Christmas Ornament Display Structure

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Team 07

Progress Report

Document

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PROJECT STATEMENT

BACKGROUND

My Star of Bethlehem LLC is a small business founded by Sandy Lochow in October of 2011 that operates out of Sedona, Arizona. Sandy and her husband, Dieter Otte, grew up just a few miles outside of Hernhut, Germany where the original Hernhut Christmas stars were conceived. After relocating to the United States over ten years ago, Sandy decided to bring the stars to America and open up her own store. My Star of Bethlehem LLC sells Christmas ornaments which are both manufactured and imported directly from Germany.

INTRODUCTION

In order to help market these Christmas ornaments, My Star of Bethlehem LLC would like to have a portable display stand designed and manufactured to highlight their products at venues such as store fronts and malls. The structure will display one ornament at a time elevating it at least six to eight feet above the ground. The design needs to be collapsible, light-weight, easy to setup and easy to take down.

NEEDS IDENTIFICATION

The client, My Star of Bethlehem LLC, indicated that they do not have an aesthetically pleasing way to easily display their Christmas ornaments when marketing their products locally. Presently, when the company is promoting their products they use a square four legged tent with three tables setup underneath in a U-shaped configuration. The Christmas stars are both displayed on these tables and hung from the top of the tent frame.

PROJECT GOAL

The goal is to design a better way to display the Christmas ornaments when My Star of Bethlehem LLC is marketing their products to potential customers. This design will provide an effective means to display their products at trade shows, private properties, shopping malls etc. Currently, this display stand is being designed for promotional applications, however; it may also have potential consumer applications depending on cost and other design criteria.

OBJECTIVES

- Inexpensive – It is important that the display stand be affordable and therefore inexpensive so that it is attractive from a sales standpoint and easy to promote.
- Easy to assemble/disassemble – By incorporating into the design an easy assembly, less time will be spent setting up and more time devoted to sales.
- Durability – If the stand material is not strong, it is likely to damage easily and break. The display stand must not damage the Christmas ornament and vice versa.
- No Damage to Star – The more damage incurred to the Christmas star from the display stand, the higher the repair costs are for the consumer. Repair costs should be kept low.
- Recyclable – It would be nice if most or the entire stand is recyclable to both reduce waste and provide the consumer with a portion of the initial investment back if they choose to sell it back to a scrap metal recycler.
- Reliability – A reliable product is easier to market. The less time the customer spends servicing the product, the more time the customer can spend using it. Additionally, more money is kept in the consumer's pocket.

Table 1: Objectives with corresponding measurements and units

Objectives	Basis for Measurement	Units
Durability	Lifespan should be ≥ the ornament	Years (yr)
Will not damage star	Cost to repair a damaged ornament	Dollars ($)
Recyclable	Amount of recyclable materials	Percent (%)
Reliability	Will not require frequent maintenance	Years (yr)
Ease of assembly	Time to assemble	Time (min)
Inexpensive	Cost to consumer stays within $500.00	Dollars ($)

CONSTRAINTS

- Ornament(s) need(s) to be elevated a minimum of six to eight feet above ground.
- Display stand must be light enough for one adult to carry.
  - Each individual component weighs less than 50 pounds.
- Ornament needs to be hung or mounted.
- Stand assembly time must not exceed thirty 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.

FINAL DESIGN

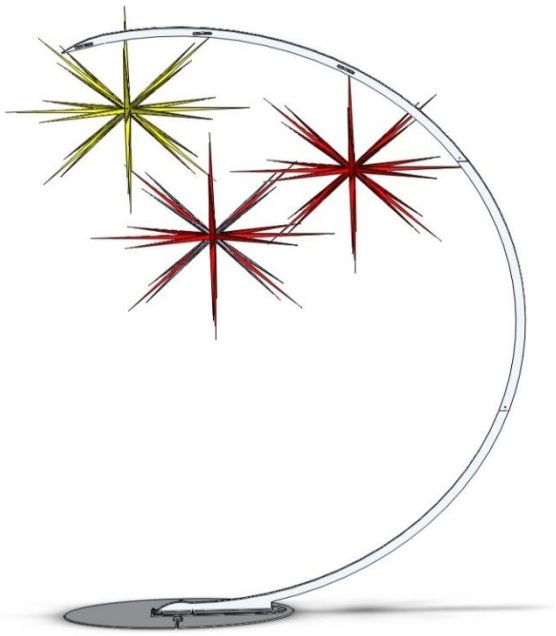

Figure 1: Sideways Arch with the 3 largest ornaments shown

Figure 1 illustrates what the Sideways Arch design will look like when fully assembled and with 3 ornaments hanging from it. No additional design modifications have been made since the last report.

