Christmas Ornament Display Structure

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Final Report
Document

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CLIENT BACKGROUND

My Star of Bethlehem LLC is an online business that operates out of Sedona, Arizona selling holiday ornaments that are imported and manufactured in Germany. My Star of Bethlehem LLC did not have an aesthetically pleasing way to showcase their ornaments when marketing at various venues. Presently, when the company is promoting their products they use a square four legged tent with three tables set up underneath in a U-shaped configuration. These holiday ornaments are both displayed on these tables and hung from the tent frame.

INTRODUCTION

Based on the needs of the client, the goal for this project was to design and manufacture a display stand that would display the client's holiday ornaments in a visually appealing way to potential customers. This design provides an effective means to display the client's products at trade shows, private properties, shopping malls, etc. The display stand was designed for promotional applications; however, in the future it may have potential consumer applications depending on the client and customer demand. The constraints for designing this stand were based on the needs of the client which required that the structure be collapsible, lightweight, and easy to both assemble and dissemble. The final design has been modeled in SolidWorks using a stress, deflection and static analysis. The manufacturing and assembly process required several modifications to accommodate the design constraints. The manufacturing process began with one sheet of aluminum which was used to cut the four sides of the hollow tubing that would comprise the arch. The base and hinge plate was cut from 2 aluminum plates. An industrial adhesive was used to secure all 4 sides of the arch creating the final rectangular cross section. Costs for this project stayed within the low thousands of dollars which was within the budget set forth by the client. The final product was presented to the general public in downtown Flagstaff, AZ in order to receive feedback on the aesthetics of the stand with ornaments attached. This feedback was obtained through surveys that were distributed while the stand was fully assembled. The overall response from the general public was positive.

CONSTRAINTS

My Star of Bethlehem LLC had a specific set of design requirements that needed to be accounted for if a display stand was going to successfully highlight the ornaments. The following lists the design constraints which had to be satisfied during the design and manufacturing stages:

- Ornaments need to be elevated a minimum of 6-8 feet above ground.
- Display stand components must be light enough for one adult to carry.
- Ornaments must be hung or mounted.
- Stand assembly time must not exceed 30 minutes.
- Stand must support two different sized ornaments.
  - Medium size: diameter = 2.29 feet, weight = 2.94 pounds
  - Large size: diameter = 4.27 feet, weight = 7.19 pounds
- Structure needs to be free standing.
- Display stand must be collapsible.
- Budget must stay within the low thousands of dollars.

FINAL DESIGN

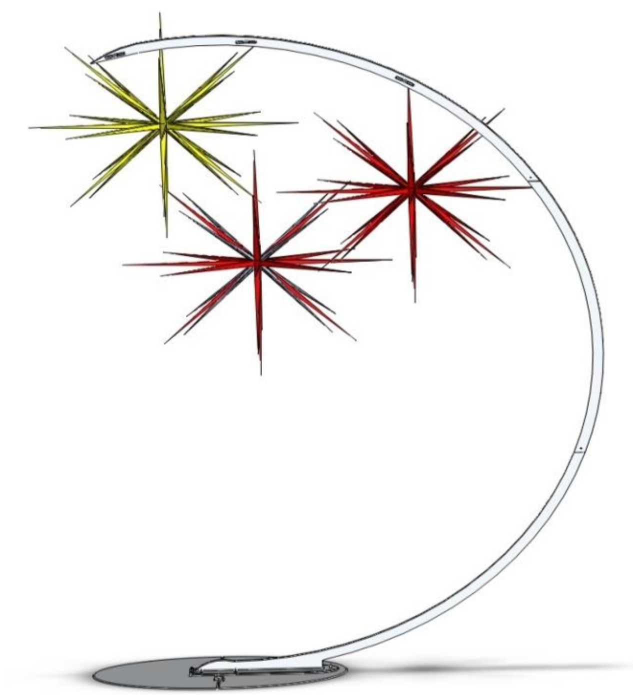

Figure 1: Display stand with 3 largest ornaments shown

Figure 1 illustrates what the final design will look like when fully assembled and with 3 ornaments hanging from it. The star configuration shown above is one of many possible configurations and does not necessarily represent what the final arrangement will be.

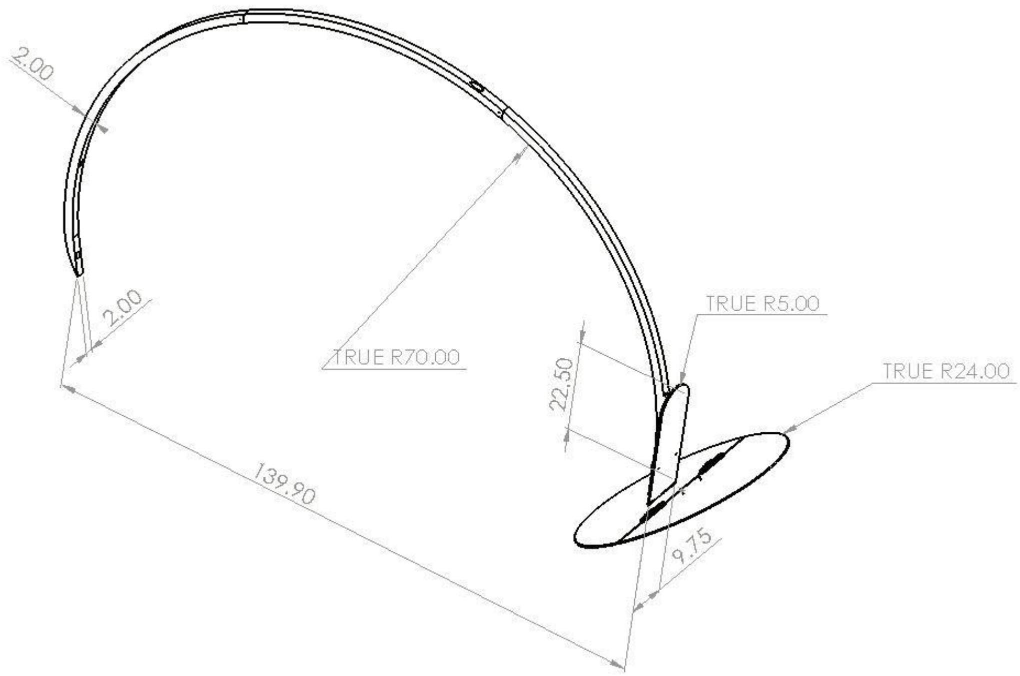

Figure 2: Display stand during arch assembly. All dimensions are in inches

Figure 2 presents the dimensions of the display stand in addition to showing how the arch will function through use of the hinge plate prior to its fully erect state. Several design modifications have been made to enhance the ease of assembly and the long term durability of the structure. These modifications include: relocating the 2 studs in the base to a location further from the hinges on the hinge plate (see Figure 10), installing permanently fixed electrical outlets in the underside of the top arch section and using thin hex nuts called jam nuts to more permanently attach all 5 threaded studs to the aluminum plates in which they are installed. The purpose of moving the 2 studs in the base further back was to decrease the angle at which the hinge plate comes into contact with the studs. By decreasing the angle, the obstruction between the hinge plate and studs is also reduced.

ENGINEERING ANALYSIS

To analyze the display stand, a full-scale model in SolidWorks was designed which was then used to find the mass properties of the entire structure. Through SolidWorks, the center of mass and the moments of inertia were generated which aided in finding the reaction forces at the base. From these forces, the stresses induced in each section of the structure from loading can be found. A static analysis of the structure, was performed which involved summing moments about the base to find the reaction force which counteracts the force induced by the arch. The surface area of the entire curved side of the arch was found by summing the individual areas of all three curved sides of each arch section. This will become important when analyzing the force due to wind on the stand which will be a maximum when the wind is impacting the stand perpendicularly from either of the two parallel sides, assuming that the wind will only impact one side at a time. The structure is divided into four sections and the three arch sections contribute to the reactions at the base relative to the section weight and location with respect to the base. For this analysis, three of the largest ornaments were used and were located at the point furthest away from the base (assuming the worst-case scenario) to approximate the maximum static load that this structure will experience. This type of scenario is not anticipated due to the client's intention of only displaying one of the largest ornaments and two of the medium sized ornaments distributed along the top arch section. The values obtained from the SolidWorks model are listed below.

