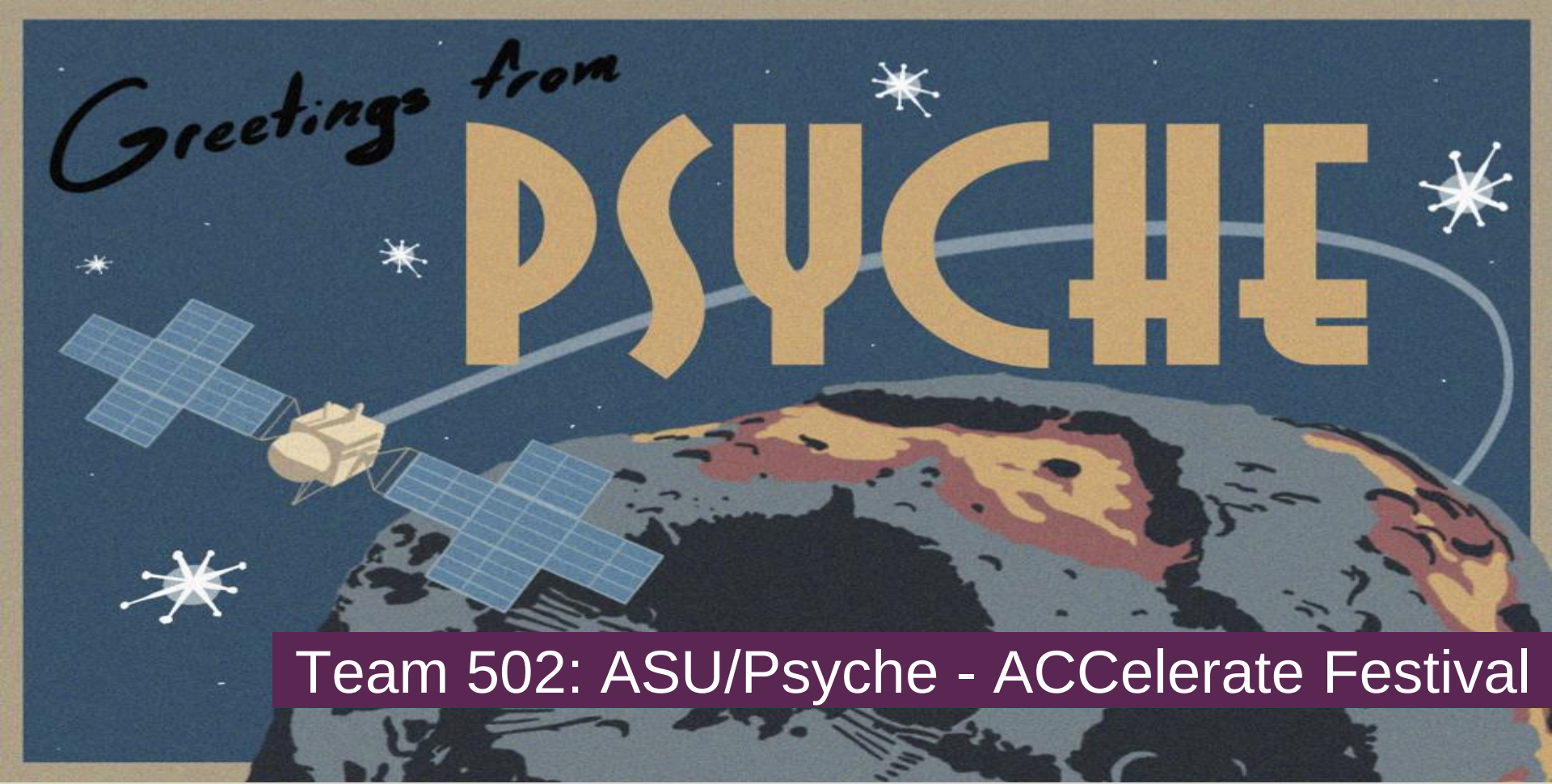


Team 502: ASU/Psyche - ACCelerate Festival

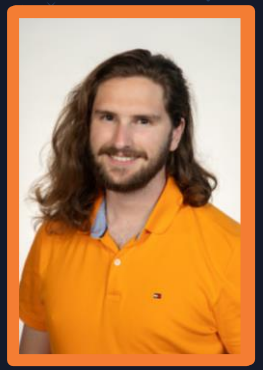
Team Members

Sara Bradley

Mechatronics Engineer

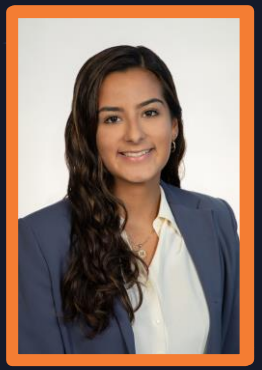
Connor Bishop

Electrical Engineer



Spencer Martin

Electrical Engineer

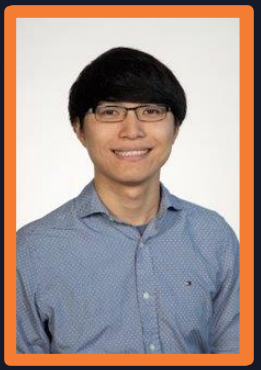


Mariam Medina

Systems Engineer

Garett Southerland

Materials Engineer



Kenneth Zhou

Mechanical Engineer

Spencer Martin

Sponsor and Advisor

Sponsor

Cassie Bowman, Ph.D. Associate Research Professor, ASU

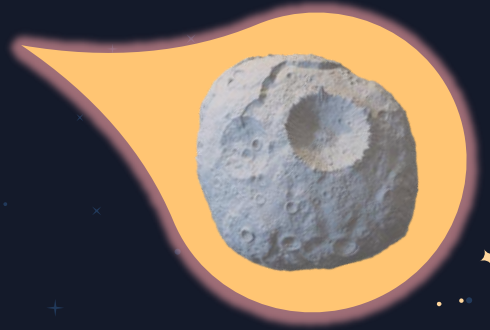
Academic Advisor

Shayne McConomy, Ph.D. ME Teaching Faculty, FSU

Spencer Martin

Project Overview

Psyche:
Psyche is believed to be the exposed core of an early planetesimal that lost its outer layers billions of years ago



Our Mission:
To educate people and generate interest in the Psyche Mission using an interactive exhibit

Challenges:
The interactive exhibit must cost less than $1k, be easily reproducible, and accessible for children

Spencer Martin

Critical Targets

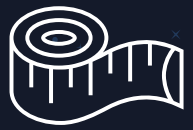


Exhibit Size

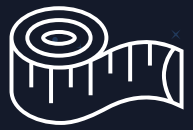
Promotion of STEAM

Cost to Replicate

Promotion of Psyche Mission

Spencer Martin

Critical Targets



Smaller than 125 square ft

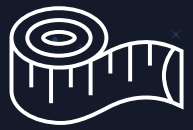
One STEAM Related Concept

Maximum of $1000

50% of Information should relate Psyche & Earth

Spencer Martin

Validation of Targets



Measure with a measuring tape

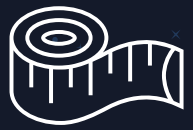
Ask questions about takeaways from users

Track orders and budget use with a spreadsheet

Review displayed content

Spencer Martin

Validation of Targets



~29 square ft

Survey Conclusions and more data collection

Spent: 612.43
Remaining: 382.57

4 sentences that relate Psyche to Earth

Spencer Martin

Targets and Metrics

Function	Method of Measurement	Target
Operates with Minimum Instruction	Using a stopwatch to time how long it takes for an intended interaction	< 1 Minute
Encourages User Interaction	Using a stopwatch to time user interactions	≥1 Minute
Generates Positive User Feedback	Using a survey to ask users how they felt about each interaction	1 Response per Interaction
Encourages Audience to Approach	Using a survey to ask users what interactive features were first noticed	2 Identifiable Features
Simplify Difficult Concepts	Use a quiz to measure user understanding of concepts	Above 50 Percent Score