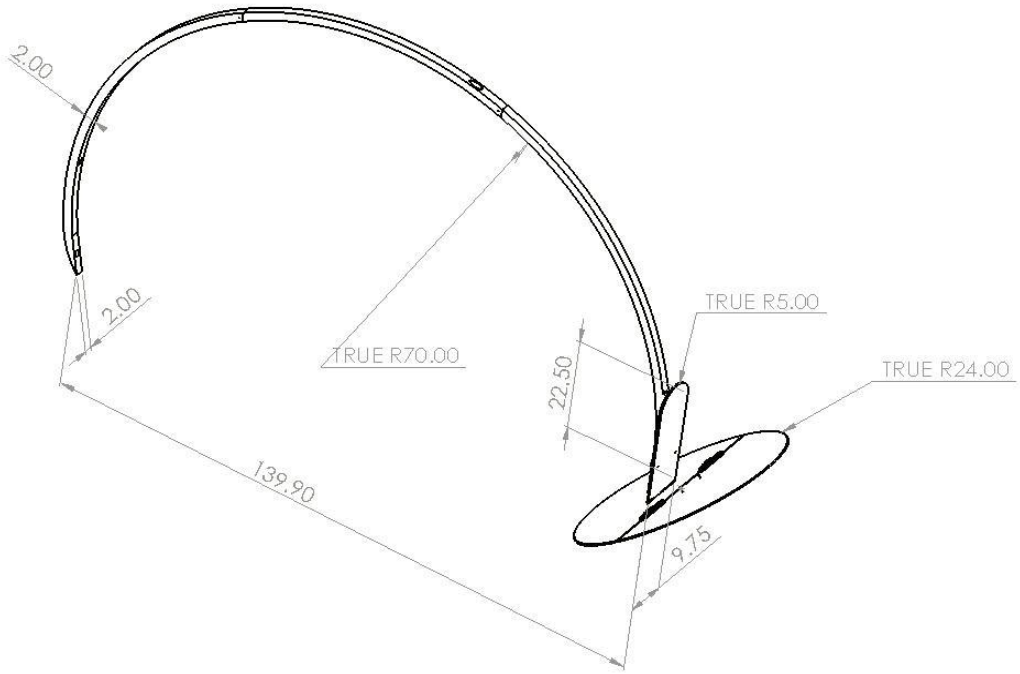

Figure 2: Sideways Arch during arch assembly. Dimensions are in inches

The Sideways Arch design satisfies all the objectives and constraints mentioned previously in the problem statement except for those that will have to be tested after prototyping. The durability and reliability may be difficult to test however in the amount of time available for this project with regards to the stand's lifespan and how frequently maintenance is required. Other objectives and constraints that will require testing in the coming months include assembly time and portability.

Of the objectives that can be tested, the stand is over 90% recyclable which satisfies the objective of recyclability. As far as the display stand being inexpensive, although the goal of the stand costing less than $500.00 was exceeded in raw materials alone, the budget set forth by the client has not been surpassed. The project is still on track to be delivered within the budget of around $1000. With the current dimensions, the display stand will be able to elevate the largest ornament at its highest point around 8 feet measured from the ground to the ornament's base. The other two ornaments will be elevated at least 6 feet which satisfies the first constraint. The second constraint is satisfied because the heaviest component, one half of the base, weighs in at about 22 pounds which is far less than the 50 pound maximum. Using the cleats located at the top section of the arch, all three ornaments will be hung satisfying the third constraint. The current design is able to support 3 of the largest sized ornaments hung at the same time and therefore satisfies the fifth constraint. The last constraint is satisfied because once assembled, the Sideways Arch needs no additional support from any person or structure.

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. 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 bend 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 aluminum with a 1/8 inch thickness from which all 4 sides of each of the 3 arch sections could be cut.