Some of the assumptions considered for the analysis of this structure were:

- Unidirectional wind flow
- Wind speed will not exceed 50 mph
- Ambient temperature will not exceed 100 ˚F
- No more than three ornaments displayed at any given time
- Uniform thermal expansion due to uniform material thickness and composition
- Force due to wind acting on the base is negligible
- Ornaments modeled as spheres with diameters corresponding to ornament size

<u>Center of mass measured from the center of the base</u>

With x being the horizontal coordinate and considered positive moving towards the curve of the arch in the latitudinal direction, the arch center of mass COM_x location is 11.32 inches away from the center of the base.

With y being the vertical coordinate and considered positive moving longitudinally towards the tip of the arch, the center of mass COM_y location is 17.52 inches above the center of the base.

With z being the depth coordinate and considered positive when pointing away from the arch when the concavity opens to the right side, the center of mass location COM_z is 0.00 inches as it is symmetric about the vertical plane which intersects the arch halfway through the cross section of the tubing.

<u>Top Section of the arch structure</u>

Force due to weight (including the 3 largest ornaments) F_{wt} = 28.5 lb

Distance from the force due to weight to the center of the base D_{fwt} = 63.68 in

Surface area of one side A_{st} = 185.44 in^2

Middle Section of the arch structure

Force due to weight F_{wm} = 4.92 lb
Distance from force due to weight to the center of the base $D_{fwm} = 72.22$ in
Surface area of one side A_{sm} = 129.33 in^2

Bottom section of the arch structure

Force due to weight F_{wb} = 21.12 lb
Distance from force due to weight to the center of the base $D_{fwb} = 70$ in
Surface area of one side A_{sb} = 192.52 in^2

Base of the entire structure

Force due to weight F_{wbase} = 52.49 lb
Diameter of base $D_{base} = 47.75$ in
Surface area of the base bottom A_{base} = 1825.64 in^2

In performing the static analysis of this structure, the weights of the ornaments were assumed to act directly above the center of the base which will not cause a moment. This differs from the concentrated load used during the engineering analysis. Therefore this moment was neglected in Equation 1.1. Summing the moments about the origin located at the center of the base, where clockwise is considered positive, the following equation was obtained:

$$\sum M_o = F_{wt}(D_{fwt}) + F_{wm}(D_{fwm}) + F_{wb}(D_{fwb}) + R_{base}(D_{base}/2) = 0 \qquad (1.1)$$

All of the values in Equation 1.1 are known with the exception of R_{base} which can be found by solving Equation 1.1. R_{base} represents the reaction at the base at the outermost edge located directly behind the extrusion on the base of the arch. This edge will provide the reaction force needed to stabilize the structure and was found to be:

$$R_{base} = 60.9806 \text{ lb}$$

This force resists the tendency of the arch to rotate about the center of the base assuming that the base can withstand the stress induced by this force. If this is true, then the base design is sufficient. This stress was calculated using Equation 1.2:

$$\sigma = \frac{M(y)}{A(e)(r_n - y)} \qquad (1.2)$$

Where:

σ = stress

M = moment

y = distance from the neutral axis to the outer fiber of the cross section

e = distance from the neutral axis to the centroidal axis

A = cross sectional area

r_n = distance from the origin to the neutral axis

Based on this analysis, the material of the stand, 6061-T6 aluminum, is strong enough to withstand the forces it will be subjected to. Therefore, the material selected is sufficient for this application.

Another important engineering analysis that must be considered is one that involves the environmental effects on the structure during use. The effects considered in the analysis are wind, temperature and precipitation. The primary focus of the environmental effects was on the wind forces as the selected material is corrosion resistant. Also, because the structure is composed of the same material throughout, the stresses induced due to fluctuating temperatures were neglected as mentioned in the assumptions.

To analyze the force due to wind, the surface areas of each side of each arch section were considered. The force was approximated assuming a maximum wind speed of 50 mph. This maximum wind speed was found from data provided by the National Oceanic and Atmospheric Administration (NOAA) for Flagstaff, Arizona [4]. This location is assumed to be sufficient for all of Northern Arizona as it is within a 60 mile radius of the primary usage area. The wind force is calculated using Equation 1.3:

$$F_w = A \cdot P \cdot C_d \tag{1.3}$$

Where:

F_w = wind force

A = projected area of object

P = wind pressure

C_d = drag coefficient

To perform this analysis the entire surface area of one grooved side (see Figure 6) for of each of the 3 arch sections must be summed because as the wind will impact the entire surface. Based on this analysis the force was found to be:

$$F_w = 35.23\ lb$$

Where:
C_d = 1.0 for flat plates
P = 0.004*V^2 (V = wind speed in mph) = 0.004*50^2 = 10.0 psf
A = 3.523 ft^2.

The projected area (A) comes from summing the individual surface areas of the curved side for each of the 3 arch sections. These values can be found above in the engineering analysis.

When the forces due to wind are analyzed by summing moments about the base, an equation similar to Equation 1.1 can be implemented to find the reaction force (R_w) necessary to prevent instability. Another analysis was used to find the center of mass for the entire structure with the ornaments attached. Using SolidWorks, the center of mass for the arch with the ornaments was found to be different than the center of the arch without ornaments. With x being the horizontal coordinate and considered positive moving towards the curve of the arch in the latitudinal direction, the location of the center of mass, $\mathrm{COM_{xa}}$, is 27.65 inches away from the center of the base.

With y being the vertical coordinate and considered positive moving longitudinally towards the tip of the arch, the center of mass $\mathrm{COM_{ya}}$ location is 17.81 inches above the center of the base.

To find the distance from the centroid of the arch to the center of the base, Pythagorean's Theorem in Equation 1.4 can be used:

$$D_{ca} = \sqrt{COM_{xa}^2 + COM_{ya}^2} \tag{1.4}$$

Where clockwise is considered positive, Equation 1.5 can be used to solve for R_w.

$$\sum \mathrm{M_o} = \mathrm{F_w}(D_{ca}) + \mathrm{R_w}(\mathrm{D_{base}}/2) = 0 \tag{1.5}$$

Where:
D_{ca} = distance of the centroid of the arch to the center of the base
R_w = reaction force acting at the edge of the base

The reaction force is found to be:

$$R_w = 31.22247\ lb$$

Equation 1.2 can be used to find the stress induced by this force which was used to determine whether or not the material and dimensions selected are sufficient.

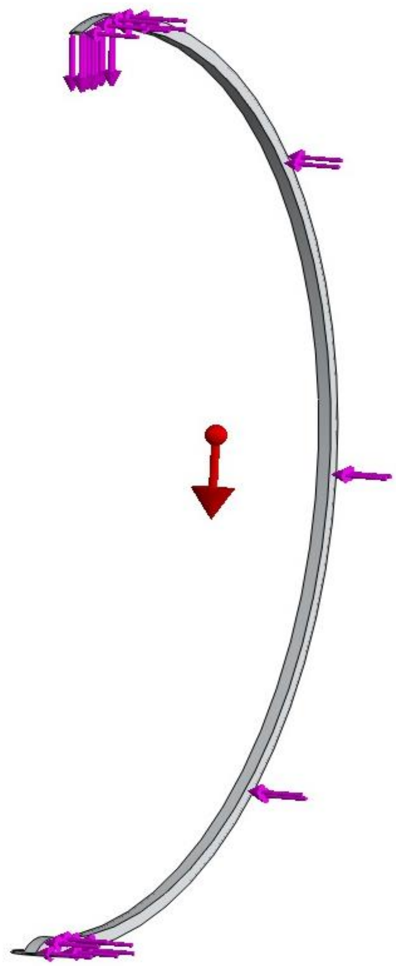

Figure 3: Force analysis using SolidWorks

The total wind force, which was found to be 35.23 pounds, is represented by the horizontal vectors which comes from the value obtained using Equation 1.3 above. The gravitational force is located at the center of mass of the structure and is represented by the red vector in Figure 3. The combined weight of the largest 3 ornaments adds to approximately 22 pounds and was concentrated at the tip of the arch to represent the worst-case scenario. This force configuration was used to generate the following stress and deflection analysis.

