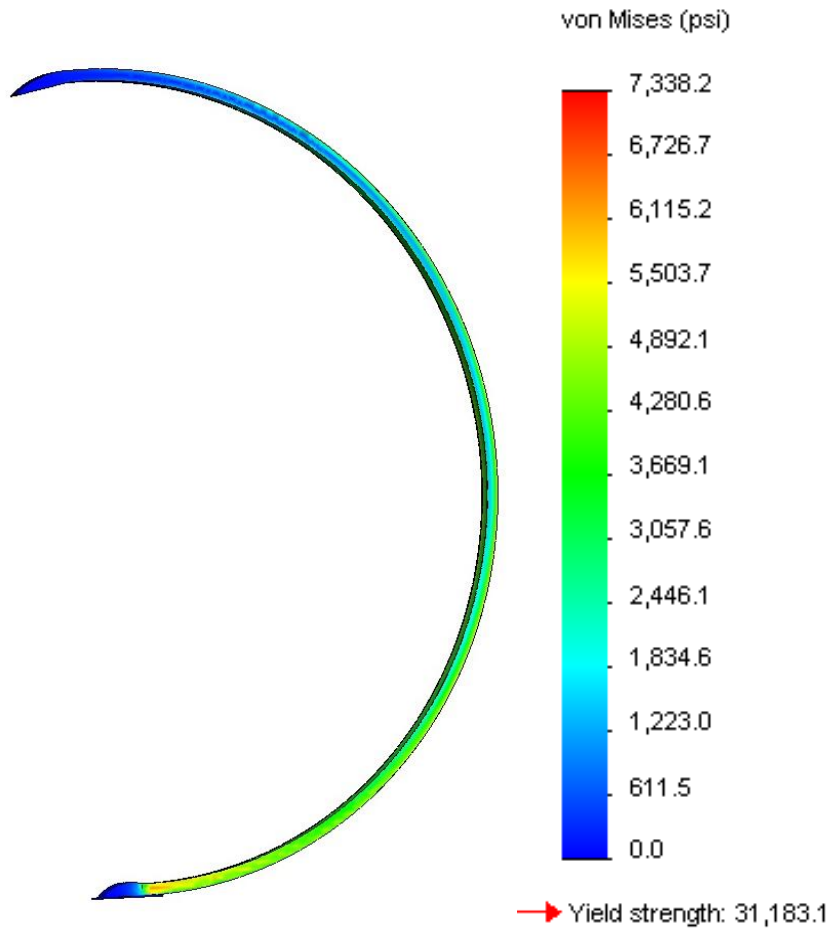
F_w = Wind Force

A = Projected Area
(507 in^2)

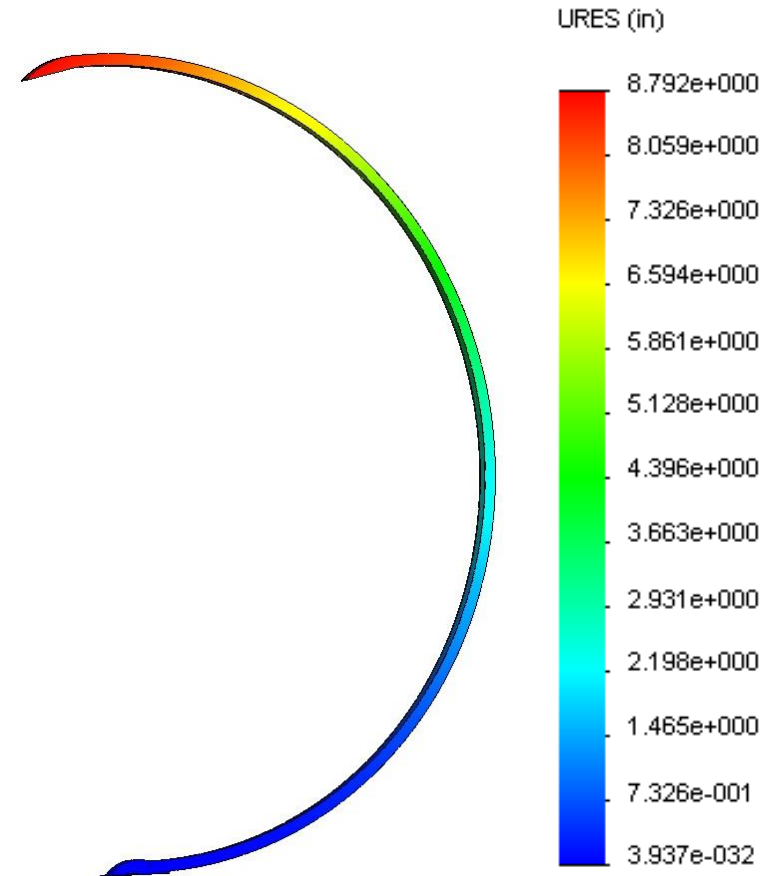
P = Wind Pressure (psi)
($0.004 \times V^2$)($1/12^2$)
(V = wind speed in mph)