Connor Bishop

Validation of Targets and Metrics

Function	Method of Measurement	Target
Operates with Minimum Instruction	Use a stopwatch to time how long it takes for an intended interaction	< 1 Minute
Encourages User Interaction	Use a stopwatch to time user interactions 	≥1 Minute Stopwatch app used to record college-age students time spent operating panels unassisted

Connor Bishop

Validation of Targets and Metrics

Function	Method of Measurement	Target
Operates with Minimum Instruction	Use a stopwatch to time how long it takes for an intended interaction	< 1 Minute
Encourages User Interaction	Use a stopwatch to time user interactions	≥1 Minute
Generates Positive User Feedback	Use a survey to ask users how they felt about each interaction	1 Response per Interaction
Encourages Audience to Approach	Use a survey to ask users what interactive features were first noticed	2 Identifiable Features
Simplify Difficult Concepts	Use a quiz to measure user understanding of concepts	Above 50 Percent Score

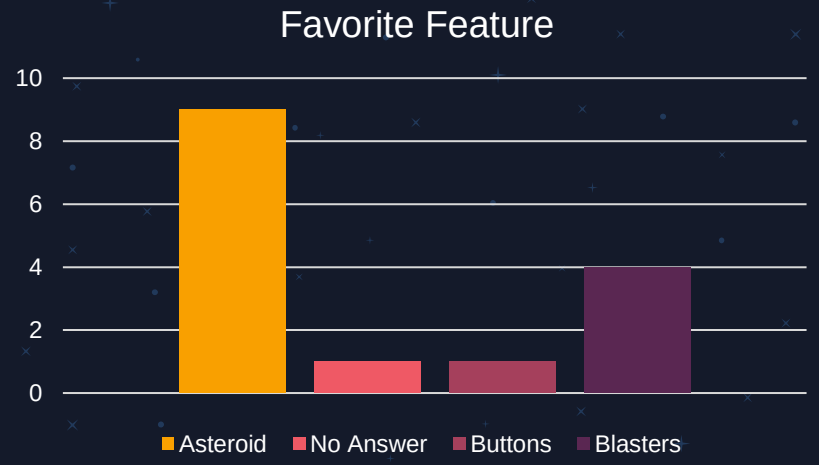
Connor Bishop

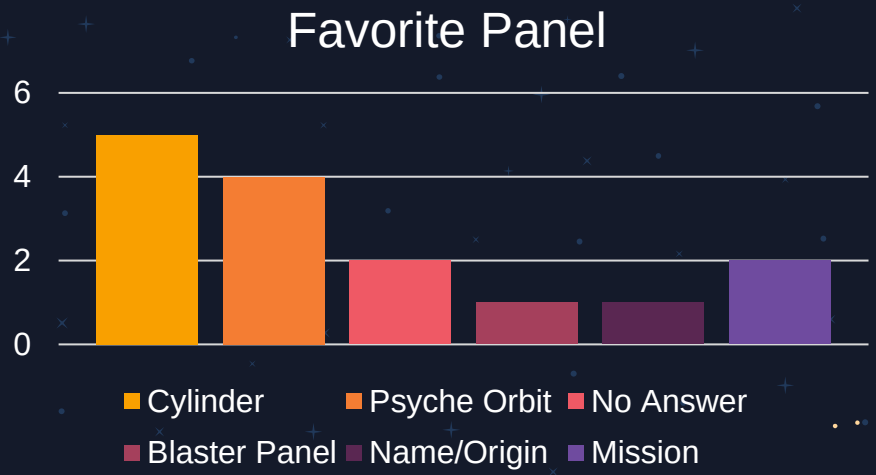
Validation of Targets and Metrics

Generates Positive User Feedback	Use a survey to ask users how they felt about each interaction	1 Response per Interaction
Encourages Audience to Approach	Use a survey to ask users what interactive features were first noticed	2 Identifiable Features
Simplify Difficult Concepts	Use a quiz to measure user understanding of concepts	Above 50 Percent Score