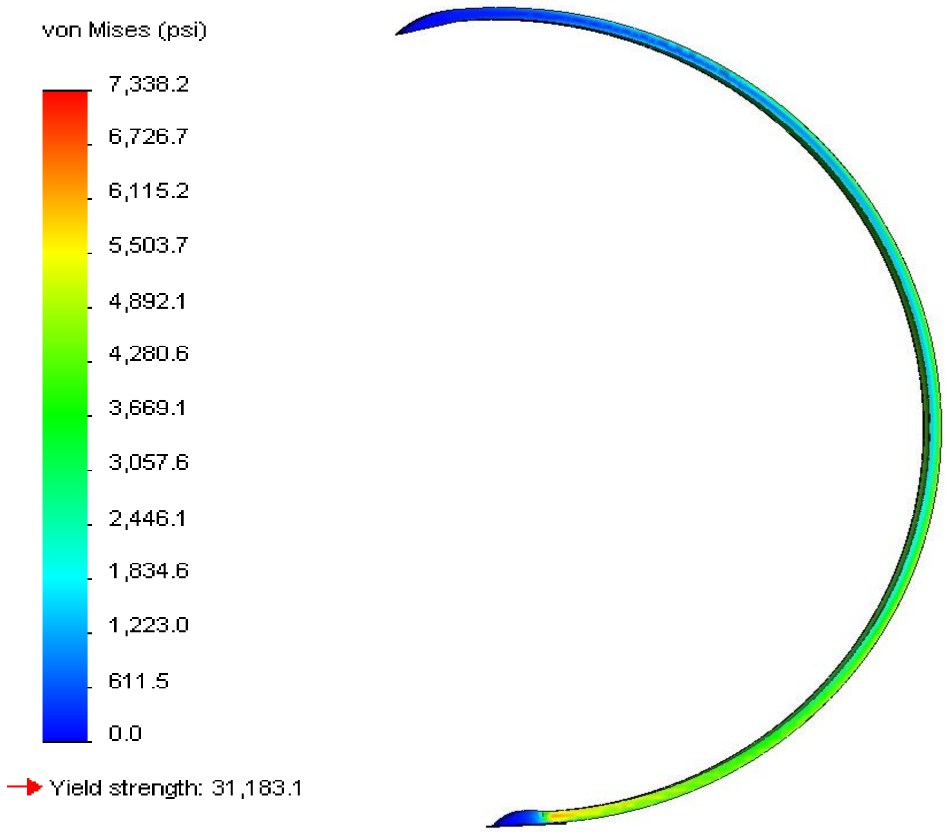

Figure 4: Stress analysis using SolidWorks

The stress analysis in Figure 4 was performed using the Von Mises failure theory. This failure theory accounts for the principal stresses that occur in the x, y, and z coordinate directions. According to the Von Mises failure theory, if the resultant stress obtained from the principal stresses exceeds the yield strength of the material then failure and permanent deformation will occur. Figure 4 shows that the maximum stress will occur at the base of the structure as predicted. The stress is maximized at this point due to the structure being supported at this location only. Stress is minimal at the arch tip because this location does not have the ability to resist deflection as it is not secured. Although the ornaments will hang from the end of the structure furthest from the base, this does not result in stress at that location. Instead, this stress is translated through the arch and results in the stress at the base. The yield strength listed under the legend is well above the maximum stress induced in this structure; therefore, it is appropriate to assume that no permanent deformation will occur and this structure will not fail.

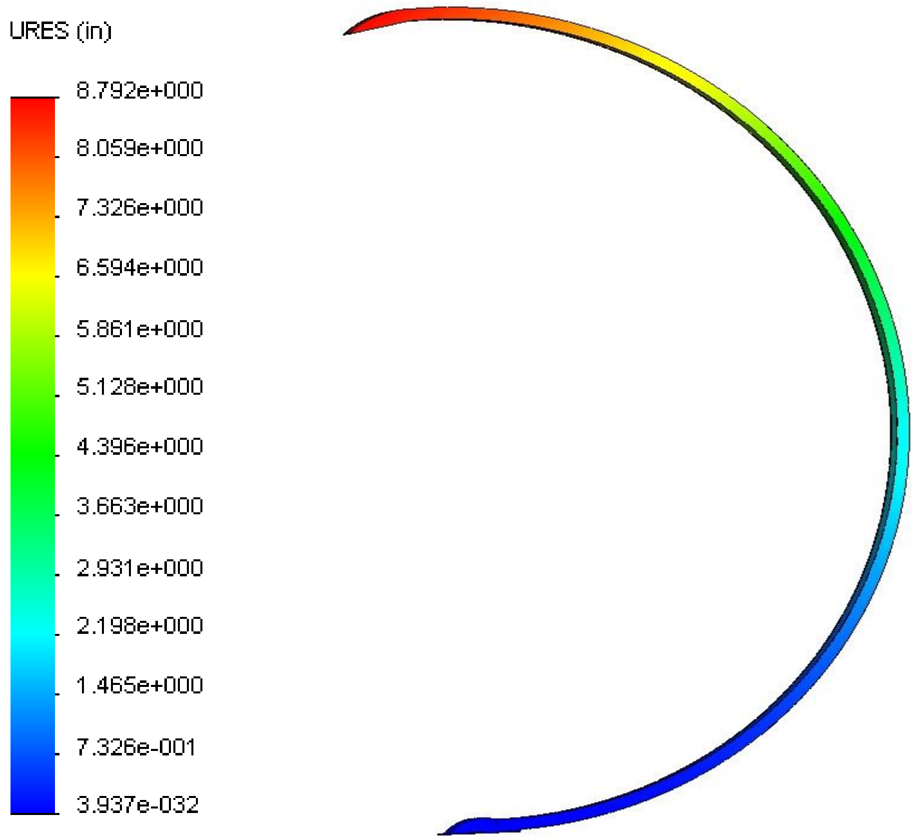

Figure 5: Deflection analysis using SolidWorks

Figure 5 shows that the maximum deflection will occur at the tip of the top arch section. This is expected as it is the location supporting the load of the ornaments and is furthest from the base. The deflection for this structure being close to nine inches may seem excessive; however, the deflection represented in Figure 5 is the resultant deflection for a “worst-case scenario.” The resultant deflection is the deflection in the vertical direction due to the ornament weight in addition to the added deflection from the wind force. This deflection is found by taking the square root of the sum of the two deflections squared individually. Also, when considering that the structure is approximately 140 inches in height, a 9 inch resultant deflection is not very significant. During the testing phase of the final product, it was found that the deflection experienced by the stand was considerably less than predicted.

MANUFACTURING

The initial manufacturing plan was to acquire three lengths of 2 inch x 2 inch square aluminum tubing that had a 1/8 inch thickness. This tubing would be formed into a 70 inch radius. The material was available and fairly inexpensive; however, the manufacturing expense with regard to time and money was substantial. This major expense occurred due to the inability of every local and state machine shop being able to form the square tubing into the desired shape as designed. In response to this major expense it was decided instead to order a 4 foot x 12 foot sheet of 6061-T6 aluminum with a 1/8 inch thickness. From this aluminum sheet, all 4 sides of each arch section could be cut.