C_d = Drag Coefficient
(1.0 for flat plates)

Engineering Analysis

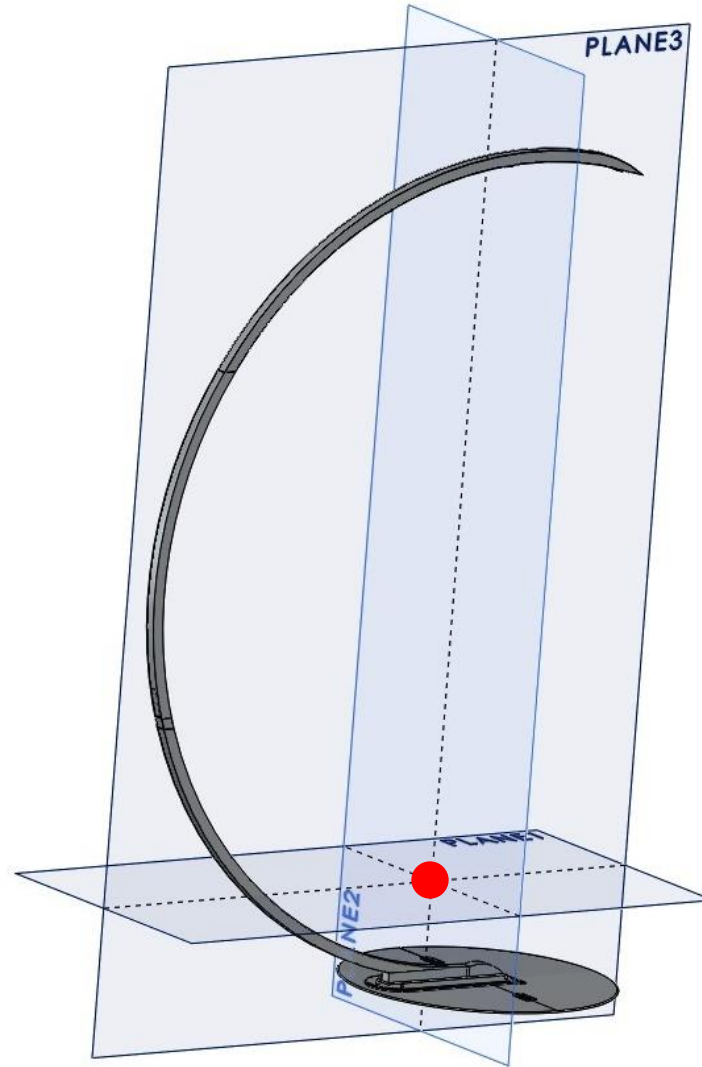


Stress Analysis