Connor Bishop

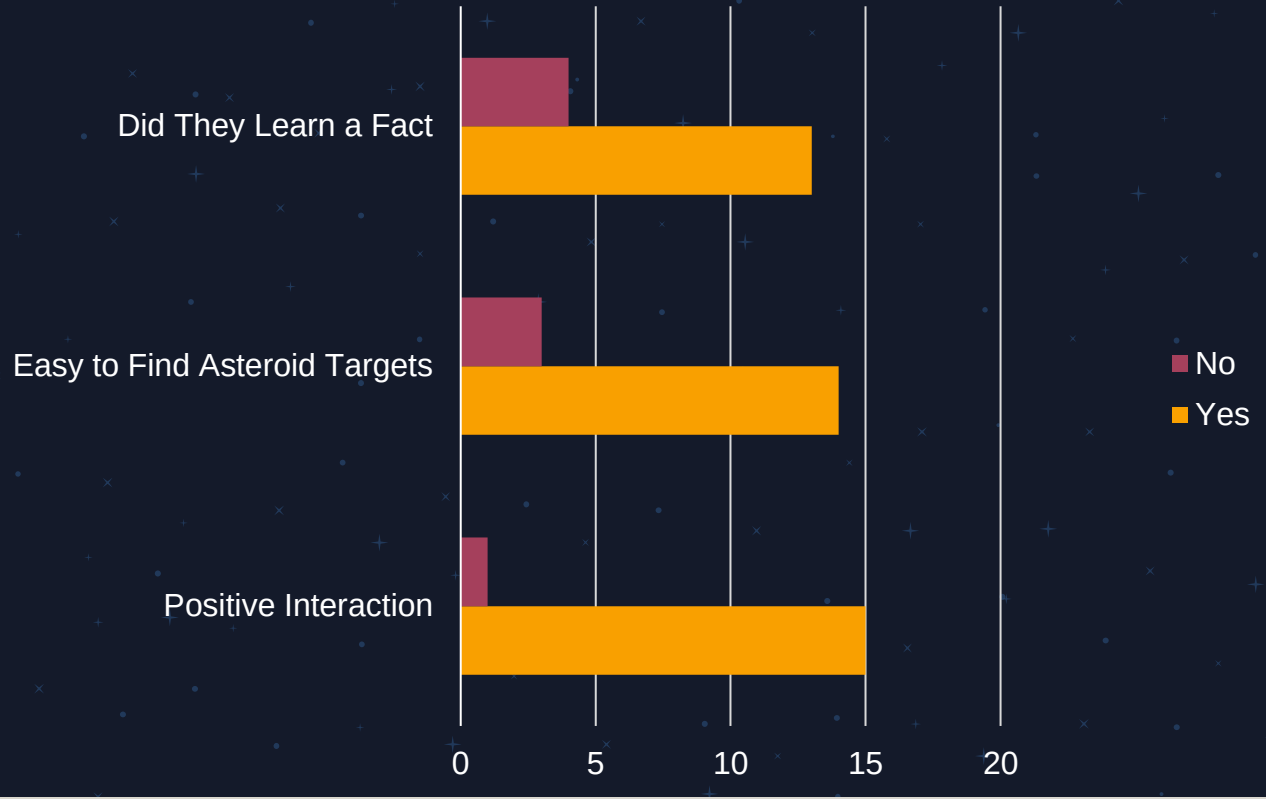
Survey Conclusions





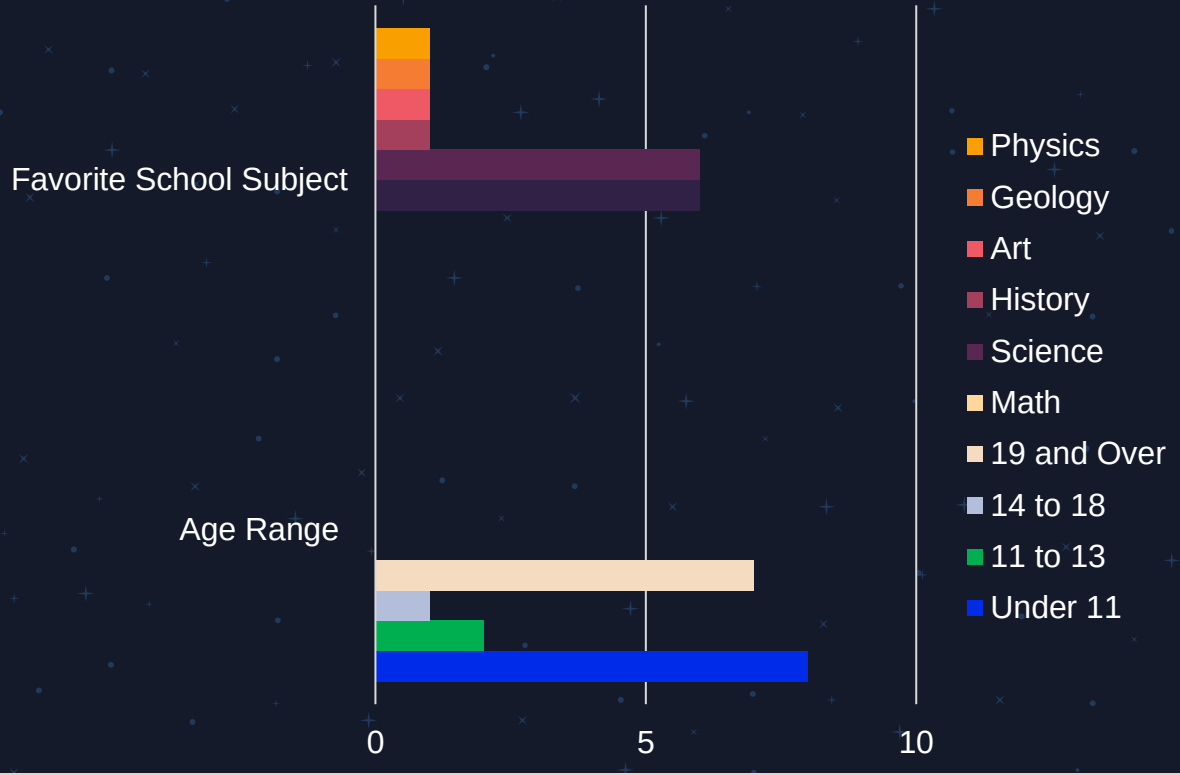
Kenneth Zhou

Survey Conclusions



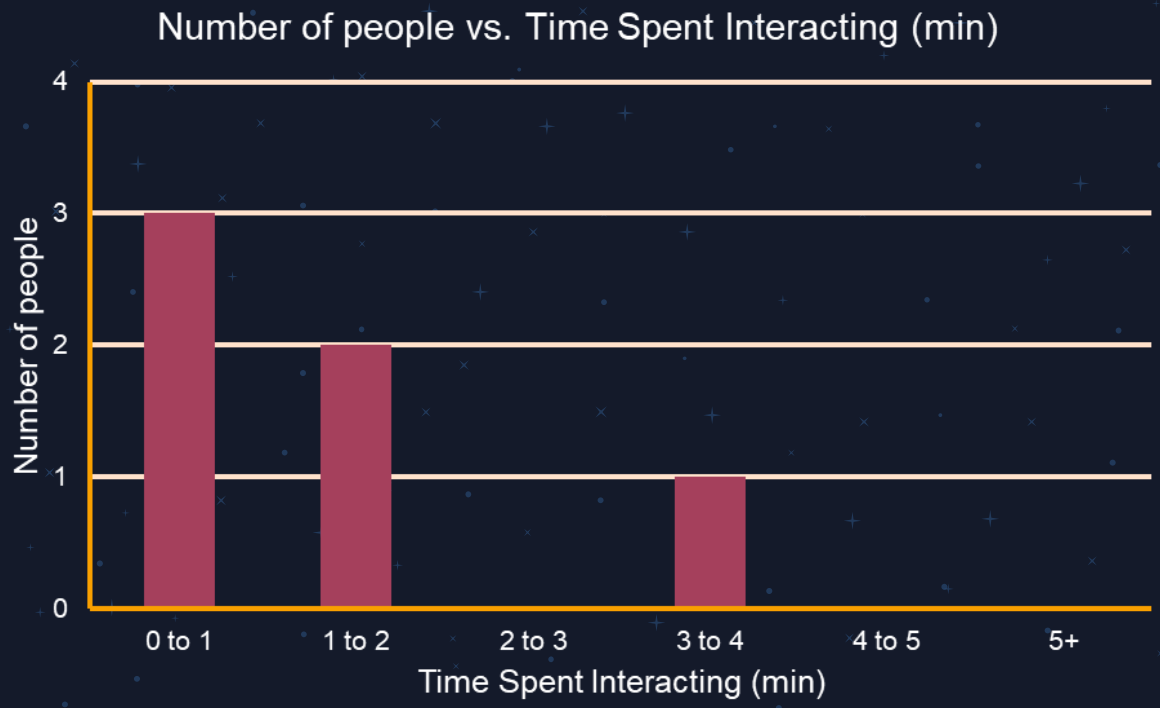
Kenneth Zhou

Survey Conclusions



Kenneth Zhou

Survey Conclusions



Kenneth Zhou

Adjustment of Design: Rotating Platform

Marjam Medina

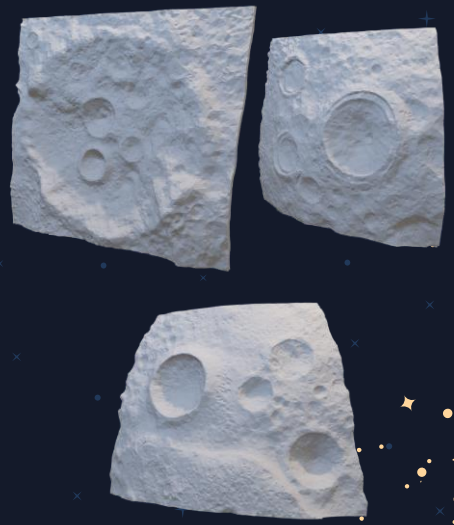
Adjustment of Design: Rotating Platform

Marjam Medina

Adjustment of Design: Rotating Platform

