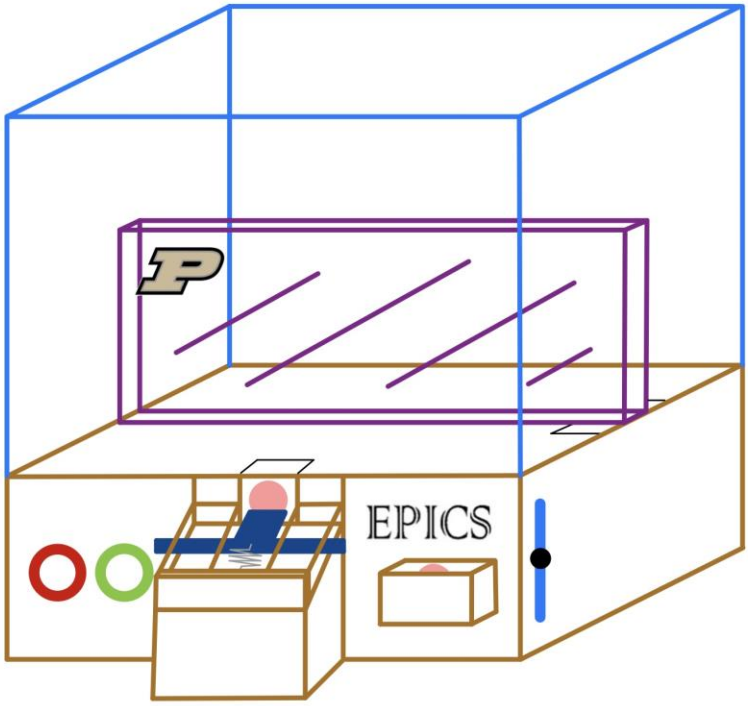


Catalyst

Children's Educational Demonstrations

EPICS®

Week 5 Fall 2021 EPICS Design Document

CONTENTS

SECTION 1: PROJECT IDENTIFICATION

PROJECT OBJECTIVE STATEMENT

The need for this project comes from a lack of understanding of how catalysts work in experiments, especially among children. Catalysts are a topic of interest in children, but they usually do not understand why they exist or how they work. The model created will show children visiting outreach events, classrooms, and museums how catalysts work and how they affect chemical reactions. Our model is one piece in creating engaging curriculum for children to better demonstrate scientific concepts.

DESCRIPTION OF THE COMMUNITY PARTNER

The CED team's project partner is the Center for Innovative and Strategic Transformation of Alkane Resources (CISTAR). CISTAR is funded by the National Science Foundation, located at Purdue. The purpose of CISTAR is to research different topics and educate others as a part of their outreach program. We work with CISTAR to build models that would be helpful in conjunction with this outreach program. The overall mission of the project is to increase interest among children understanding and interest in scientific concepts. We are working to make an exciting and interesting model to show how catalysts work in chemical reactions. When the model is completed, it will be delivered to CISTAR to be used at outreach events, in classrooms and in science museums.

STAKEHOLDERS

Besides the children that will be using and interacting with the model, other stakeholders include parents and families accompanying children and CISTAR who are involved with the usage and maintenance of the model. One of the goals of CISTAR is to educate children in interesting and memorable ways, which our model will contribute to. Parents and families have similar important interests, because they are bringing children to the museum to learn in new and innovative ways. They want their children to experience all that the museum has to offer, and we want them to be pleased with the experience their children are having.

PROJECT SCOPE

In the beginning weeks of the spring 2022 semester, we expect to have a fully completed model of our design that will be ready for testing. When the prototype is completed, we will use a risk assessment and other tests in order to evaluate the safety and effectiveness of the design. The design of our project will be in-scope, because our design addresses all the needs of our client.

USER NEED LIST

Need #	Stakeholder	User Need
1	CISTAR	*Usable as a teaching tool, improves lesson*
2	Child	*Easy and fun to use, help explain context of lesson*
3	Parent	*Must be child safe (no pinch points, electronics not hot, etc.)*

EXPECTED OVERALL PROJECT TIMELINE

Project Start Date: January 20, 2021 *Original Target Delivery Date:* April 2022.

SECTION 2: SPECIFICATION DEVELOPMENT

DESCRIPTION OF THE USE CONTEXT

Task Analysis:

1. Student starts with clicking the no catalyst button to raise the wall up.

2. Uses launcher to attempt to fire 3 balls of the wall at its full height

3. Once all balls have been fired over, they will be location in the return system under the model's floor.

4. Reset the balls by sliding a small door on the side of the model.

5. Click the catalyst button on the front of the model lowers the wall which demonstrates the addition of the catalyst.

6. Fire all three of the balls over for a second time.

8. The time with the lower wall should be much easier for the children to shoot the balls over the wall. This shows that the addition of a catalyst makes it easier for a reaction to take place.