From this aluminum sheet, each of the 4 curved sides composing each of the 3 arch sections will be cut. These 4 sides will be assembled and welded at the corners to create a 2 inch x 2 inch square aluminum tube that has the desired design shape. Figure 3 below is a diagram of how the 4 sides composing the arch will be cut from the sheet.

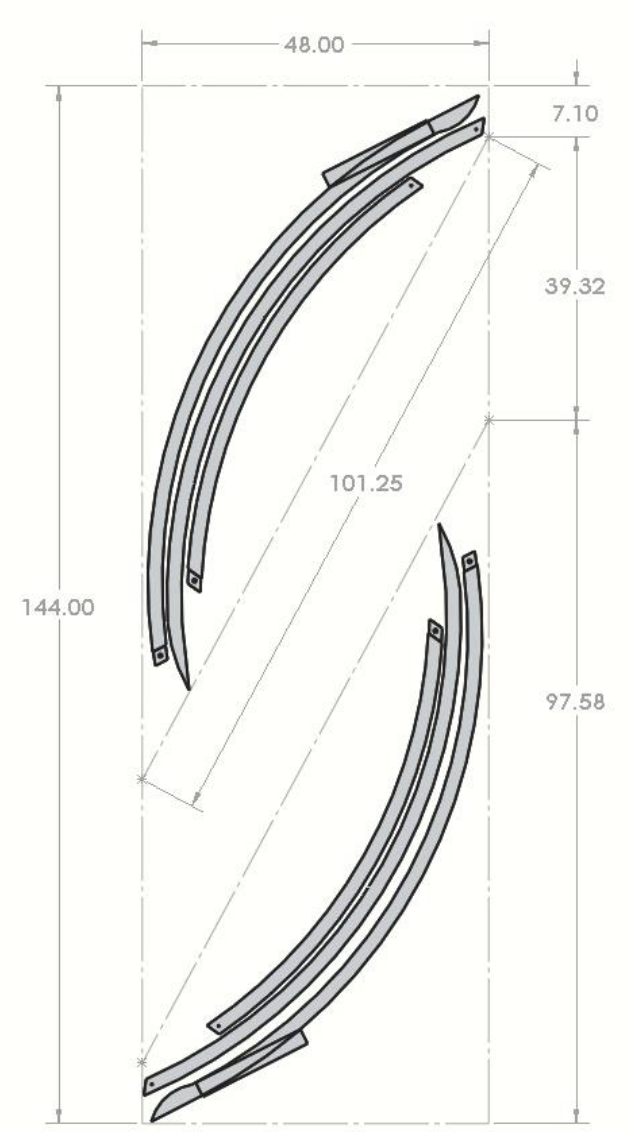

Figure 3: 4 x 12 foot aluminum sheet used for cutting arch sections. Dimensions are in inches

Figure 3 shows the dimensions of the aluminum sheet and 2 of the curved sides composing the arch. The material forming the parallelogram in the middle will be used to cut the remaining 2 sides of the arch.

After the arch sections have been cut from the sheet, they will be set aside for later modifications which will facilitate the interlocking at the 2 joints. See Figure 5 for joint locations. At this time, the base will be constructed out of two 1/4 inch thick aluminum plates. These plates measure 2 feet x 4 feet and will be cut into semicircles with a 2 foot radius. These semicircles will then be positioned with their straight edges together. Two hinges will be placed over the seam made by the two semicircles at either end and welded in place. These hinges will utilize a quick release pin so that once removed, the hinges will separate allowing the base plates to be carried separately.

Once the hinge plate has been attached to the base plate (see Figure 6) by welding hinges in between the two plates and using a quick release pin, the lower arch section can be attached to the hinge plate. The lower arch section will fasten to the hinge plate by means of another plate (arch plate) that has been welded to the bottom of the extruded rectangular portion of the curve (see Figure 6). The arch will then fasten to the hinge plate using 3 PEM studs that have been mounted in the hinge plate. To secure the hinge plate to the base during operation, there will be 2 PEM studs mounted in the base plate that will penetrate through both the hinge plate and the arch plate so that the entire structure can be secured together disabling the hinging capability of the stand.