The dimensions of the tubing were modified due to a request from the client to have the dimensions correspond to the golden ratio (Equation 1.6), which is believed by some to improve the visual aspects of the structure. These 4 sides were assembled and attached using an industrial adhesive which created a 2 inch x 3.2 inch rectangular aluminum tube which had the desired design shape (see Figure 6).

$$\frac{a+b}{a} = \frac{a}{b} \sim 1.618 \tag{1.6}$$

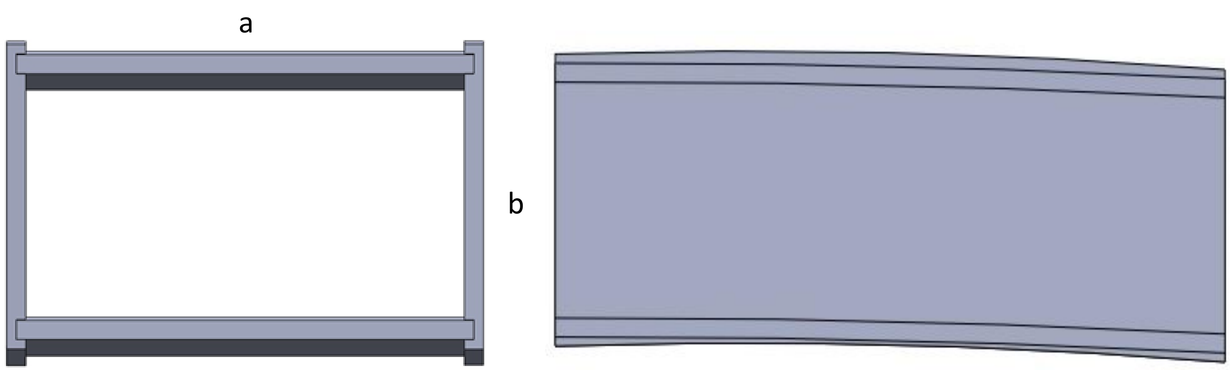

Figure 6: Arch cross section (left) and curved side with grooves (right)

Figure 7 below is a diagram of how the 2 curved sides composing the arch were cut from the aluminum sheet. The material forming the parallelogram in the middle was used to cut the remaining 2 straight sides of the arch which were bent by hand.

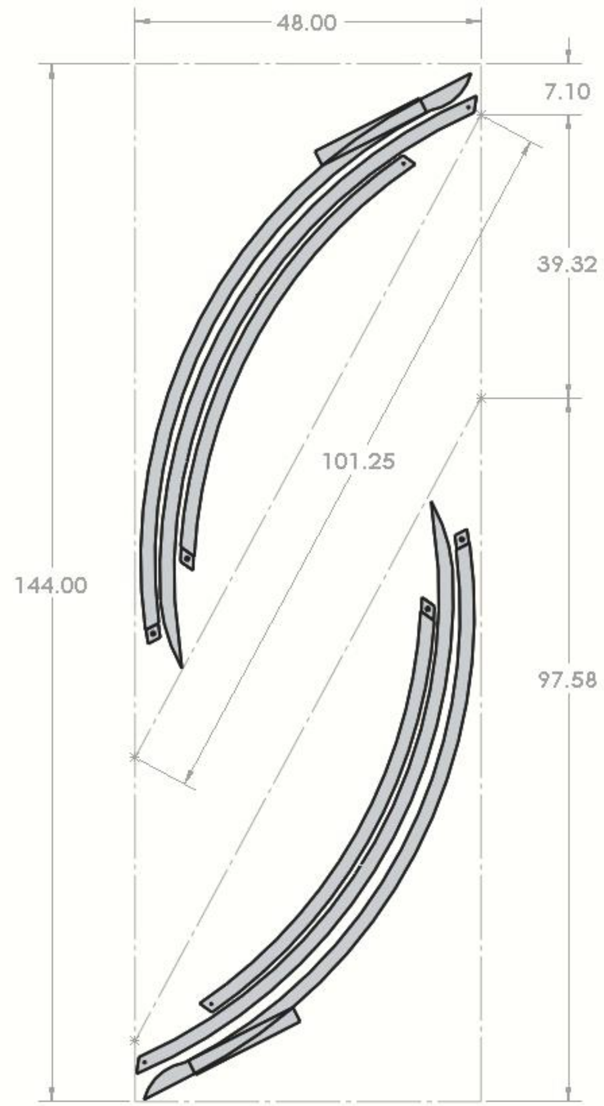

Figure 7: 4 x 12 foot aluminum sheet used for cutting arch sections. Dimensions are in inches

The base was constructed out of two 1/4 inch thick aluminum plates. These plates measured 2 feet x 4 feet and were cut into semicircles with a 2 foot radius. These semicircles were then positioned with their straight edges together. Two hinges were positioned over the seam made by the two semicircles at symmetric distances from either end and fastened with threaded PEM studs. These hinges utilize a quick-release pin which allow the base plates to be carried separately when removed (see Figure 10).

Once the arch sections were constructed, three weather resistant tamper-proof outlets were mounted in the underside of the top arch section which allows the user to plug the ornaments directly into the stand eliminating the need to thread the ornament electrical cords through the tubing. The three outlets are merged and attached to a single electrical cord that is permanently attached to the top section of the arch. When the user plugs this electrical cord into an outlet, the ornaments are illuminated.

Lastly, based on the locations that the client selected for the ornamnets, locations for the dock cleats were determined. To install these dock cleats in the desired locations on either side of the top section of the arch, 12 stainless steel sheet metal screws were used (see Appendix A: Figure 9).

ASSEMBLY

See Appendix D for detailed assembly instructions.

COST ANALYSIS

The final costs for the display stand prototype are shown in Table 1. The analysis accounts for purchases associated with raw materials, hardware and adhesives and only those that were used in manufacturing. It does not accurately reflect the cost of manufacturing as all the construction was done in the campus machine shop free of charge. If this stand were to be mass produced on a large scale, manufacturing costs would be significant as labor and other factors would need to be accounted for. Table 1 illustrates that the majority of the expenses came from purchasing the raw materials needed. Approximately one quarter of the costs went to hardware and the remainder to adhesives. An itemized cost analysis can be found in Appendix B. The project stayed within the low thousands of dollars which was within the budget set by the client. As a result, the client was pleased with the final cost.

Table 1: Final 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 SURVEYING

On the first Friday of April, 2013 the display stand was assembled and set up in Heritage Square of downtown Flagstaff. The client was present along with the designers and manufacturers of the stand. The purpose of this meeting was to distribute surveys to the general public in order to gather feedback related to the display stand. This survey can be found in Appendix C. The types of questions asked and the overall response received from the general public can be found in Table 2. The feedback received from these surveys was generally positive and was similar to the opinions of the client which indicated a successful final product and design. Figure 8 below is an image of the display stand fully assembled with the ornaments illuminated in downtown Flagstaff. This is how the general public viewed the stand as the surveys were being conducted.

Table 2: Results of General Public Survey

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)

Figure 8: General Public Display

CONCLUSION

The client for this project was my Star of Bethlehem LLC, which is a small online business based in Sedona, Arizona selling decorative ornaments that are both imported from and manufactured in Germany. The client requested that a portable display stand be designed and manufactured to highlight their products at various marketing locations. The final design chosen to satisfy this need is able to support 3 of the largest ornaments sold by My Star of Bethlehem LLC, elevates each ornament at least 6 feet above the base, can be assembled in roughly 10 minutes, is portable, and lightweight.

Several modifications needed to be made to the display stand to ensure the best possible product. These modifications included permanently fixing electrical outlets to the top of the arch for easy user assembly, using an industrial adhesive versus welding on the arch to improve the aesthetics of the final product, welding the corners at each end of the middle arch section for added strength at the joints, and lastly, routing grooves in the left and right sides of the arch for ease of manufacturing and aesthetics. Furthermore, 5 jam nuts were affixed to the 5 threaded studs as a precaution to prevent the studs from detaching from the aluminum plates in which they were installed.