How Users will Interact:

Sally:

Persona Group: Child

Age: 12

Education: Middle school

Occupation: None

Ethnicity: Caucasian

Family Status: Single, 2 Siblings, Mother, Father

Sally is at an outreach to learn about a variety of scientific concepts. She has recently been interested in learning about what catalysts are and how they work. She heard about how the outreach event has a lesson about catalysts. She and her friends decided to go to the event to learn about catalysts. The instructor explains what a catalyst is to the children and allows them to use the catalyst model that Purdue EPICS created to gain a better understanding of how catalysts work. Sally is able to get a more in-depth understanding of the action of catalysts by observing how, without a catalyst, trying to shoot a ball over a wall is much harder than when you add the catalyst, because the catalyst lowers the height of the wall making it easier to shoot a ball over.

BENCHMARKING

The team did not find any similar devices in the market in prior research, so the products will be compared to those already in use by CISTAR. The Catalyst team is therefore unlikely to encounter issues with intellectual property in this project.

SPECIFICATION LIST

Need #	User Need	Spec #	Specification
1	*Child safe*	1.1	*No exposed electrical components*
		1.2	*3 or fewer pinch points*
2	*Easily moveable*	2.1	*Less than 20 pounds*
3	*Durable*	3.1	*Does not show major signs of wear after user testing*
4	*Shows how catalyst works*	4.1	*Use game to demonstrate process*
		4.2	*Educational material to further explain*
5	*Easy to maintain*	5.1	*Materials obtainable on Amazon*
		5.2	*CAD files on SharePoint*
		5.3	*Unit cost < $300*

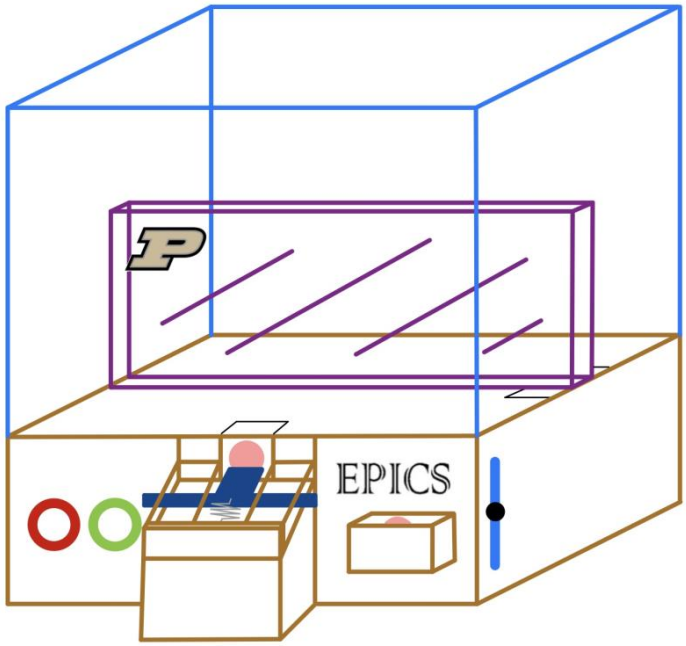
SECTION 3: CONCEPTUAL DESIGN

CONCEPT GENERATION

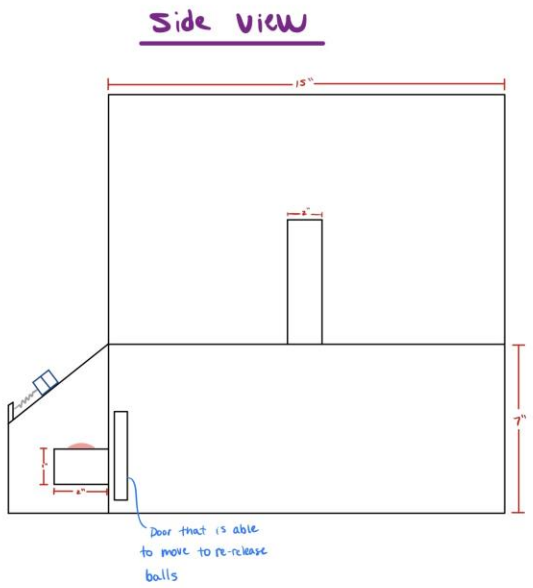
The project partner was clear with his needs, so most of the concept generation was done through prototyping.

Overall view:

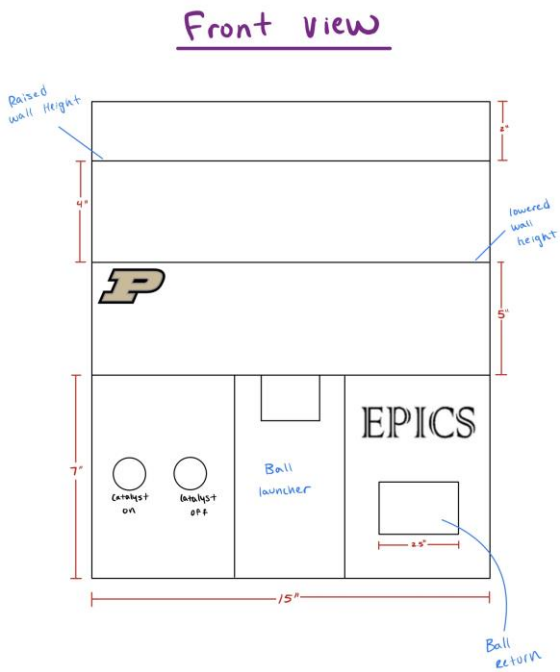
This picture gives an overall view of the project. It demonstrates how there are two buttons to move the wall up and down with use of a motor and microswitches. It also shows that there is an external ball delivery system.