To secure the interlocking sections of the arch together, a spring loaded locking plunger system will be implemented. Two plungers will be located on opposing sides at each of the 2 joints. The arch sections will feature mating male and female parts with regard to their attaching sections. These female attachments will be created by leaving an open end within the aluminum tubing for the male component to mate with. To create the male attachment, 8 curved 3 inch long x 1 ¾ inch wide pieces of aluminum will be cut from the sheet seen in Figure 3 and welded in place on the inside of each of the tubing walls leaving an 1/8 inch gap on either side.

Once the bottom section of the arch is attached to the hinge plate and the hinge plate attached to the base, the next step is to assemble the remaining 2 sections of the arch. After the remaining sections are in place, there will be a mock presentation of the stand with some proposed ornament configurations which will be voted on and selected by the client. Once the ornament configuration is selected, holes will be made in the underside of the top arch section to facilitate the threading of the electrical cords through the hollow tubing. Depending on where the client wants to retrieve the end of the cord with the plug, a location for a retrieval opening can be determined.

After the locations of the holes for the electrical connections have been determined, two cleats will be mounted on either side of these holes (see Figure 1). These cleats will be used to hang and stabilize the ornaments while on display. Tapered sheet metal screws will be used to secure the cleats in place.

COST ANALYSIS

The overall cost for the first prototype is shown below in Table 2. Although the display stand will still be made out of aluminum, the grades of aluminum have changed since the last report. Instead of 6063-T52 and 3003-H14 the entire stand will now be made of 6061-T6 aluminum. This was done for one primary reason, to simplify the welding process. Because the prototype involves so much welding, having the same grade of aluminum throughout ensures that each aluminum component has the same material properties and thus the same melting point.

The bottom section of Table 2 contains the hardware that will be used with the exception of nuts and or washers which will contribute a negligible cost. Manufacturing costs are not listed here as they are anticipated to be approximately zero. The type of manufacturing required for this stand can be done in the campus machine shop. For this reason, no outsourcing should be necessary. As a result, the final cost reflected below is an estimate for manufacturing the first prototype.

Table 2: Cost estimate for prototype

Qty	Item Description	Size (w x t)	Length	Price (each)	Total Cost
1	6061-T6 Aluminum Sheet	48 x 0.13	144	$295.80	$295.80
2	6061-T6 Aluminum Plate	24 x 0.25	48	$115.55	$231.10
2	6061-T6 Aluminum Plate	12 x 0.25	24	$62.65	$125.30
		Size (D)			
4	18-8 Stainless Steel Quick-Release Pin	0.19	3	$2.18	$8.72
4	Retractable Captive Panel Plunger Press in	0.25 (pin)	0.75	$4.12	$16.48
6	Surface-Mount Lift-Off Hinge without holes	0.19 (pin)	2	$3.56	$21.36
6	Rope Cleat Wing Style	0.25 (rope)	3.5	$0.92	$5.52
1	Press-In Captive Stud 18-8 Stainless Steel (Pack of 10)	0.25	1.5	$9.26	$9.26
				Sales Tax	$60.65
				Shipping	$73.50
				Final Cost	$847.69