For the engineering analysis, a stress, deflection and a static scenario were considered. The stress analysis employed the Von Mises failure theory which combines the 3 principle stresses in the x, y, and z coordinate directions into one equivalent stress. If the equivalent stress is below the yield strength of the material, failure and plastic deformation will not occur. As the stress analysis demonstrated, accounting for wind and ornament loading, the equivalent stress was far below that of the yield stress of the material. This means that failure will not occur in the display stand.

To manufacture the arch itself, a 4 foot x 12 foot sheet of 6061-T6 aluminum was used which provided sufficient material to produce all 4 sides of the arch as well as the male attachment components. Grooves were cut into the 2 curved parallel sides which, along with an industrial grade adhesive, facilitated in the manufacturing. The final rectangular cross section corresponded to the golden ratio which some believe has visually appealing qualities. The base and hinge plate were cut from two ¼ inch 6061-T6 aluminum plates.

In performing a cost analysis at the completion of the project, costs were shown to be within the budget of the low thousands of dollars. All costs were approved which resulted in a final cost that the client found satisfactory. As all manufacturing was able to be done in the campus machine shop, the cost analysis does not accurately reflect the cost of manufacturing. If this display stand were to be manufactured on a large scale, manufacturing costs would be significant.

The assembly stand was set up with illuminated ornaments in downtown Flagstaff in order to conduct some surveys with the general public. This survey can be found in Appendix C. The purpose of these surveys was to get some feedback from the public regarding among other things, how well the stand highlights the ornaments and what the average person was willing to pay for a stand. Overall, the response was positive.

The project was very successful and was completed within the budget set by the client. The client was very pleased with the final product as it exceeded expectations. All of the design requirements were met and through testing, the deflection at the tip of the stand proved to be much less than the deflection analysis showed. Furthermore, the stand has been tested in 35 mph winds without issue.

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APPENDIX A: ADDITIONAL DISPLAY STAND FIGURES

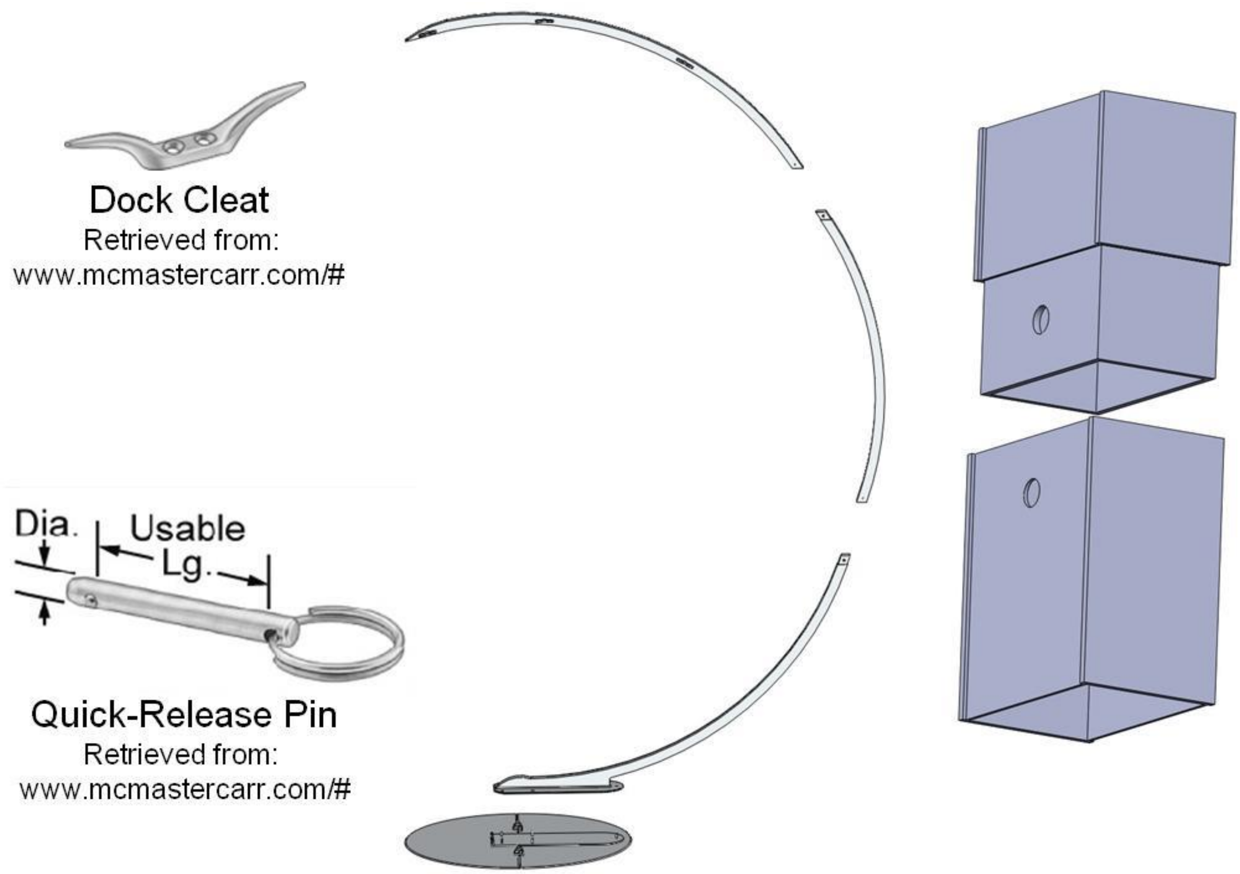


Figure 9: Exploded views of Sideways Arch including quick release pins

Figure 9 illustrates how the various sections of the display stand are assembled. The picture on the far right demonstrates the male and female attachment system that facilitates the assembly of the arch. The quick-release pin seen in the bottom left corner inserts into 2 holes, one on either end of the middle arch section, to secure the arch components after attachment. There are a total of 6 dock cleats featured of the top section of the arch. Although only 3 cleats can be seen in Figure 9, the other 3 are in similar locations offset by approximately 10 inches on the other side. A total of 6 components make up the display stand, 3 in the arch and 3 in the base. The base consists of 2 halves and one hinge plate (see Figure 10).