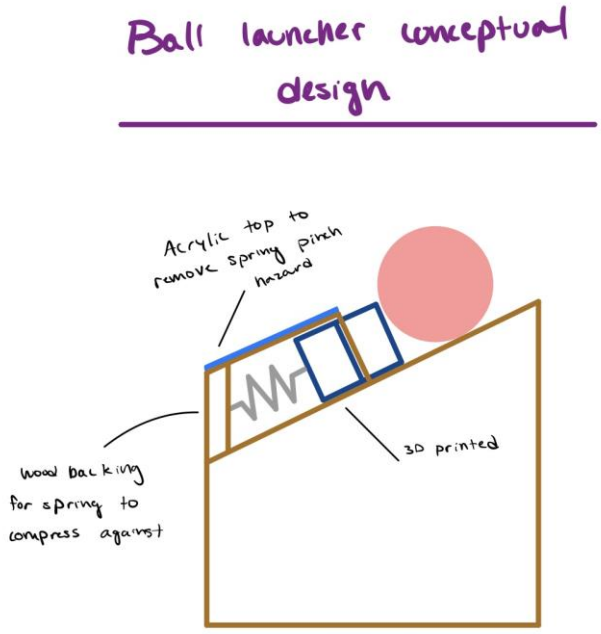
Side View:



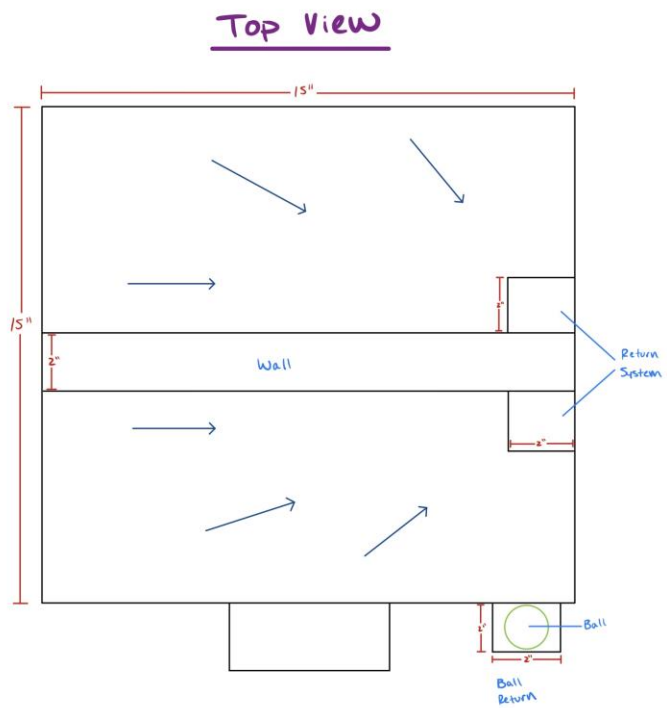
Front View:



Ball launcher:


Ball launcher conceptual design
Acrylic top to remove spring pinch hazard
Wood backing for spring to compress against
3D printed

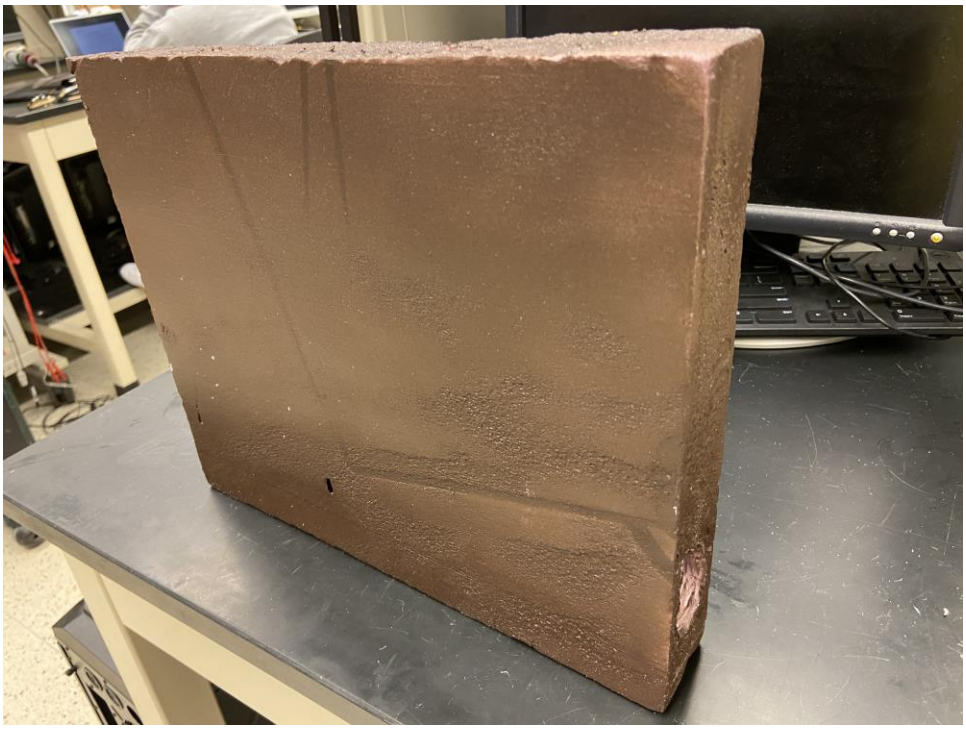
Aerial View:


Top View
15"
15"
2"
Wall
Return System
2"
1"
Ball
2"
Ball Return

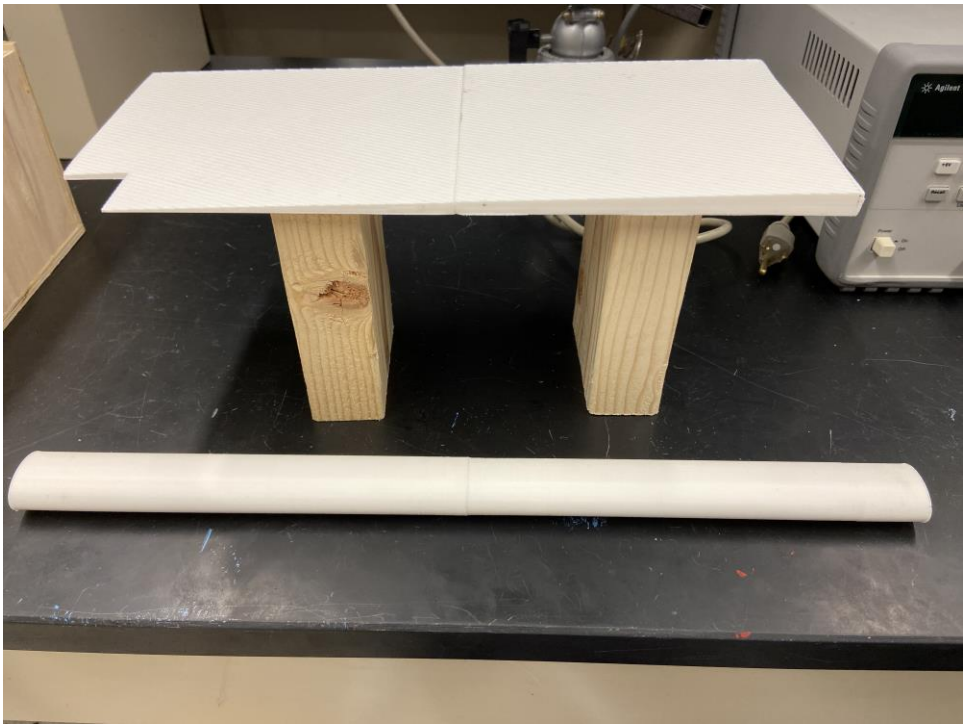
PROTOTYPING

The wooden box has been glued and the wood panel door has been secured with a hinge.

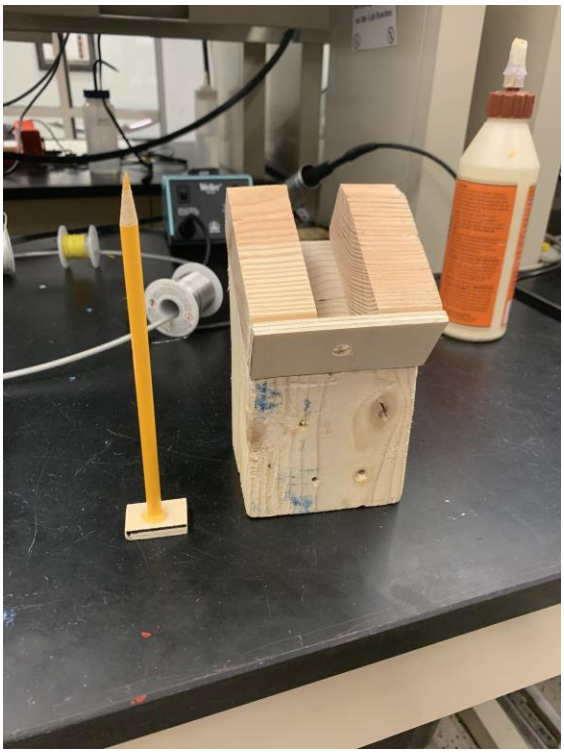
The Foam wall has been cut and spray painted.



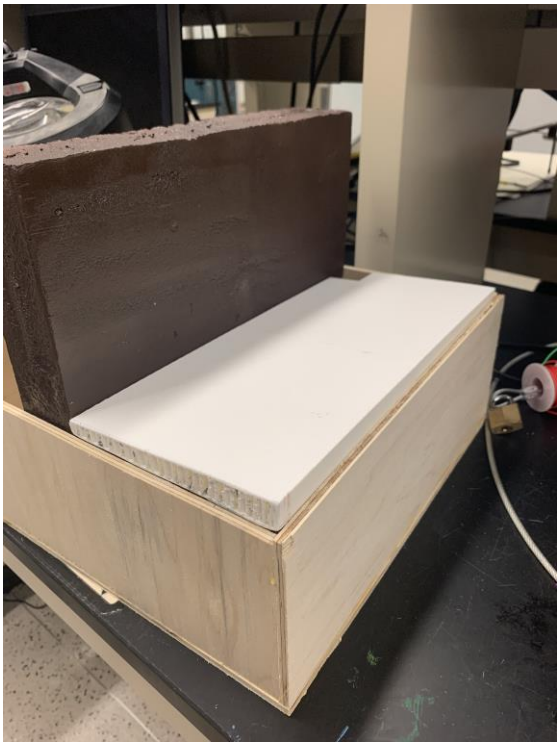
The 3-D printed parts have been made and sanded to fit the box.