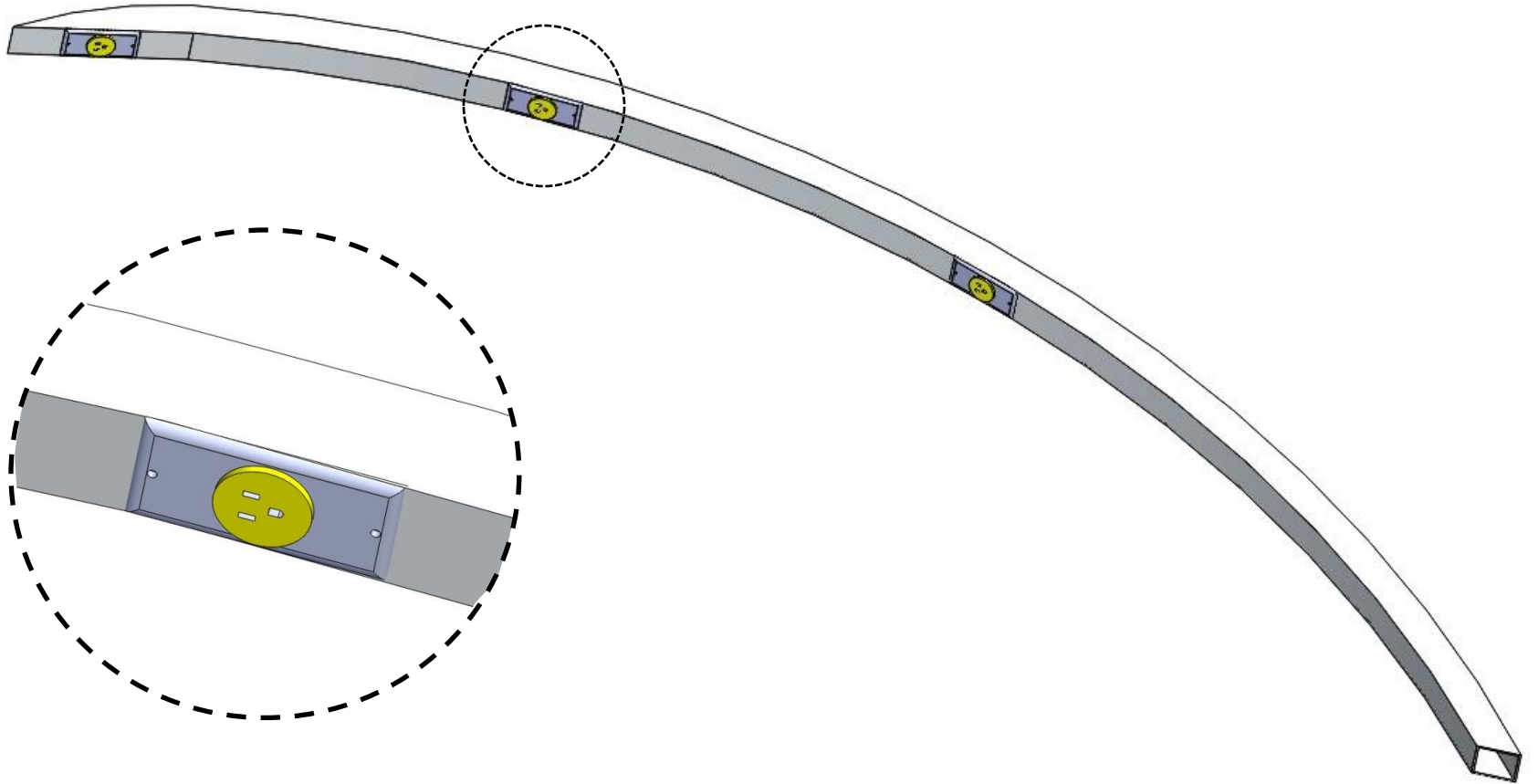
Deflection Analysis

Static Analysis

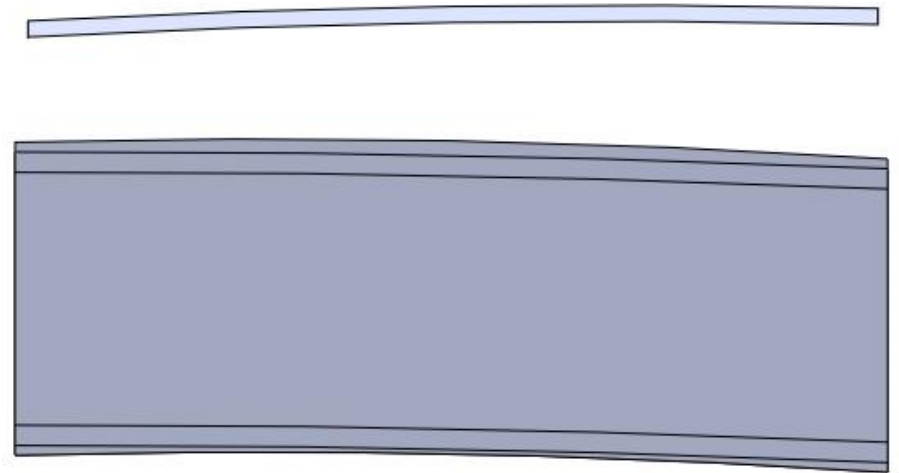
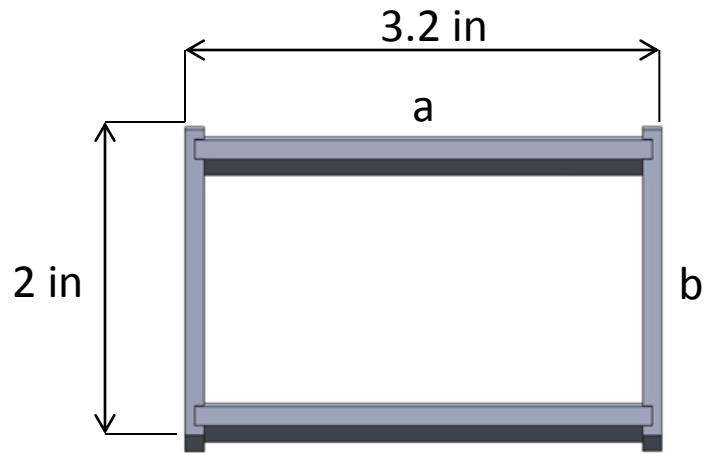