Marjam Medina

Adjustment of Design: Asteroid



1 Large Feature

3 Smaller Features

Marjam Medina

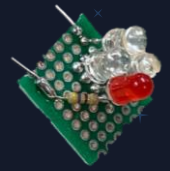
Adjustment of Design: Asteroid

2 Large Features

3 Smaller Features

Marjam Medina

Adjustment of Design: Asteroid



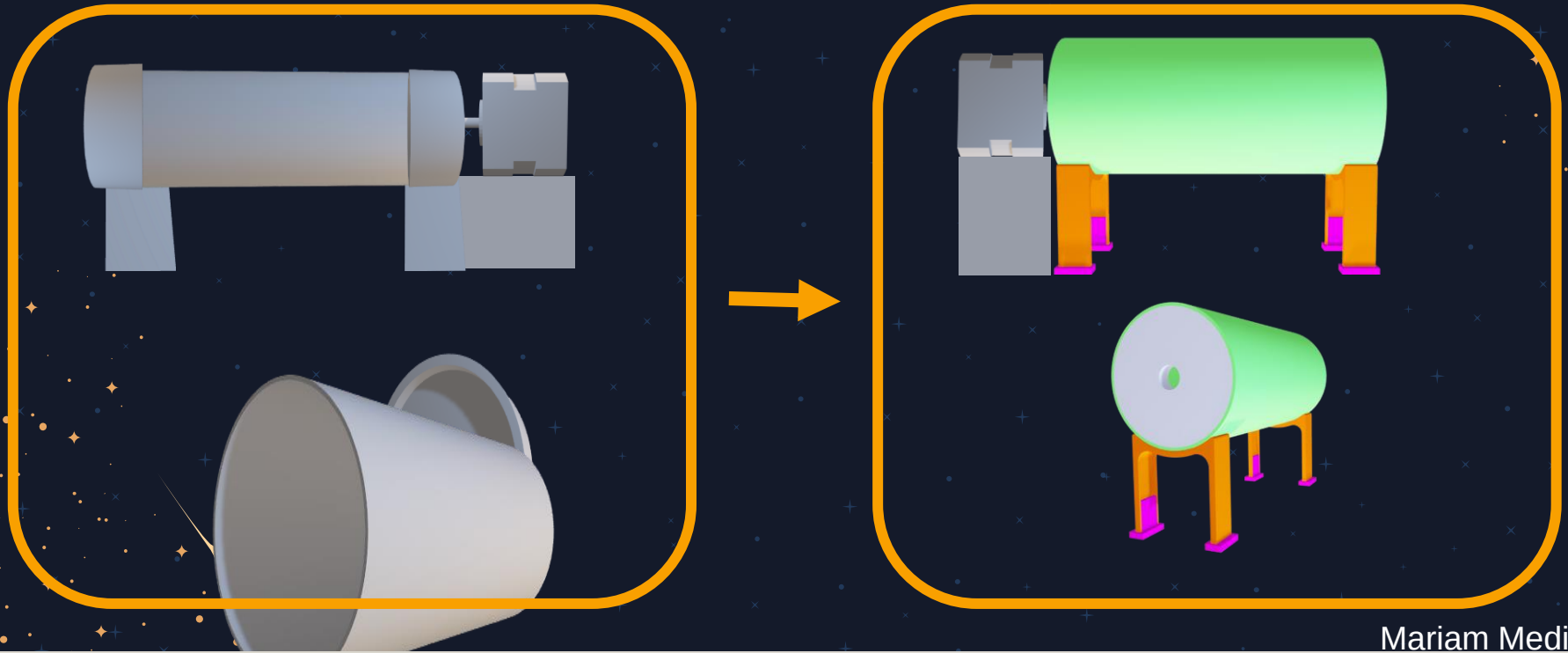
4 Emitters → 12 Emitters

More targets will help users find a target to interact with

More efficient interactions will encourage the user to further explore the exhibit