All dimensions are in inches

w = width, t = thickness, D = diameter

Sales tax only applies to products bought in Arizona

PROJECT PLAN

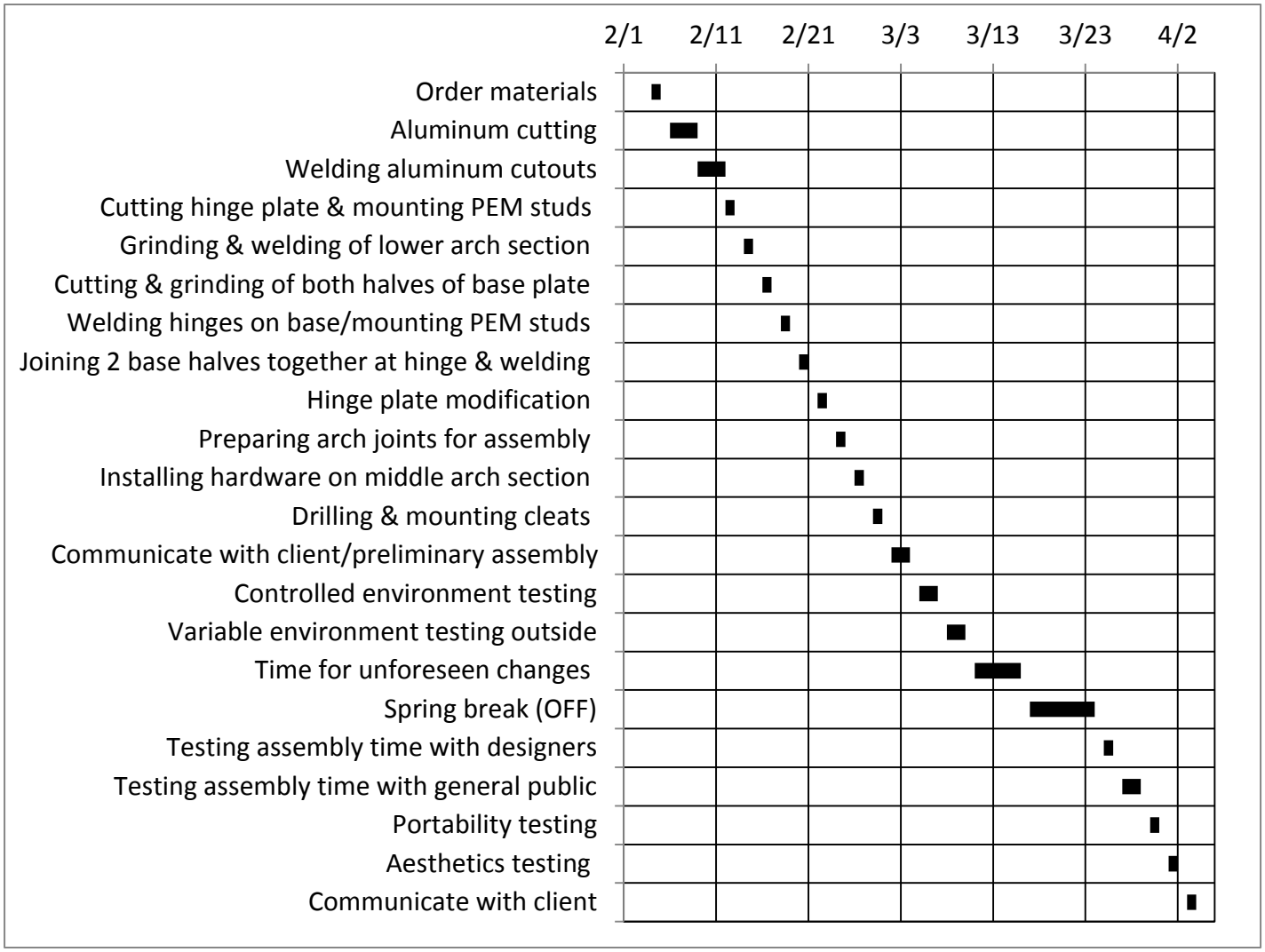

Figure 4: Project timeline for spring 2012

Figure 4 highlights the tasks associated with manufacturing and testing that will be completed this semester. Materials are scheduled to be ordered this Monday, February 4th with manufacturing scheduled to begin shortly after. Almost a week's time has been reserved before spring break to address any unforeseen issues that may arise in the manufacturing process. This time also ensures that the project stays on schedule in case certain tasks take longer than expected. Currently, the prototyping phase is scheduled to finished 2 weeks prior to spring break while the testing phase should be complete by the beginning of April.

CONCLUSION

My Star of Bethlehem LLC does not have an aesthetically pleasing way to display their Christmas ornaments to potential customers while marketing and is requesting a display stand to assist in showcasing their ornaments. The goal for this project is to design an effective and visually appealing way to display the Christmas ornaments at marketing locations. The client's requirements were to have a portable, collapsible, light-weight, easy to setup and easy to take down display stand. The final design for the aluminum display stand will consist of three arch sections and two halved base plates at the bottom hinged together. The stand will be light weight and easy to assemble due to its thin tubing and multiple sections. A hinge plate at the base of the arch will assist in assembly. The display stand no longer utilizes square aluminum tubing but rather incorporates cutting each arch section out of aluminum sheet metal. Cutting the aluminum out of sheet metal versus bending has simplified the manufacturing process. This change resulted because the resources were not available to bend square tubing thus making manufacturing for the previous design impossible. The final design satisfies the constraints for this project except those that require testing and has come in under budget. The project timeline will be followed closely to ensure that the manufacturing and testing of the prototype is completed in a timely manner.