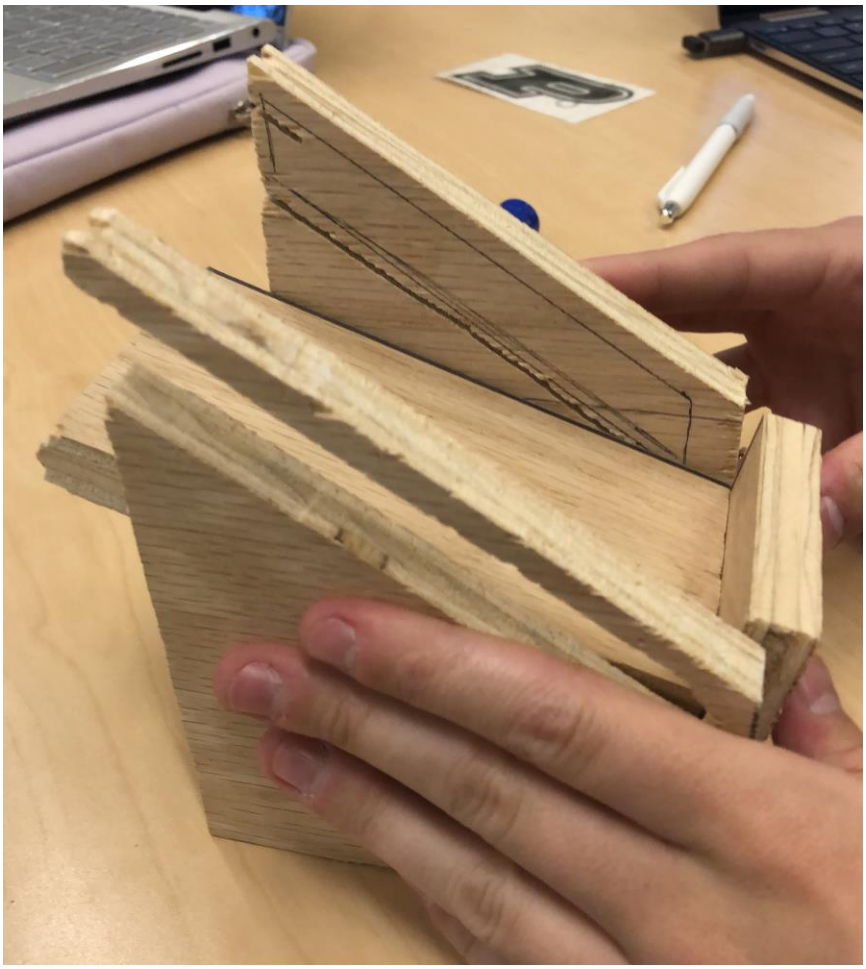
Work on the launcher is almost complete. Once the glue is dry, we can attach a spring to a pencil to finish off the launcher.



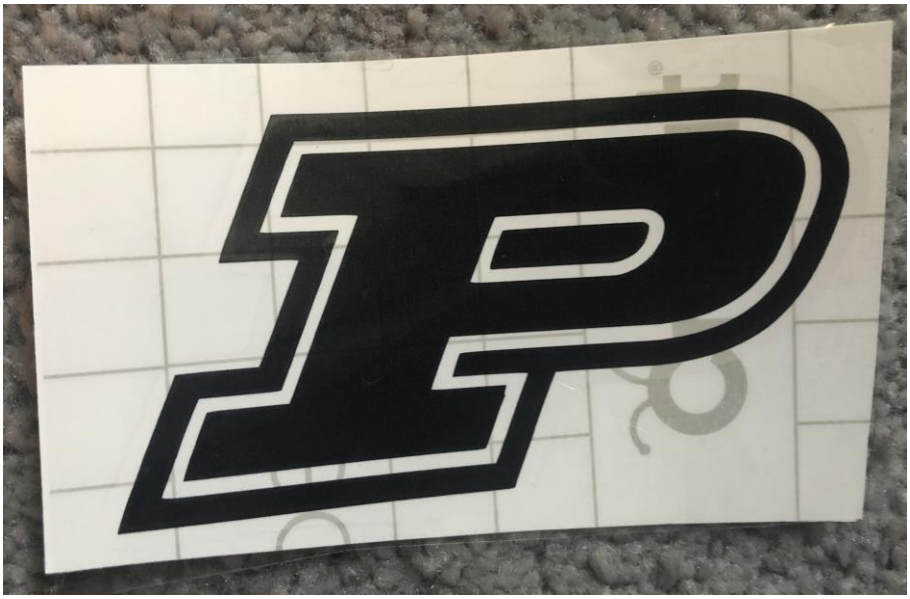
Below is a piece where the wall and the base panel have been put in the box. Once all the work on the inside of the box is complete, everything will be glued down.