- Red dot represents the center of mass

Design Modifications - Assembly

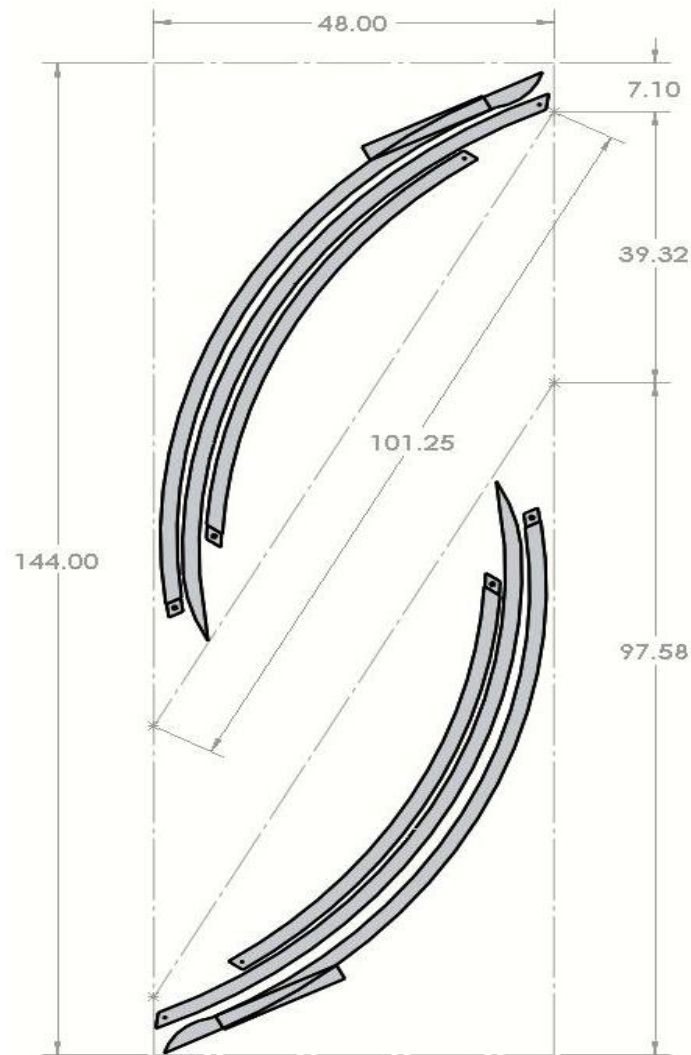


Design Modifications - Manufacturing



Golden Ratio:
 $(a+b)/a = a/b \sim 1.618$

Manufacturing



All dimensions
are in inches

Material: 6061-T6
Aluminum

Cost Analysis

Category	Total Cost	Sales Tax	Shipping	Final Cost	% of Final Cost
Raw Materials	\$652.20	\$60.65	\$65.00	\$777.85	57.8
Hardware	\$282.88	\$22.50	\$19.88	\$325.26	24.2
Adhesives	\$227.67	\$15.16	\$0.00	\$242.83	18.0
			Final Cost	\$1,345.94	

General Public Survey Questions

My Star of Bethlehem

Please circle one:

Visual appearance of the display

1 – Not appealing 2 – Somewhat appealing 3 – Neutral 4 – Appealing 5 – Very appealing

How well the display stand compliments the ornaments

1 – Not well 2 – Somewhat 3 – Neutral 4 – Well 5 – Very Well

Holiday decorative quality

1 – Not festive 2 – Somewhat 3 – Neutral 4 – Festive 5 – Very Festive

This display catches my attention

1 – Does not catch my attention 2 – Somewhat 3 – Neutral 4 – Catches my attention
5 – Demands my attention

Does this display create interest in the ornaments?

1 – No interest 2 – Some interest 3 – Neutral 4 – Moderate interest 5 – Very interested

Would you use the stand during the festive season only or all year around?

1 – Never 2 – Only during Christmas season 3 – On multiple holidays 4 – All year around

If you were to buy a stand, what is the threshold amount of money beyond which you would not consider buying it?