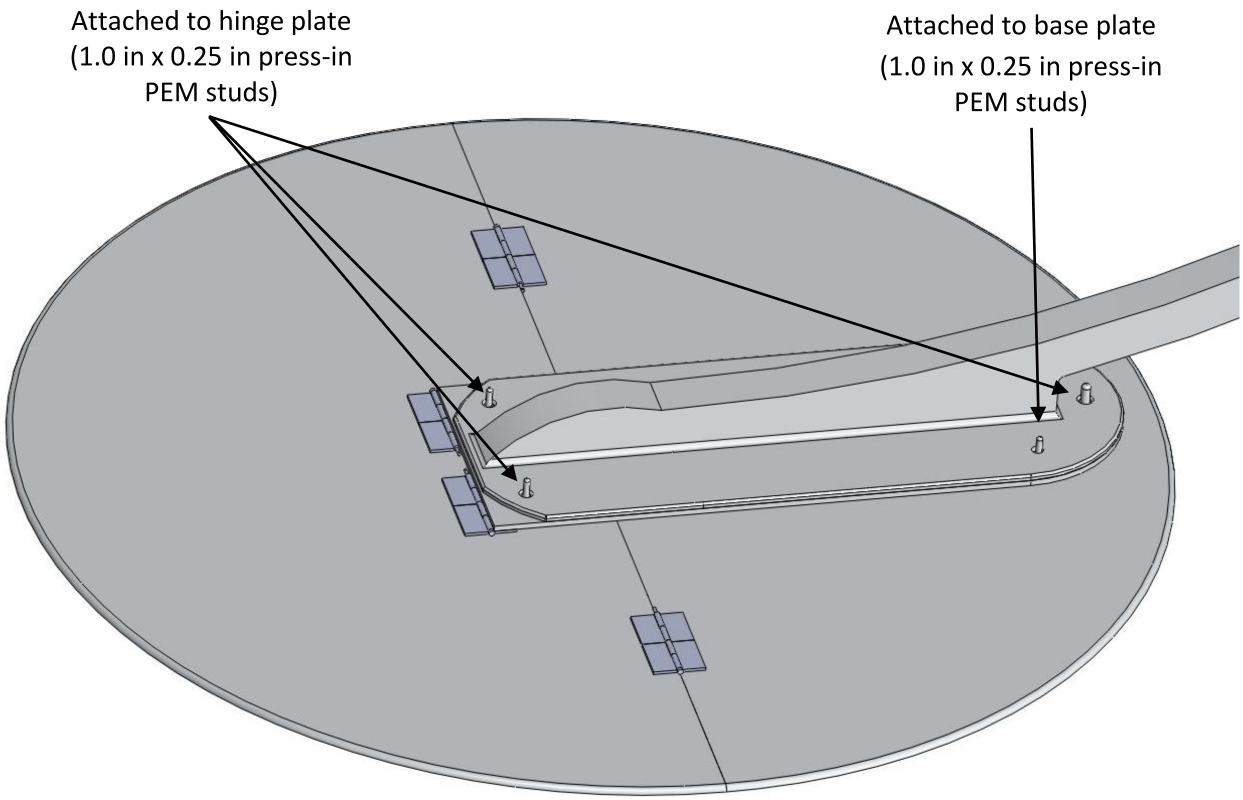


Figure 10: Base with bottom of arch attached to hinge plate

Figure 10 illustrates how the bottom section of the arch will attach to the hinge plate. Three studs, 2 in the front near the hinge and 1 in back, will facilitate the attachment. Another 2 studs in the base near the back of the arch will attach the hinge plate to the base.

APPENDIX B: ITEMIZED COST ANALYSIS

Qty	Item Description	Price (each)	Total Cost
1	6061-T6 Aluminum Sheet	$295.80	$295.80
2	6061-T6 Aluminum Plate	$115.55	$231.10
2	6061-T6 Aluminum Plate	$62.65	$125.30
3	Metal Bonding Epoxy	$52.13	$156.39
2	Metal/Concrete Epoxy	$7.49	$14.98
1	300 mL Dispenser	$41.49	$41.49
5	300 mL Mixing Tip	$2.17	$10.85
2	300 mL Mixing Tip	$1.98	$3.96
4	18-8 Stainless Steel Quick-Release Pin 3/16", 4" Length	$2.32	$9.28
3	18-8 Stainless Steel Press-in Captive Stud 1/4"-20 (pack of 10)	$6.15	$18.45
1	Milwaukee 2-3/4" Wire Brush Cup	$19.97	$19.97
1	2-3/4" Crimp Wire Brush Cup	$5.99	$5.99
1	Diablo 4.5" Flap Disk 80GR	$7.97	$7.97
1	4.5" 60GR Zirconia Flap Disk	$5.59	$5.59
2	4.5" 80GR Zirconia Flap Disk	$5.99	$11.98
2	Diablo 1/8" x 3/8" Router Bit	$17.97	$35.94
1	Wood Dowel 5/8" x 36"	$2.79	$2.79
1	1-1/4" Black Drywall Screws	$4.79	$4.79
2	Straight Router Bit 1/8"	$17.99	$35.98
1	4" Gold Deck Screws	$4.99	$4.99
1	Bolt, Nut, Screw Misc.	$2.10	$2.10
3	Almond NYL Single Outlet	$2.99	$8.97
4	Sheet Metal Screw Zinc 8pk 8x3/4" & 10x1/2"	$1.18	$4.72
1	15A 125V Orange Grip Plug	$4.99	$4.99
25	Wire Black 600V Rubber Yellow Cord 1'	$0.75	$18.75
1	34 Yellow In-Sure 4 Port Connector 10pk	$2.19	$2.19
2	4"x0.045"x5/8" Metal Cut-Off Disk	$1.99	$3.98
2	Assorted Fasteners	$3.79	$7.58
1	Jigsaw Blades 4"	$13.99	$13.99
1	Jigsaw Blades 4"	$8.99	$8.99
7	Wing Style Rope Cleat, Brass, 3/16", 2.5" long	$1.54	$10.78
2	18-8 Stainless Steel Quick-Release Pin 3/8", 2.5" Length	$2.34	$4.68
8	Surface-Mount Lift-Off Hinge with Holes	$3.43	$27.44
Sales tax only applies to purchases made within Arizona		**Sales Tax**	$98.31
		Shipping	$84.88
		Final Cost	$1,345.94

APPENDIX C: GENERAL PUBLIC SURVEY

Survey

My Star of Bethlehem

<u>Please circle one:</u>

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 <u>not</u> consider buying it?

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

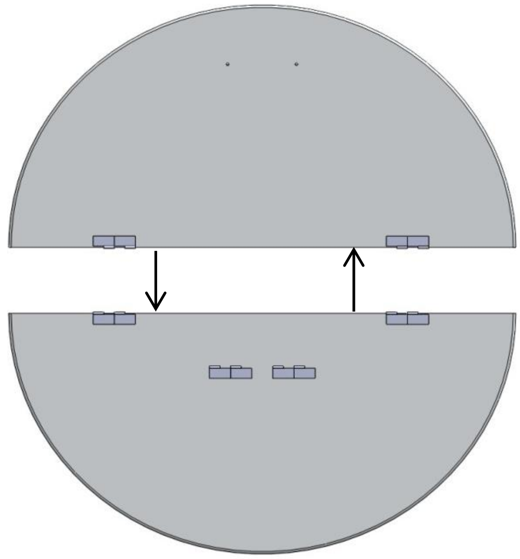
How much significance would you attribute to the fact that it is produced in the US?