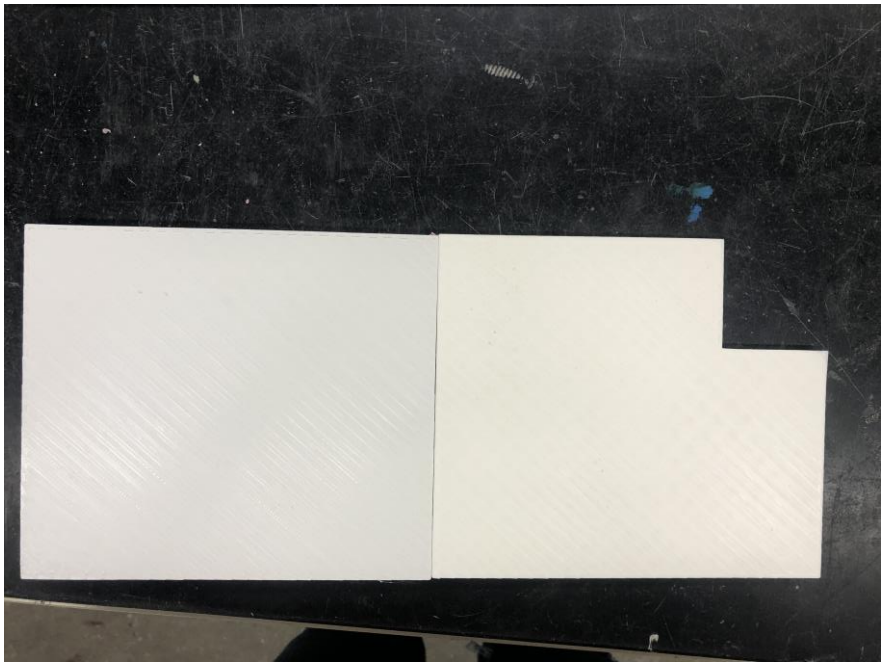
Slingshot Prototype



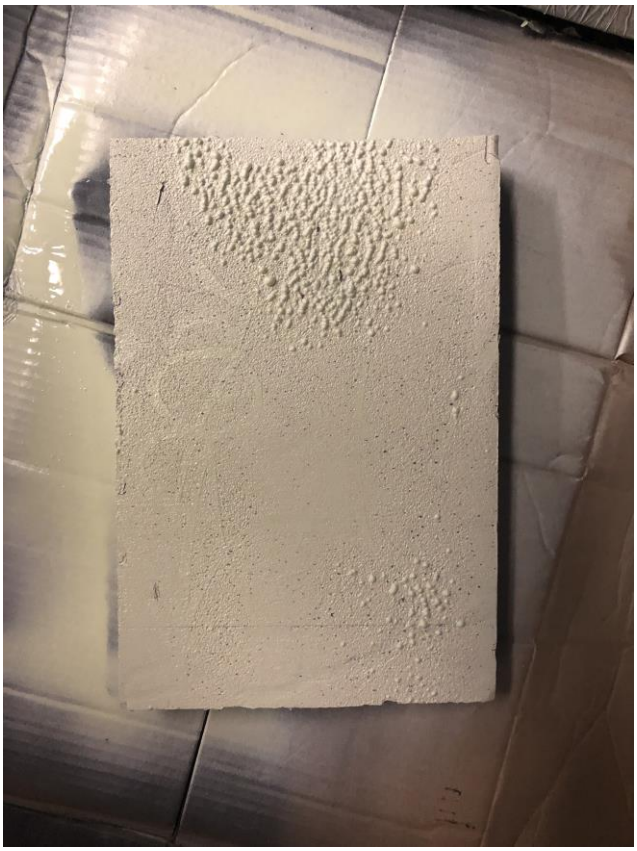
Purdue sticker that will be put on the wall.



3D printed base (The other side is a mirror image of it)



Failed attempt at spray painting the wall that was cut.



CONSTRUCTION

SECTION 4: DETAILED DESIGN

BILL OF MATERIAL (B.O.M)

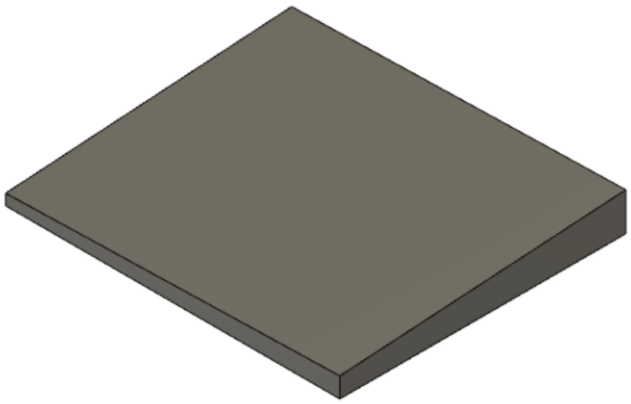
This section includes a list of all components, whether manufactured or purchased, that will go into the final design.