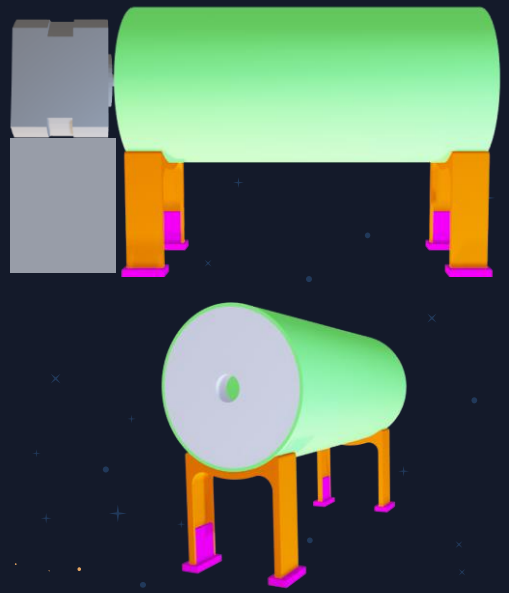
Marjam Medina

Adjustment of Design: Solenoid



Mariam Medina

Adjustment of Design: Solenoid



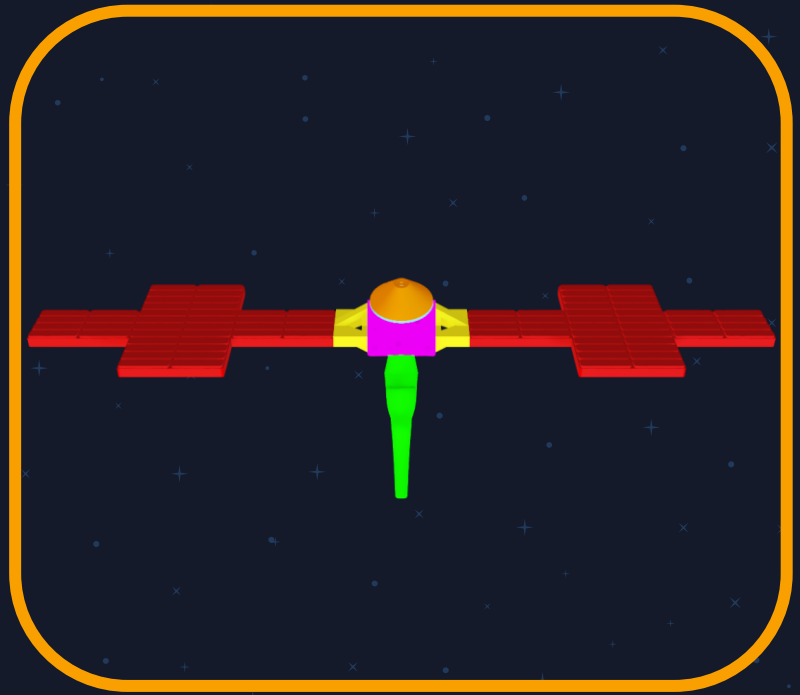
Step on DDR pad to spin

↓

Press a button to spin

Mariam Medina

Adjustment of Design: Blaster

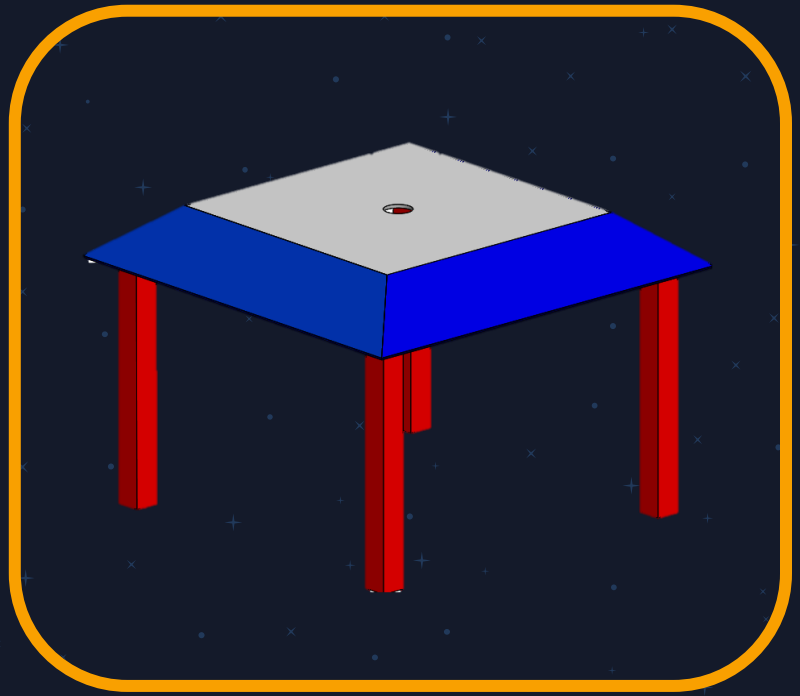


Sara Bradley

Adjustment of Design: Blaster

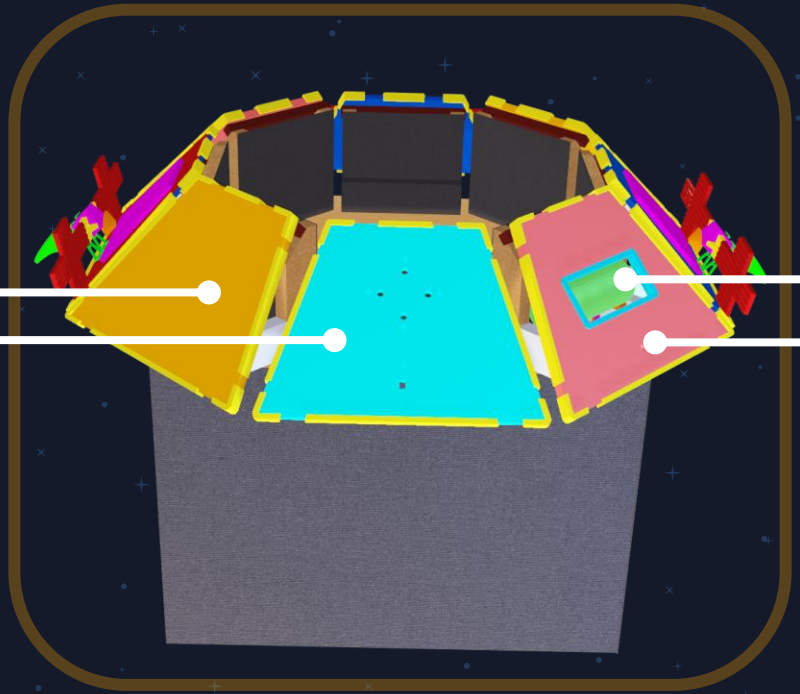
Sara Bradley

Adjustment of Design: Structure Design



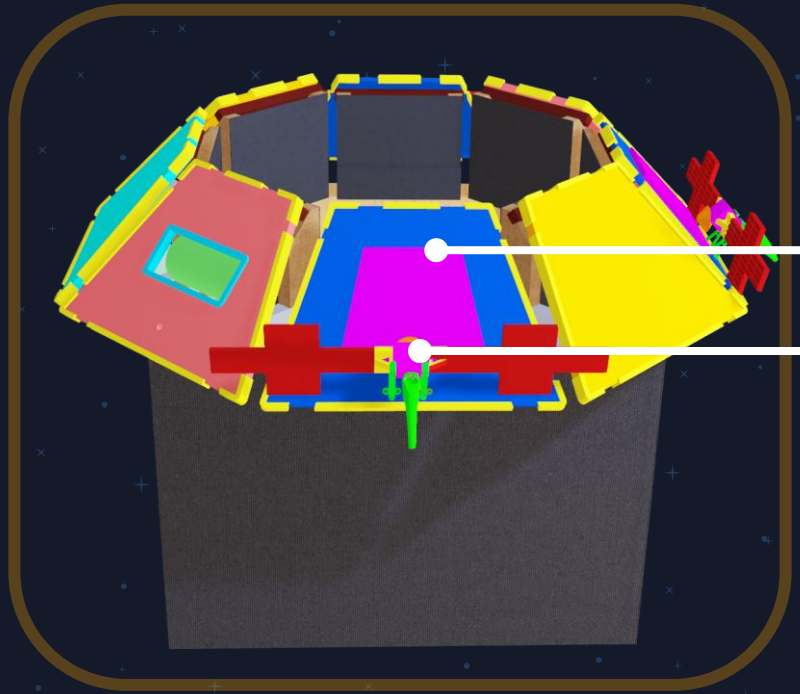
Sara Bradley

Structure Design



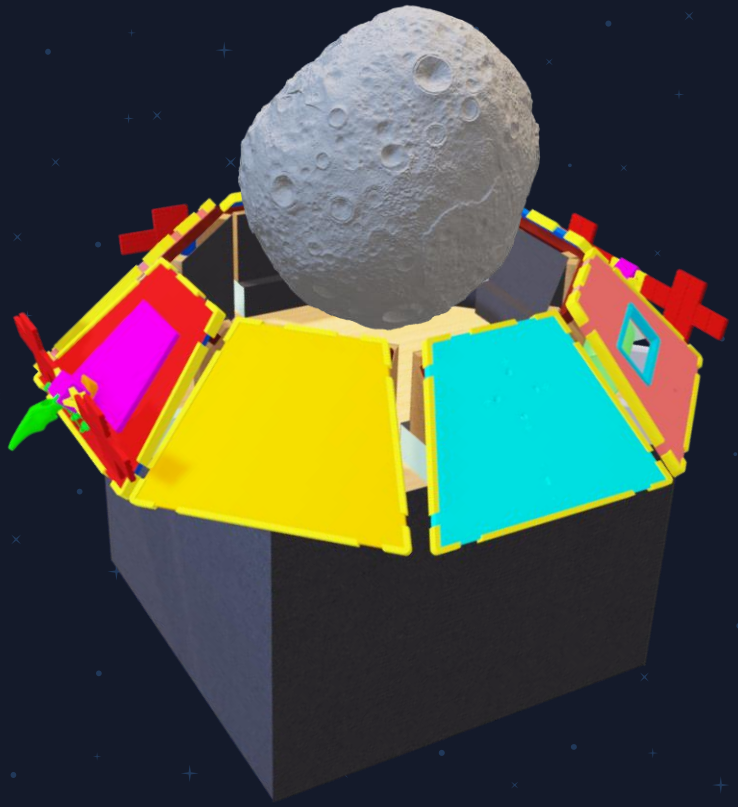
Sara Bradley

Structure Design



Sara Bradley

Full Design



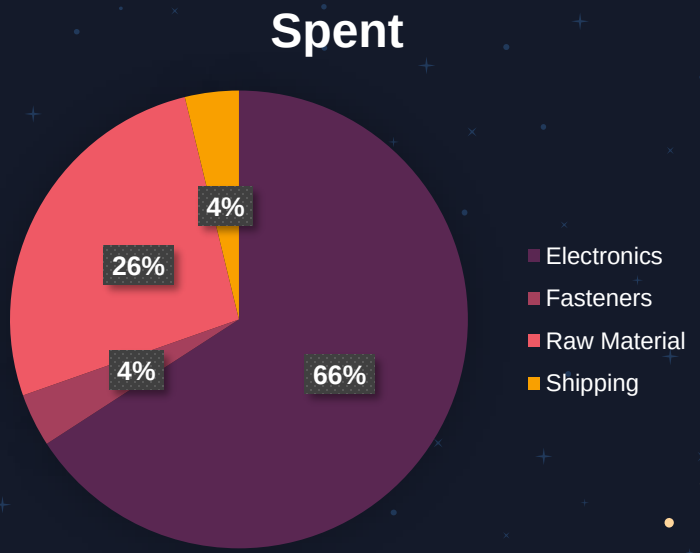
*Asteroid not to scale with the rest of the model

Sara Bradley

Budget

Spent: $612.43

Electronics	$403.33
Fasteners	$23.01
Raw Material	$162.79
Shipping	$23.30
Total	**$612.43**
Remaining	**$382.57**

