

# Warren J. Baker Endowment

*for Excellence in Project-Based Learning*

# Robert D. Koob Endowment *for Student Success*

CAL POLY

## Proposal Cover Page

**Title of Project:** Avalon Submersible Support Structure

**Proposal Authors:**

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Previous Baker/Koob Endowment funding? (circle one):      **Yes**      **No**

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**Faculty Advisor:** Eileen Rossman

**Department:** ME

**Faculty Advisor Email:** [erossman@calpoly.edu](mailto:erossman@calpoly.edu)

**Telephone:** 805-756-7424

**Anticipated Start Date:** November 17, 2016

**Anticipated End Date:** June 2, 2017

**Total Funds Requested (\$):** 500

**Signature of Faculty Advisor:** \_\_\_\_\_

**Date:** \_\_\_\_\_

## **I. Abstract**

The Morro Bay Maritime Museum (MBMM) is a local non-profit organization that is currently looking for a new way to support the Deep Submergence Rescue Vehicle (DSRV), Avalon, that they have on display. The DSRV is currently sitting on a Short Haul Vehicle (SHV) trailer and the total weight (32 tons) is currently being supported by the SHV's tires. This is a source of concern for the MBMM due to the weathering the tires have undergone. The MBMM is looking for a support structure that will aesthetically add to the display and take the weight off of the tires for safety.

The Maritime Museum wants to professionally manufacture and install this structure by the end of June 2017. In order to meet this deadline, we will have a final design report completed by June 2, 2017. The report will include a description of our final design, the manufacturing process, and a summary of the performed testing and analysis. We also intend to include a detailed CAD model, the accompanying engineering drawings, and a full scale prototype of the support structure at that time.

## **II. Introduction**

The MBMM and the City of Morro Bay worked together to obtain a long term loan of the Avalon from the Naval Historical Center in Washington D.C. In June of 2012, the Avalon arrived at its new home in Morro Bay. With the acquisition of such a unique part of U.S. Naval history, there is now the need to safely display the Avalon in a manner that is befitting of this unique piece of history. Due to its waterfront location, the SHV tires are exposed to the rain, fog, sea winds, and UV rays from the sun. The MBMM is concerned that the weathering of the tires coupled with the amount of time that they have been supporting the weight of both the DSRV and the trailer, could cause the tires to fail. Therefore, the MBMM is looking for a structure that will take the weight off of the tires, while still eventually allowing the DSRV to be transported to its final destination in a proposed interpretive center nearby.

## **III. Objectives**

After developing a list of our sponsor's requirements, we then generated a list of engineering specifications. These are outlined below:

1. The new structure will remove all weight from the tires of the existing trailer.
2. Every piece of structure will be under 5,000 pounds to ensure mobility.
3. The structure will be able to be manufactured on site.
4. The design will indicate a projected cost of under \$10,000.
5. The MBMM will not need to perform maintenance on the trailer, such as applying new coats of paint, more than annually.
6. Using the local supplier that the MBMM has on hand will be a top priority in selecting materials.
7. The new structure will not impede the visibility of the DSRV any more than the current trailer.

8. The structure will be able to account for up to 9 inches of variance between the front and back of the DSRV due to the uneven ground that it currently rests on.
9. The height will be able to be adjusted in increments no larger than 3 inches
10. We will be able to lift the current structure such that the tires are up to 4 inches off of the ground.
11. The amount that the structure extends beyond the tires will be limited so as to not present a tripping hazard for the public.
12. The structure will be able to withstand a lateral acceleration of 0.52 g's as derived by USGS for maximum expected seismic activity in Morro Bay.
13. The height of the new structure will maximize the clearance between the ground and the point at which the public accesses the DSRV for tours.
14. The structure will be able to support the combined weight of the DSRV, the weight of the trailer that it currently sits on, and the weight of people inside the DSRV taking the tour (approximately 32 tons).

#### **IV. Methodology**

Prior to developing any designs, we completed extensive research. After performing a preliminary loads analysis, we generated a reasonable understanding of the structural requirements, and conducted research into how industry has solved similar problems. We then began developing ideas on how to solve the problem. We are currently performing a subjective evaluation of each idea by comparing it to both the sponsor's requirements, and our engineering specifications. Eventually, we will converge on one or more solutions that meet the requirements which we will present during our Preliminary Design Review. After receiving feedback from our sponsor, we will begin the detailed design of our chosen solution. This phase includes choosing materials and sizes, as well as ensuring it is all able to be manufactured.