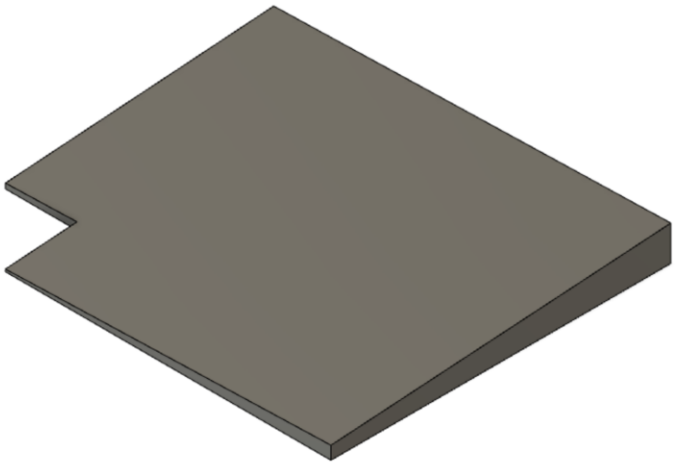
Sub-Assembly	Item	Catalog/ Part No.	Manufactured/ Purchased	Vendor/ Method	Qty.	Cost/ Unit
Appearance	acrylic	4334464	Purchased	Menards	1	$23
Bottom of box	Wood	1251201	Purchased	Menards	2	$14.19
Electrical	Battery Pack	B07C6T6YCZ	Purchased	Amazon	1	$8.48
Electrical	Motor	B07CV89QSP	Purchased	Amazon	1	$11.99
Electrical	Scissor Lift	AHBLQD-F1	Purchase	Amazon	1	$16.99
Electrical	Buttons	B01N11BDX9	Purchased	Amazon	1	$10.00
Electrical	Batteries	B0035LCFNQ	Purchased	Amazon	1	$16.24
Electrical	Bread Board	n/a	Purchased	EPICS Lab Supplies	1	$0.00
Slingshot	springs	n/a	Purchased	Amazon	1	$10

Box	Acrylic box	n/a	Purchased	n/a	1	$143.55
Slingshot	Plastic balls	B08BLQKPQV	Purchased	Amazon	1	$8.99
Appearance	Spray Paint	K02762007	Purchased	Amazon	1	$8.91
			Total Project Costs		$286.53	
			Device Cost:		$286.53	

PRINTS/SCHEMATICS/CODE

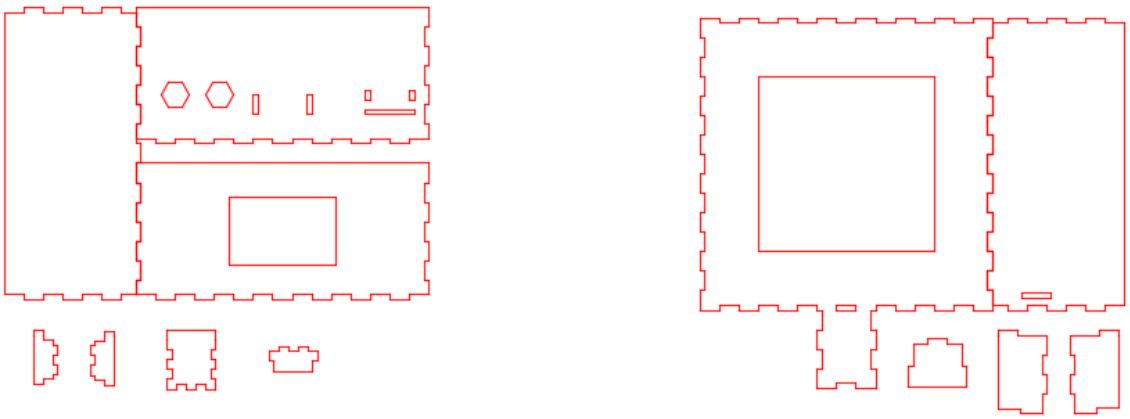
Catalyst Base 3D Prints:





The base was created at an angle so that the balls may roll down into the cutout hole to be reused.

Box design that will be laser cut into wood:



This design will be used for the laser cutter to cut this design into quarter inch think wood.

MANUFACTURING AND ASSEMBLY PROCESSES

3D printing and laser cutting are used in order to ensure the design is custom and accurate. The 3D printed parts include the ball launcher, as well as the slanted plate between the wood and acrylic that make the balls roll back to the launcher.

The wooden box panels are going to be laser cut on final model.

Acrylic box on top part of model is going to be outsourced.

Once the necessary parts have been 3D printed, laser cut or purchased, follow the process listed below.

Process:

RISK ANALYSIS

To be completed once first model is built

VERIFICATION AND VALIDATION

This section should include a table summarizing the results of verification activities for the project. A link to the verification test report should also be included in the table. Verification is the process of making sure the design outputs meet the design specifications. Each specification should be verified, which can take any form that confirms that the specification is met. Be sure to consider any residual high risks from the assessment.

Spec #	Specification	Verification
1.1	*No exposed electrical components*	*All electrical work will be designed to be contained within the box.*
1.2	*No pinch points*	*Model should not have any potential pinch points.*
2.1	*Less than 20 pounds*	*Weight will be measured to ensure it is less than 20 lbs.*
3.1	*Does not show major signs of wear after user testing*	*Model stays fully functioning and gives off professional appearance.*
5.1	*Bought obtainable on Amazon*	*Most parts will be purchased from Amazon.*
5.3	*Unit cost < $300*	Total cost per unit will be calculated at the end to ensure price is within desired range.