1 – \$500 2 – \$750 3 – \$1000 4 – \$1500 5 – \$2000

General Public Survey Results

Sample size = 43 people

Category	Response of the Majority
Appearance	Appealing
Stand Complemented Ornaments	Very Well
Decorative Quality	Festive
Captures Attention	Catches my attention
Ornament Interest	Created moderate interest
Display Time	All year round
Maximum Purchase Price	\$883.73 (average)



Conclusion

- Client Background
 - My Star of Bethlehem LLC
 - Small online business
 - Based in Sedona, AZ
 - Need
- Design Constraints
 - Height, set up time, portable and lightweight
- Final Design
 - Height ≈ 12 ft, R ≈ 70 in
 - Von Mises stress (7,340 psi) < Y.S. (31,183 psi)
- Manufacturing
 - Prototyping challenges
- Cost Analysis
 - Final costs \approx \$1,346.00
- Public Surveys
 - Positive feedback

References

- [1] Dr. Dieter Otte
Associate Professor of Computer Science
Department of Electrical Engineering/Computer Science
CEFNS at Northern Arizona University

- [2] McMaster-Carr. (n.d.). *Quick-Release Pins*. Retrieved from
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- [3] Andress, K. (2002, March 03). *Wind loads*.
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- [4] Delinger, Dan. (2008, August 20). *Wind- maximum speed- (mph)*.
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- [5] McMaster-Carr. (n.d.). *Rope Cleats*. Retrieved from <http://www.mcmaster.com/#rope-cleats/=mh9yez>

Questions

All dimensions are in inches