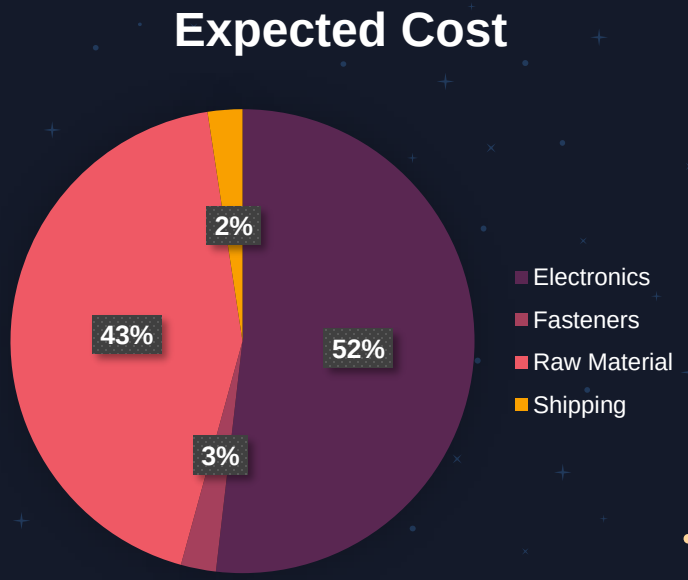


Garett Southerland

Budget to Replicate

Expected: $612.43

Electronics	$499.59
Fasteners	$23.58
Raw Material	$417.36
Shipping	$23.3
Total	**$963.83**



Garett Southerland

Future Work

Integrate the DDR pad

Optimize asteroid rotation and control both directions of rotation

Add screens to text panels for electronic updates

Garett Southerland

Lessons Learned

- Users dislike surveys
- Making sure everyone understands the project scope and responsibilities is extremely important
- Assemblies can be directly imported into PowerPoint in color
- Team members have different priorities
- Tolerancing and fitting parts of different material and manufacturing methods together
- Asking before assuming information

Garett Southerland

Summary

Our design and construction created an interactive museum exhibit that educates people about the Psyche mission.

Our exhibit was tested at an open house event and met our requirements.

Currently, we are collecting more user data to include for the presentation on April 6.

Garett Southerland

Additional Slides

Additional Slides

Project Overview

Objective | **Problem** | **What is Psyche?** | **Present Mission**

Spencer Martin

Project Overview

Objective

The objective of this project is to create interest in the Psyche Mission with an interactive exhibit.

Spencer Martin

Project Overview

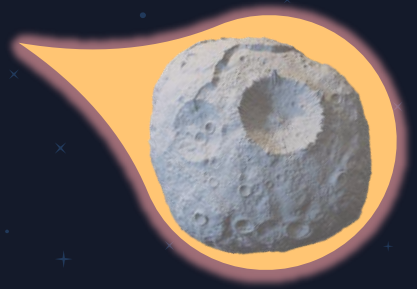
Problem

The problem is ensuring a lasting interest in the Psyche Mission and Science, Technology, Engineering, Art, and Math (STEAM).

Spencer Martin

Project Overview

What is Psyche?



Psyche is an asteroid the size of Massachusetts!

The remains of a Planetesimal (Planet) with an iron-nickel core that experienced many violent collisions.

Psyche is believed to be the core of that planet.

Spencer Martin

Project Overview

Present Mission

Psyche project is targeting an October 2023 launch on a SpaceX Falcon Heavy rocket.

Spencer Martin

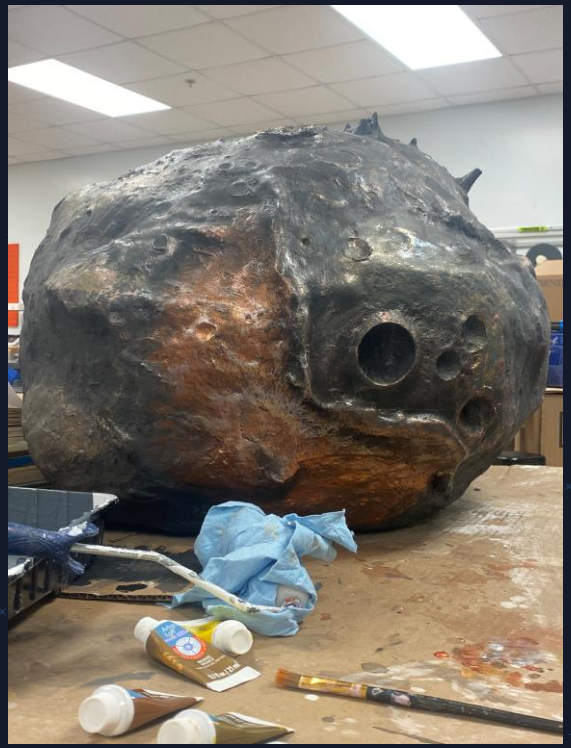
Open House Demonstration

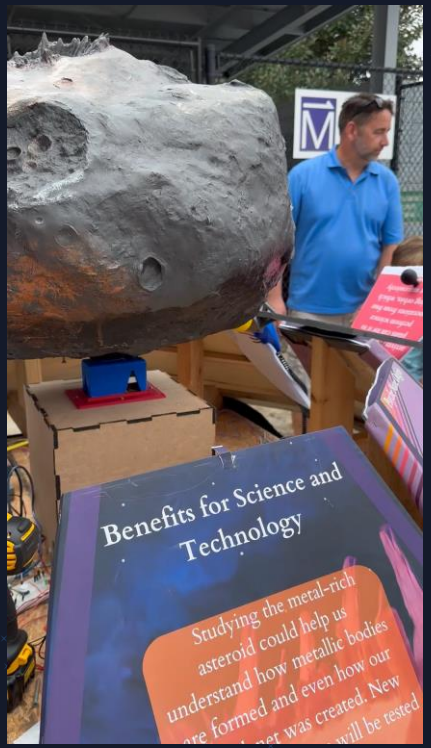
Systems were tested for their performance when operated by users

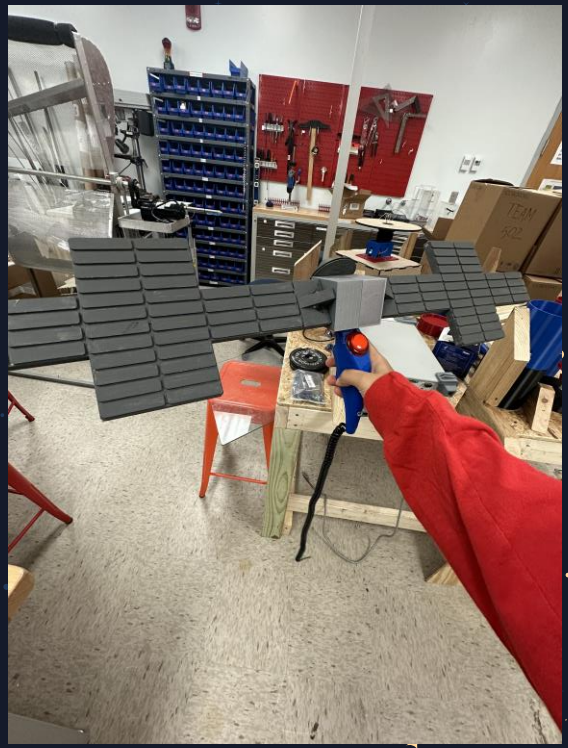
Additionally, the survey information retrieved will be used to improve the interactive elements