REFERENCES

[1] Industrial Metal Supply Co. (2010). *Industrial Metal Supply Co.* Retrieved from http://www.industrialmetalsupply.com/

[2] McMaster-Carr. (n.d.). *McMaster-Carr.* Retrieved from http://www.mcmaster.com/#

[3] Otte, Dieter. (2012). *My Star of Bethlehem; The Star That Keeps on Giving*. Retrieved from http://mystarofbethlehem.com/

APPENDIX: ADDITIONAL DISPLAY STAND FIGURES

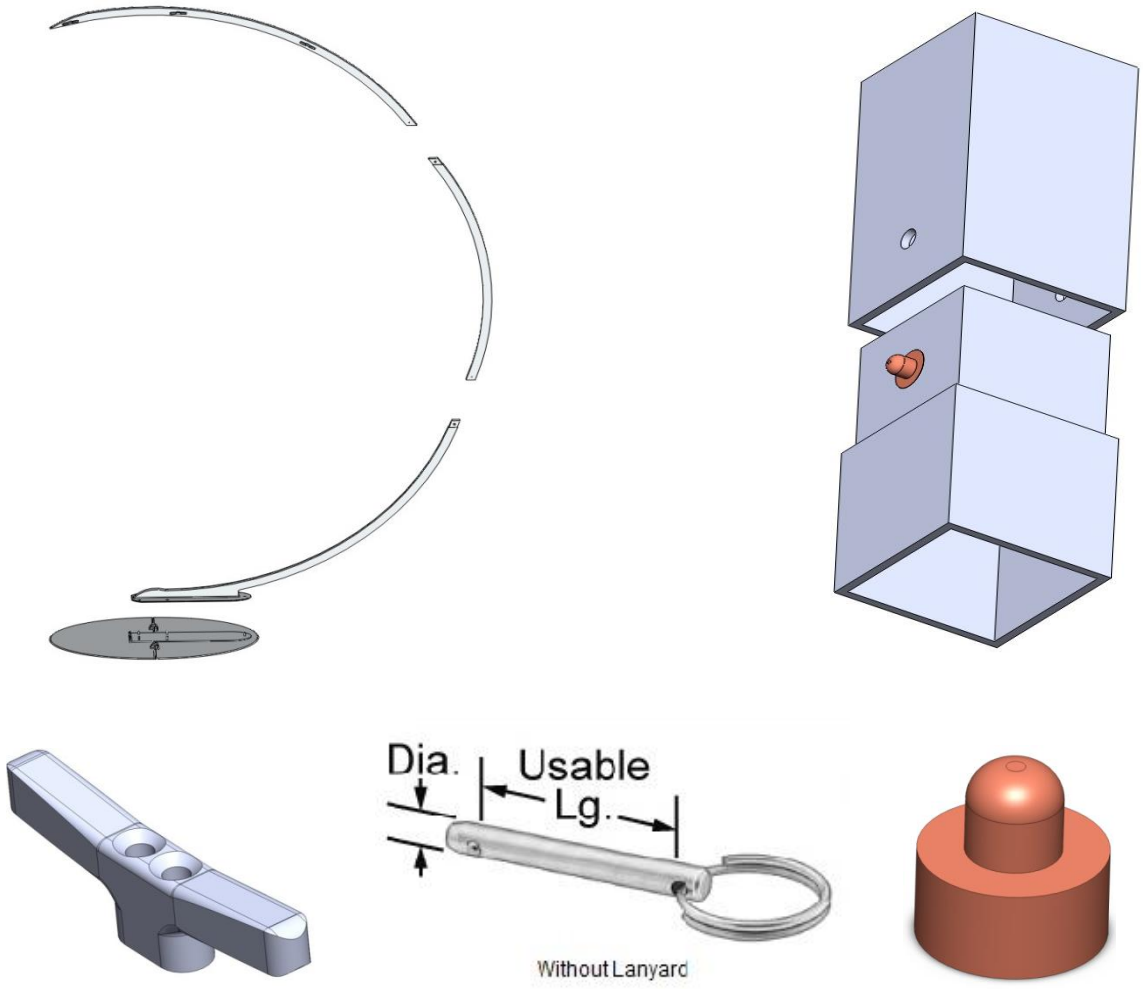

Figure 5: Exploded views of Sideways Arch including quick release pins

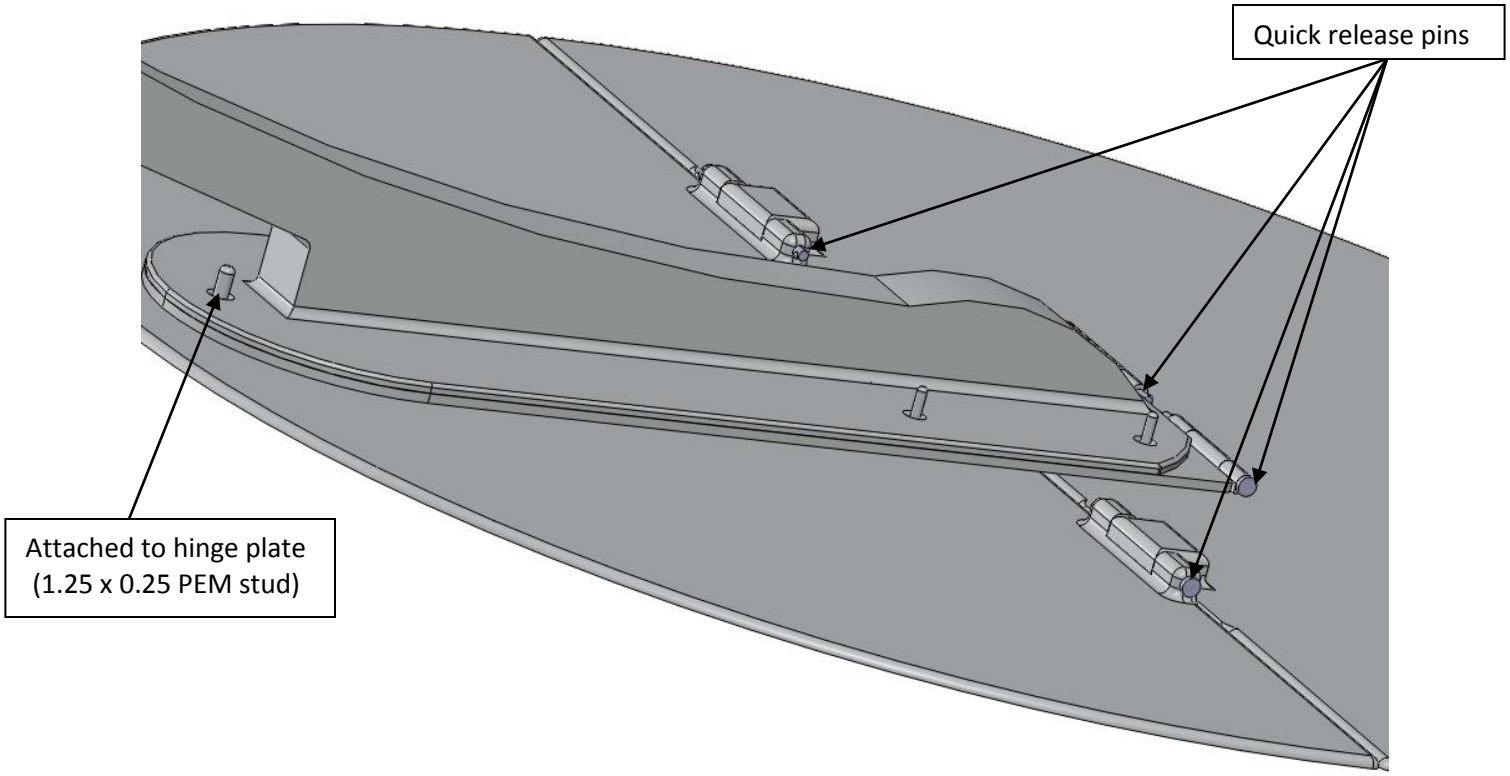

Figure 6: Arch base attached to hinge plate

Figure 6 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 just in back of the 2 near the hinge attach the hinge plate to the base. See Figure 7 for another view.