The scope of our project prevents us from manufacturing the structure for final use. In order to overcome this, we plan on creating a model of the structure that will allow us to walk through and simulate the fabrication steps. Here, we will talk to the fabricator who will actually build the structure to verify our design is simple to build with the available resources. As we progress, we will do an in-depth validation and verification of our design to the requirements and specifications. Here we will quantify our validations and prepare them for the report. After we finish the design, we will prepare a report that explicitly describes our methods, assumptions, and decisions we made to reach our final design. This report will be presented to our sponsor at the Final Design Review Exposition. After completing our design, we will give a set of documents, in addition to the prototype, to the MBMM at the Final Design Review Exposition. These documents will fully communicate our design and the processes necessary to build, install and maintain the support structure.

## **V. Timeline**

Five major milestones will be completed during the course of this project. Here, these milestones are outlined in chronological order. The goal of the Preliminary Design Review on November 17, 2016 is to present our chosen design concept and document the evidence that led to our decision. The main goal of the Critical Design Review on February 7, 2016 is to present our final design in detail including detailed drawings and documentation of costs. The Project Update Report on March 16, 2017 serves to update our sponsor during the “build phase” of the project. This will include pictures of our progress in constructing our prototype. The main purpose of the Project Hardware and Safety Demonstration on May 2, 2017 is for our advisor to review our prototype and decide if it meets the safety requirements necessary to begin testing. Our Final Design Report will include a description of our final design, an outline of the manufacturing processes used, and a summary of the testing that was performed. Our final design will be presented at the Project Exposition on June 2, 2017 and on this day, we will present our sponsor with our Final Design Report as well as our prototype.

## **VI. Final Products and Dissemination**

Our final product will include the following: part drawings, assembly drawings, a Bill of Materials, a fabrication process document, an installation/removal document, a scaled prototype, and a detailed report. Our final design will be presented to the sponsor and all attendees of the Senior Project Exposition on June 2, 2017. In addition, we will handoff our final scaled prototype as well as all of the documentation described above on June 2, 2017.

## **VII. Budget Justification**

We are requesting help in purchasing a complete 3D CAD model of the DSRV. Having this resource will permit us to focus more on developing and creating the supporting structure. Due to the lack of actual blueprints and specifications of the DSRV, creating an accurate 3D CAD model of the Avalon would be an extremely difficult endeavor. The existing 3D CAD model will give us the assurance that any models developed in the course of this project will be as accurate as possible and capable of providing useful data. A 3D printed scaled prototype of the structure will also be required in order to conduct a test analysis of the support's structural integrity and behavior under seismic conditions. \$300 out of the \$356 of non-computer material fees requested would go towards 3D printing. The Cal Poly Digital Fabrication Lab charges \$5 per cubic inch and at this rate, it will allow for 60 cubic inches to be produced for the prototype support structures. The other \$56 will go towards building a full scale wooden prototype. The cost of lumber is \$2.83 per 2x4 at our local Home Depot store, and the total is based on purchasing 20 pieces of lumber. The subtotal does not include the sales tax on any of the purchases, therefore we rounded the total budget requested up to \$500 in order to cover the sales tax.

## C. Budget Sheet

<b>Student Applicant(s):</b>	Alexandra Zaragoza Octavio Mendoza Austin Eslinger	
<b>CENG Faculty Advisor:</b>		Eileen Rossman
<b>Project Title: Support Structure for Avalon Submersible</b>		<b>Requested Funding</b>
<b>Travel</b>	<i>subtotal</i>	<b>\$0.00</b>
Travel: In-state		<b>\$0.00</b>
Travel: Out-of-state		<b>\$0.00</b>
Travel: International		<b>\$0.00</b>
<b>Operating Expenses</b>	<i>subtotal</i>	<b>\$ 0.00</b>
Non-computer Supplies & Materials		<b>\$356.60</b>
Computer Supplies & Materials		<b>\$100.00</b>
Software/Software Licenses		<b>\$0.00</b>
Printing/Duplication		<b>\$25.00</b>
Postage/Shipping		<b>\$0.00</b>
Registration		<b>\$0.00</b>
Membership Dues & Subscriptions		<b>\$0.00</b>
Multimedia Services		<b>\$0.00</b>
Advertising		<b>\$0.00</b>
Journal Publication Costs		<b>\$ 0.00</b>
<b>Contractual Services</b>	<i>subtotal</i>	<b>\$481.60</b>
Contracted Services		<b>\$ 0.00</b>
Equipment Rental/Lease Agreements		<b>\$0.00</b>
Service/Maintenance Agreements		<b>\$0.00</b>
<b>TOTAL</b>		<b>\$500.00</b>

## **D. References**

[1] Angus, R., 2013, "Fitted for Purpose: The Retelling of Morro Bay's Maritime Culture," San Luis Obispo County Visitor's Guide, from <http://www.slovisitorsguide.com/fitted-for-purpose/> (accessed 10/11/16).