Garett Southerland

Open House Demonstration





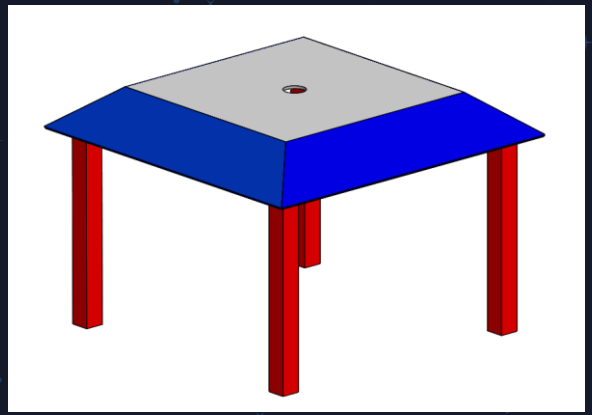


Garett Southerland


Benefits for Science and Technology


Psyche Orbit
The Psyche spacecraft and solar panels are about the size of a


Spacecraft Technology
Use the Psyche Pointer to reveal information below
Once the spacecraft arrives at the asteroid, plans call for it to perform science operations from four staging orbits, which become successively
Multispectral Imager



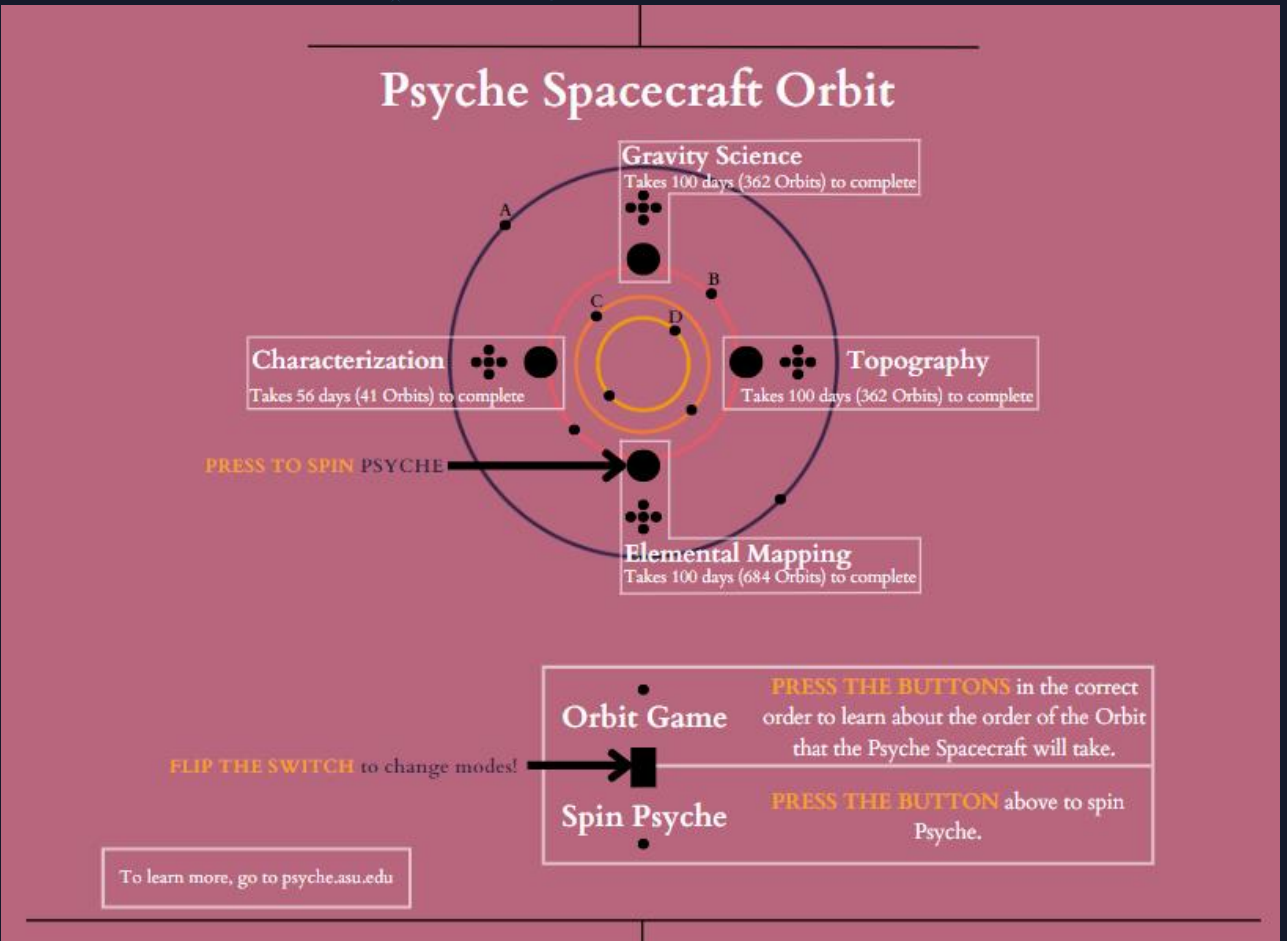
PUT extra stuff in the slides after this

Open House Demonstration

Survey data (17 surveys completed)
Features first noticed: Asteroid (15), panel flippers (1), panels (1)
Favorite panel: Cylinder (5), Psyche orbit (4), Mission (2)
blaster panel (1), name/origin (1)
Favorite feature: Asteroid (9), blasters (4), cylinder (1)
Positive interaction: yes (15), no (1)
Easy to find blaster targets on Asteroid: yes (14), no (3)
Facts learned: metal world (5), size of Mass. (3), spaceship (2),
235 million miles away (1)
Age range: 19 and over (7), under 11 (8), 11-13 (1), 14-18 (0),
Favorite school subject: science (8), math (6), art (1), history (1)