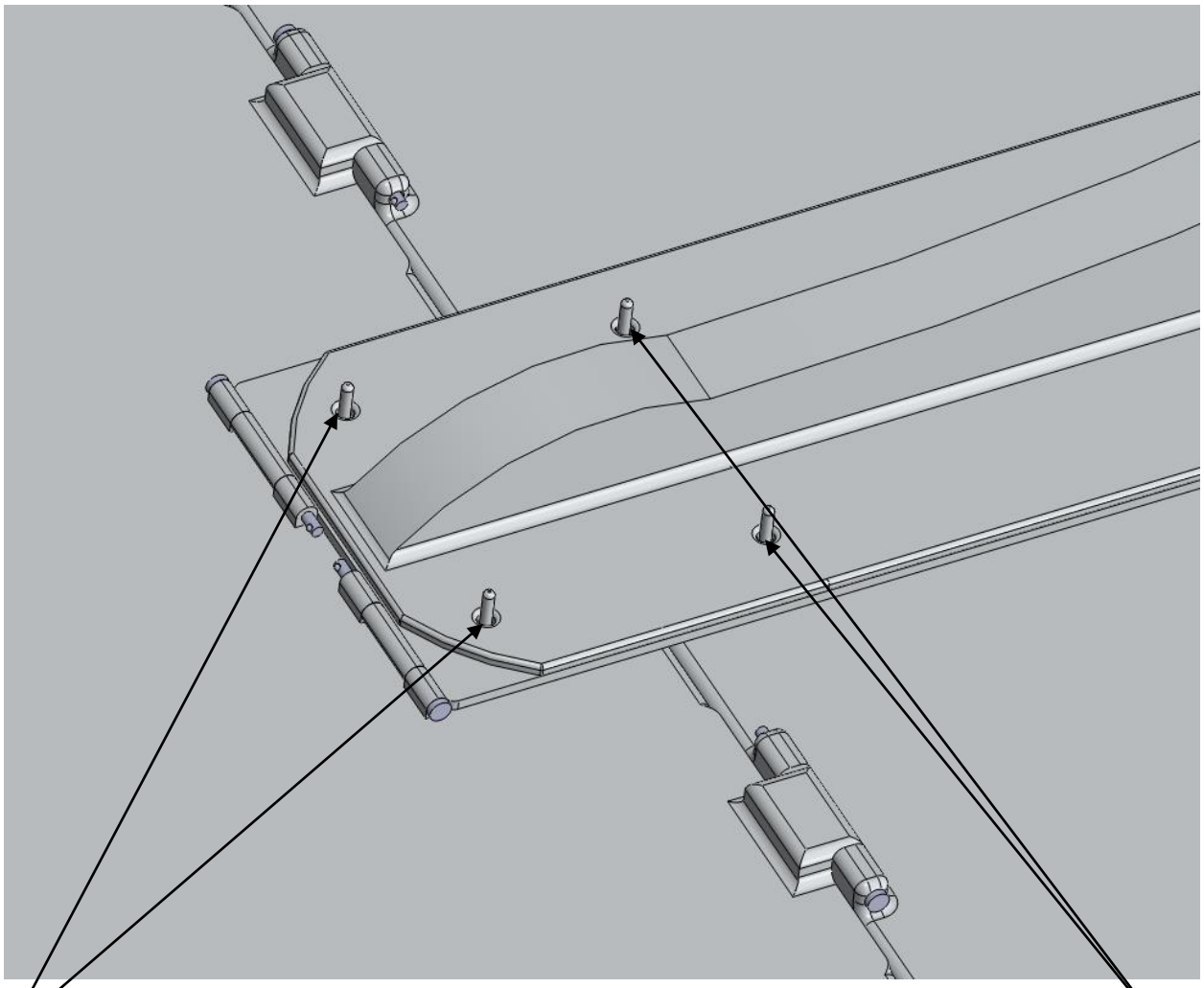

Figure 7: Isometric view of arch base attached to hinge plate