1 – It doesn't matter 2 – Some significance 3 – Neutral 4 – Important

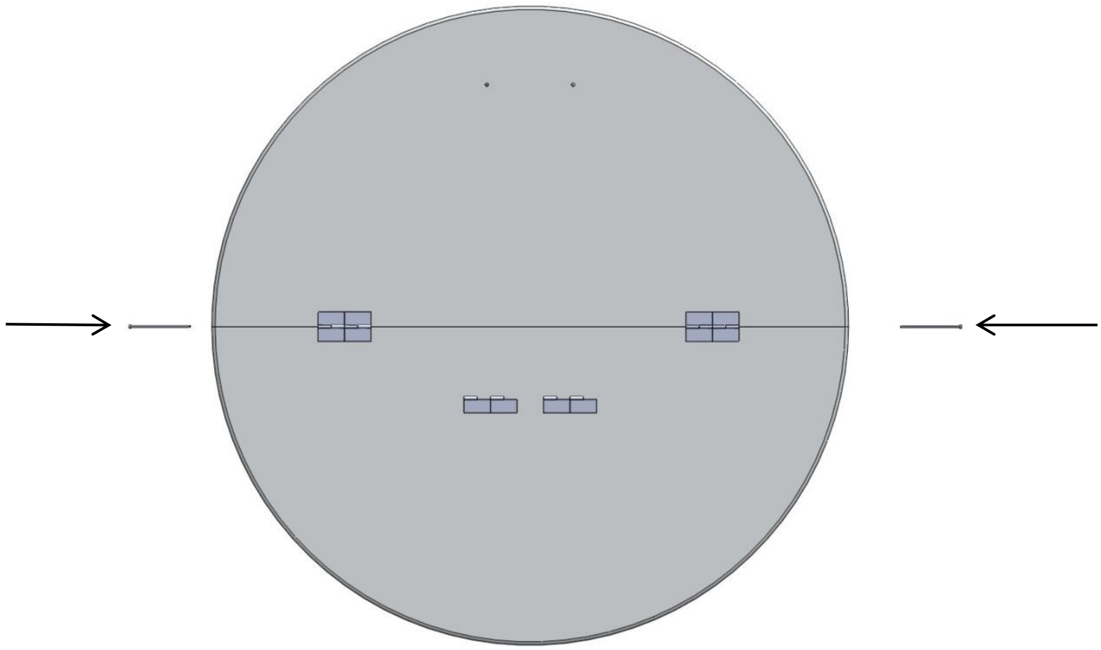
5 – Very important

APPENDIX D: ASSEMBLY INSTRUCTIONS

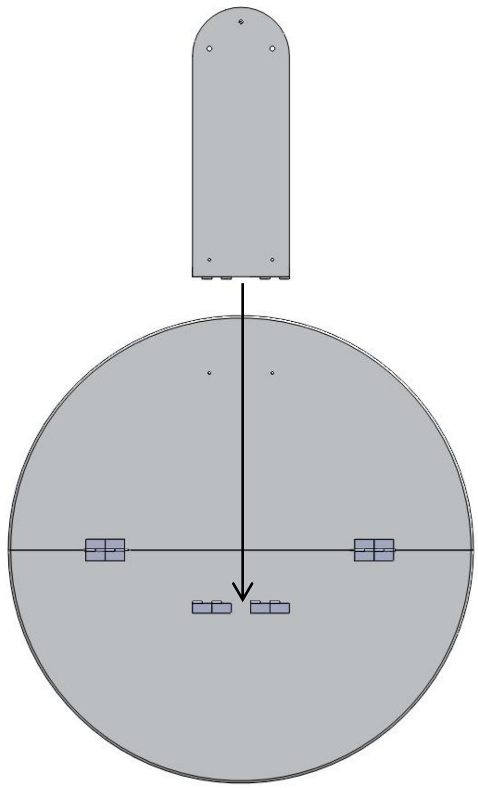
Step 1 - Assemble Base: Take one half of the circular base and lay it flat on the ground. Align this half with the other half of the base so that the hinges mesh together.



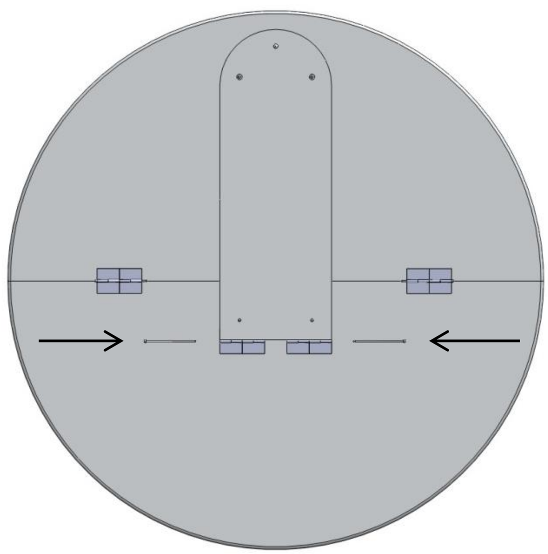
Step 2 – Insert Quick Release Pins into Base: Once both halves are assembled, take two 4 inch long (usable length) quick-release pins and insert them into the base hinges.



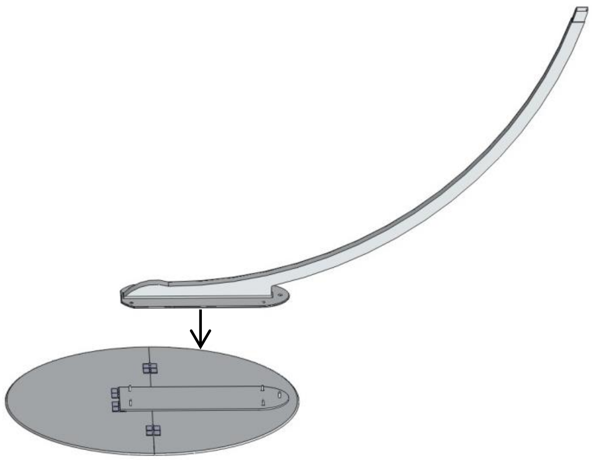
Step 3 - Secure Hinge Plate: Center the hinge plate with the base. Align the hinges attached to the hinge plate with the remaining pair of hinges on the base.

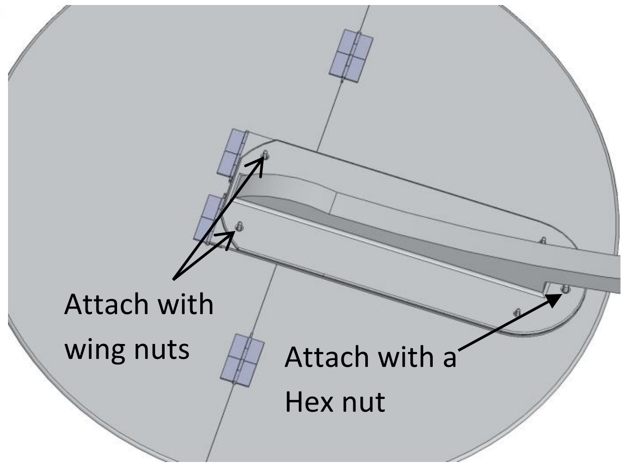


Step 4 – Insert Quick Release Pins for Hinge Plate: Take two 4 inch long (usable length) quick-release pins and insert them into the pair of hinges. After installing the quick release pins, lay the hinge plate back so that it sits flat and parallel with the base. Two threaded studs in the base should protrude through the hinge plate.

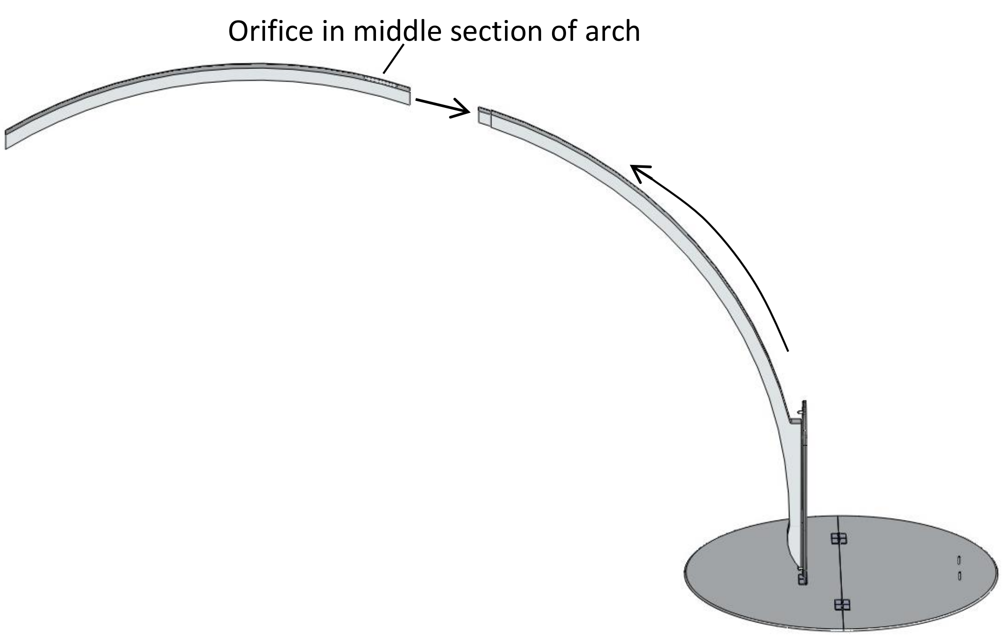


Step 3 – **Attach Bottom Section of Arch:** Take the base of the arch and align it with the corresponding studs mounted in the hinge plate. Secure the bottom section of the arch to the hinge plate by securing 2 wing nuts and 1 hex nut to the 3 threaded studs protruding from the hinge plate.