SECTION 5: PROJECT DELIVERY

TUTORIALS

- Delivery Process:
  - https://engineering.purdue.edu/EPICS/teams/team-documents/project-delivery
- Delivery Checklist:
  - https://engineering.purdue.edu/EPICS/teams/team-documents/delivery-checklist

Partner agreements mandate the completion of the delivery checklist. Failure to complete the checklist and receive EPICS administrative approval may result in personal liability.

Do NOT deliver a project until the checklist is completed and approved by both the advisor and EPICS administration.

USER/SERVICE MANUAL

A user manual should be provided to the community partner to aid them in use and basic maintenance of the product. An in-house manual or engineer to engineer guide may also be created to aid future teams in servicing and troubleshooting the product. Insert a link to each manual here.

DELIVERY CHECKLIST

Should be completed by the team prior to delivery. Link or copy the completed checklist onto this page.

CUSTOMER SATISFACTION QUESTIONNAIRE

Should be completed by the community partner two weeks after delivery. Link or copy the completed questionnaire onto this page.

- Customer Satisfaction Questionnaire: https://tinyurl.com/EpicsCustomerSatisfaction

RECORD OF PROJECT DELIVERY

Please add or link to a photo and/or video of the project at the time of delivery.

SECTION 6: CURRENT SEMESTER RECORD

This section should contain information on the current semester only. It should be moved to Appendix A at the conclusion of the semester.

POINT OF CONTACT FOR FUTURE TEAM MEMBERS (E.G DESIGN LEAD)

Name:

Clare Hilton

Email: **hilton13@purdue.edu**

Phone:

314-707-2209

POINT OF CONTACT AT THE COMMUNITY PARTNER ORGANIZATION

Name:

Maeve Drummond Oakes

Email:

maeve@purdue.edu

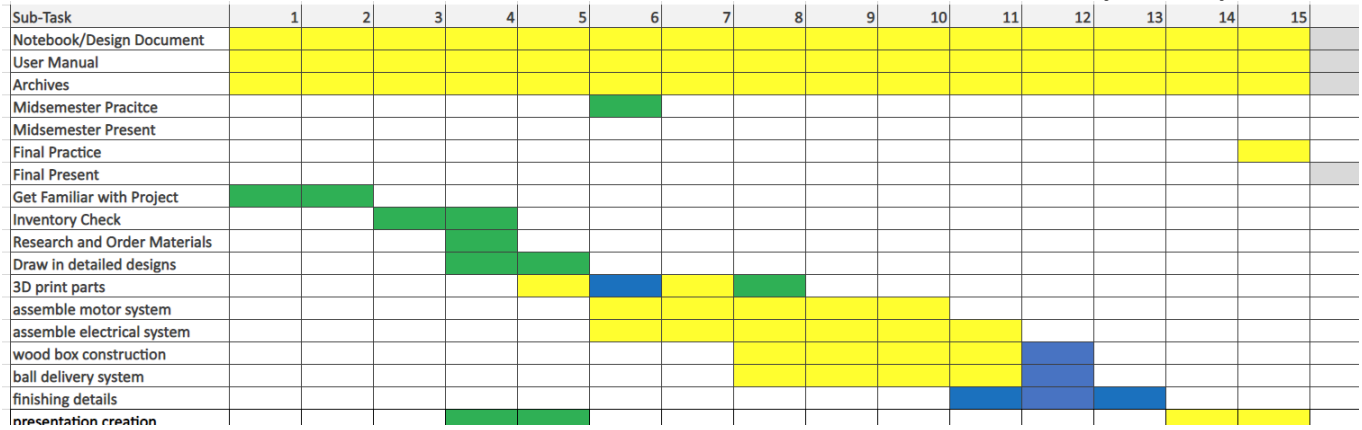
CURRENT PROJECT STATUS

This semester we are working on creating a fully functional model of our project to be delivered in April 2022. We have begun to build the final product. The acrylic box arrived. The pieces have all been cut, stained, and glued together.

CURRENT SEMESTER PROJECT TIMELINE

The project is expected to be delivered early next semester, with a fully functioning professional-looking model created that passes all verification requirements.

Legend	
Completed	
In Progress(on-time)	
In Progress(behind)	
To Be Completed	
Postponed	



Sub-Task	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Notebook/Design Document															
User Manual															
Archives															
Midsemester Pracitce															
Midsemester Present															
Final Practice															
Final Present															
Get Familiar with Project															
Inventory Check															
Research and Order Materials															
Draw in detailed designs															
3D print parts															
assemble motor system															
assemble electrical system															
wood box construction															
ball delivery system															
finishing details															
presentation creation															

TRANSITION REPORT

All CAD models, box laser cut patterns, and necessary files can be found under files on the CED Teams page. If any questions are to arise, please email Clare Hilton (Fall 2021 Design Lead) at hilton13@purdue.edu to request access.

APPENDIX A: PAST SEMESTER RECORDS

Past semester records are accessible in the files tab in the CED Team's page.