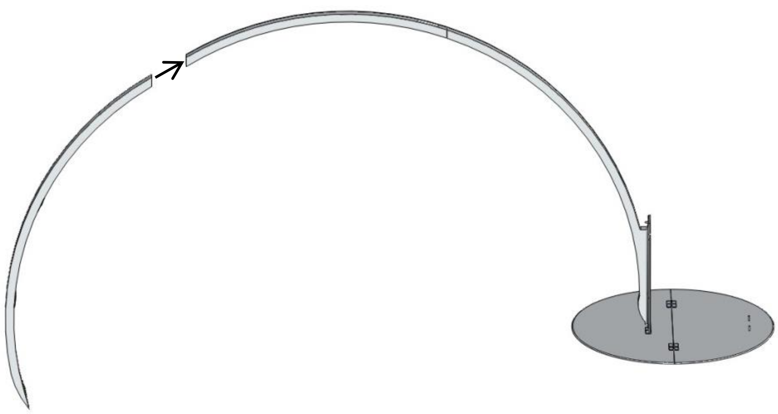


Step 4 –Attaching the Bottom and Middle Arch Sections: Rotate the lower arch section forward as far as the hinge will allow. Attach the middle arch section to the lower arch section by sliding the male attachment of the bottom arch section into the female attachment closest to the orifice in the middle arch section.

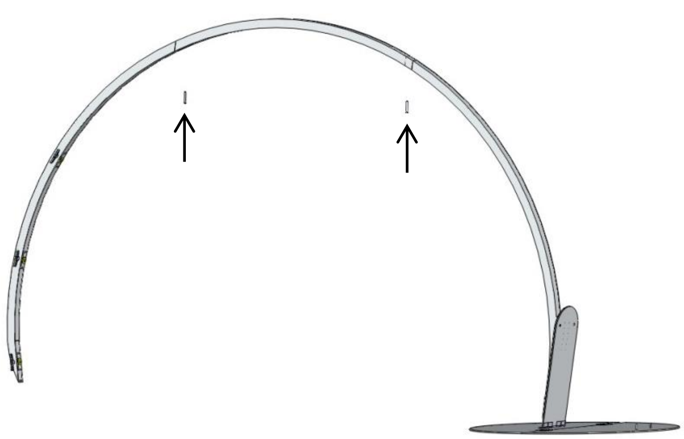


Step 5 - Threading Electrical Cord: The top arch section has a yellow electrical cord extending out of the end that you want to attach to the middle section before attaching the top section to the middle section. Pass the orange plug through the hollow tubing of the middle section. Pass the plug through the middle section until no more cord can be fed through. Once this is done, walk to the office located in the back of the middle arch section. A small chain within reaching distance can be seen. Grasp the small chain and pull it in the direction of the hinge plate. The plug should now be out of the middle section of the stand. Pull as much of the cord length out of the orifice as possible.

Step 6 - Attaching the Top Section to the Middle Section: To attach the top section of the arch to the middle section of the arch, insert the male attachment of the top arch section into the female attachment of the middle arch section.

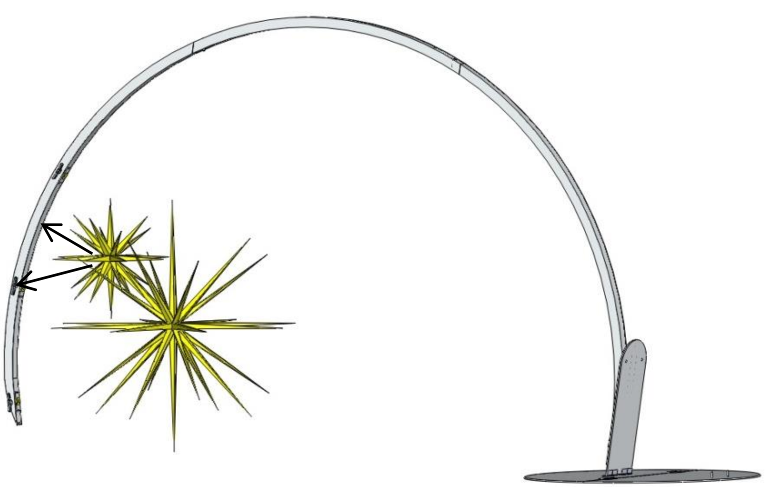


Step 7 - Insert Quick Release Pins into Top and Middle Sections: After the top and middle arch sections are attached, secure these sections by inserting a 2.5 inch quick-release pin (usable length) through the holes located at either end of the middle section. Lower the two attached sections forward until the tip of the top section rests on the ground.



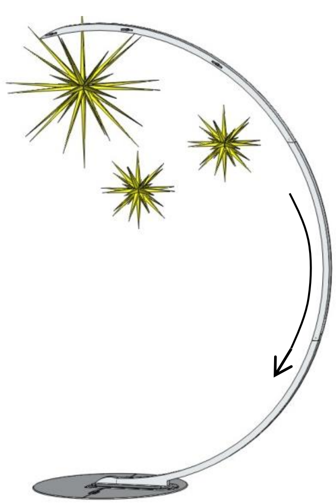
Step 8 – Attach the Largest Ornament: To attach the largest ornament to the top of the stand, place the ornament approximately 1 foot from the tip of the stand so that the ornament is oriented with the electrical cord directed toward the outlet that is closest to the tip of the arch. Using the rope that was provided in the ornament kit, secure the ornament to the stand using the two dock cleats located closest to the arch tip. The ornament can now be plugged into the outlet that is closest to the end of the arch.

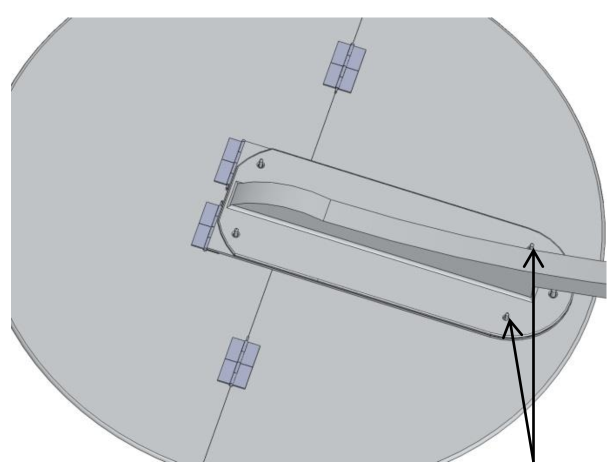
Step 9 – Attach the First Medium Size Ornament: To attach the medium sized ornament to the middle display location, place the ornament in position so that the electrical cord is oriented toward the middle outlet. Use the previously installed ornament to support the medium sized ornament while securing the rope of the medium sized ornament to the dock cleats that are located closest to the middle outlet (repositioning of the largest ornament may be required). Plug the ornament into the middle outlet.



Step 10 – Attach the Final Medium Size Ornament: To attach the final medium size ornament, place the ornament in the desired location so that the electrical cord is oriented toward the outlet furthest from the ground. Plug the ornament into the outlet furthest from the ground; this will assist in maintaining the desired ornament location while attaching the rope to the two dock cleats furthest from the ground.

Step 11 – Rotate the Display Stand into Position: While standing under the middle section of the arch, grasp the arch with both hands above head and push up. The stand should start to move in a rotational motion, walk forward towards the arch so that the stand rotates into position while maintaining a firm grasp on the arch. When capable, stand on the round base to ensure that it does not slide during this operation. Constant force will be required to hold the stand in place until the hinge plate is secured to the base. Once the hinge plate is flat on the base, place one foot on either side of the lower arch section which rests on top of the hinge plate, in a crouched position with feet on either side of the lower arch section, secure the two remaining studs to the arch using two wing nuts.





Step 12 – Illuminating the Ornaments: Take the orange plug located at the end of the yellow electrical cord and plug it into an outlet to illuminate the ornaments.