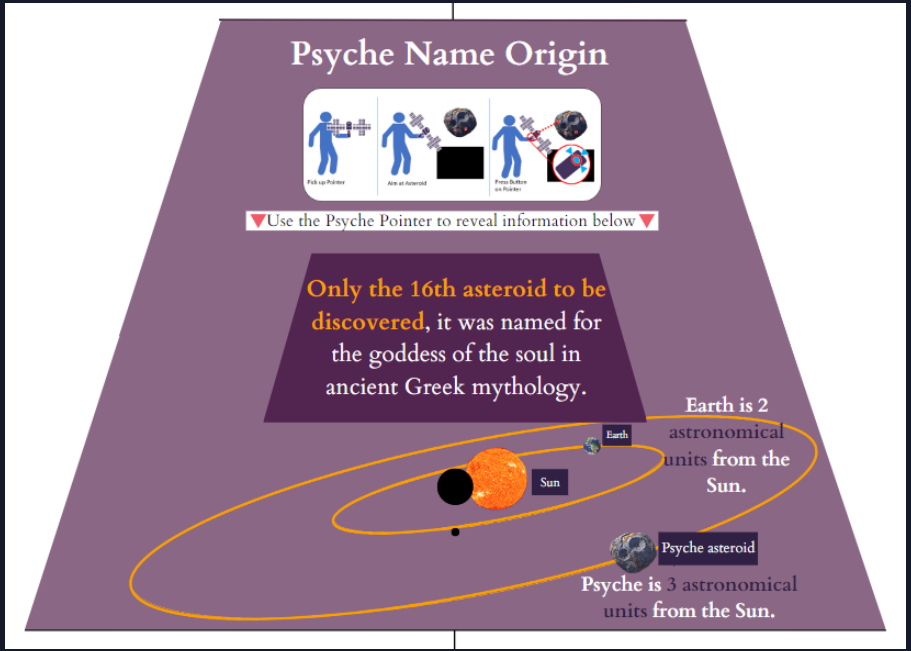
Connor Bishop

Panel Designs

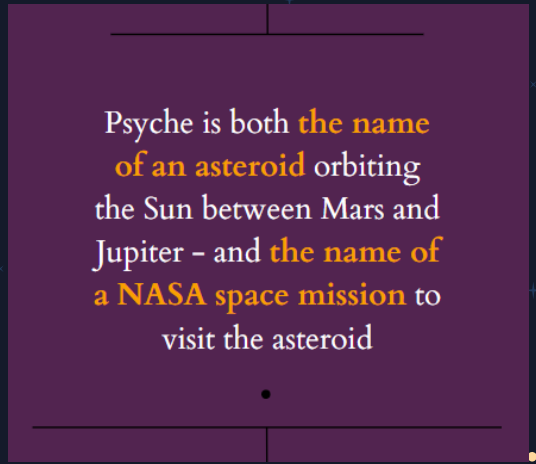


Memory game/spin the asteroid panel

Panel Designs

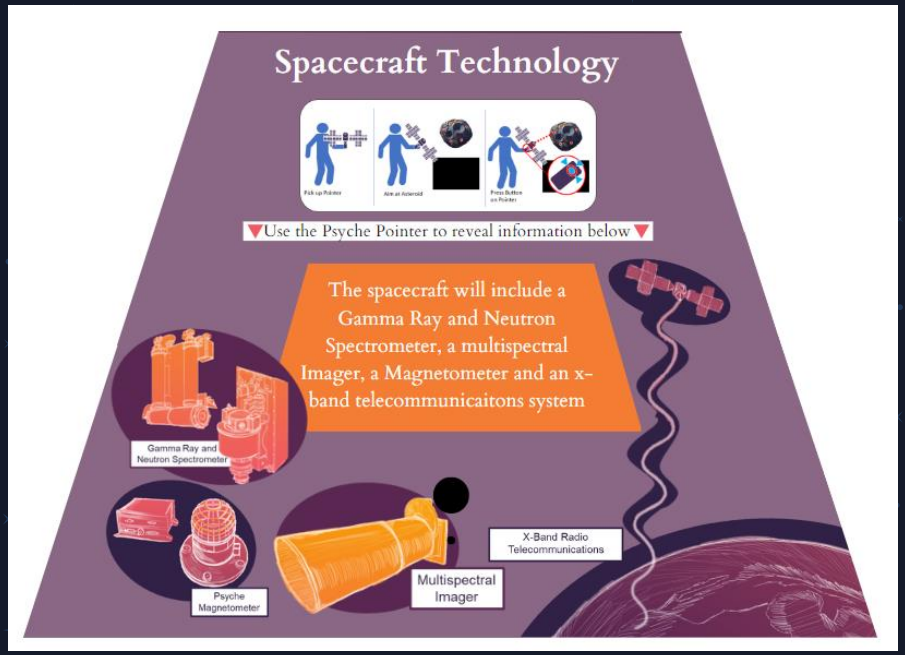


Flipper 1 - base



Flipper 1 - top

Panel Designs

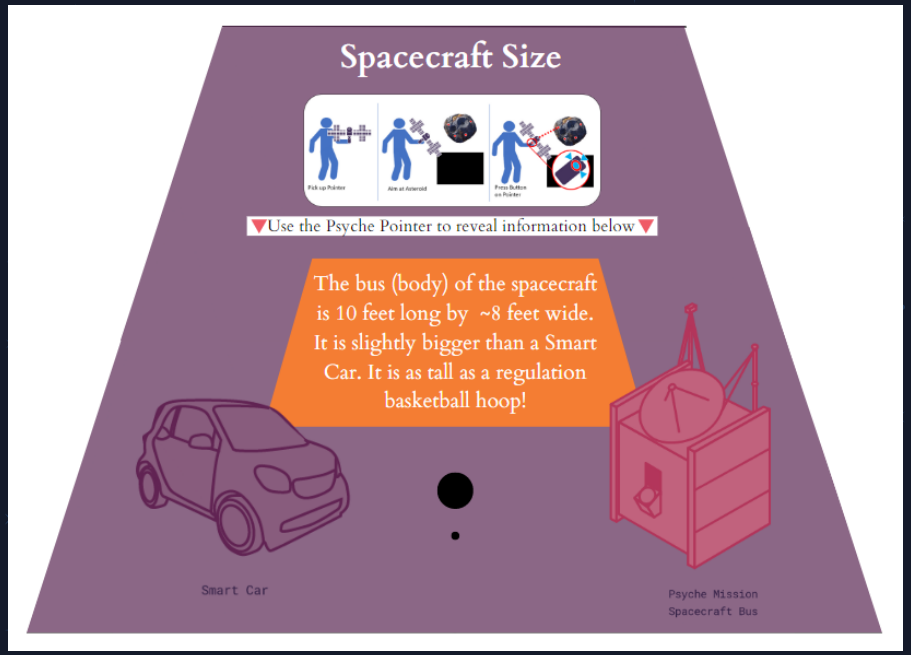


Flipper 2 - base

Once the spacecraft arrives at the asteroid, plans call for it to perform science operations from four staging orbits, which become successively closer.

Flipper 2 - top

Panel Designs



Flipper 3 - base

Flipper 3 - top

Panel Designs

Solenoid 1 - base

Solenoid 1 – on solenoid

Panel Designs

Solenoid 2 - base

Solenoid 2 – on solenoid

Panel Designs

Benefits for Science and Technology

The spacecraft will be powered by solar electric propulsion technology, a technology currently being developed for future missions to Mars!

Text 1

Panel Designs

Text 2

Project Overview

It is believed that Psyche is the remains of a planetesimal with an iron-nickel core that experienced many violent collisions.

The problem is ensuring a lasting interest in the Psyche Mission and Science, Technology, Engineering, Art, and Math (STEAM).

Kenneth Zhou

Accessibility Considerations

Height of text panels

Ease of use people in wheelchair

Angle of text panels

Change picture to new model

Garett Southerland

Accessibility Considerations

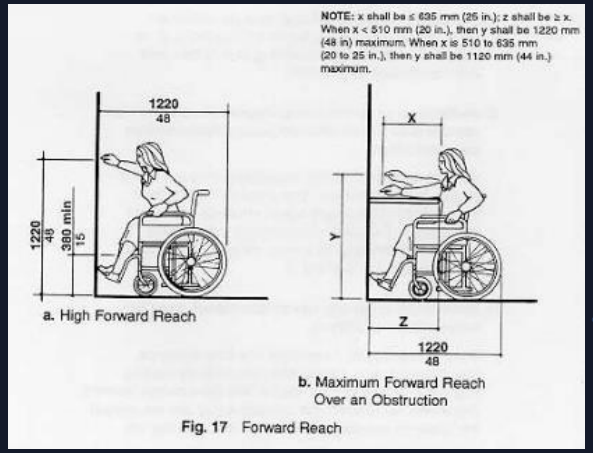


Fig. 17 Forward Reach

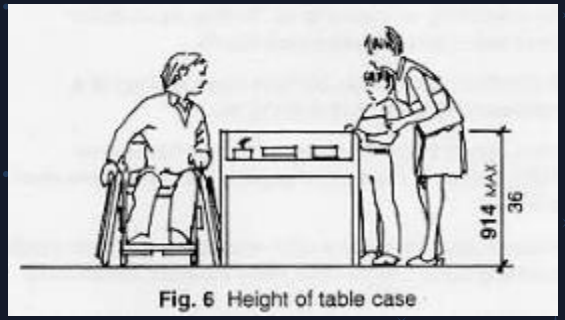


Fig. 6 Height of table case

Fig. 26 Cane detection of wall-hung case

Garett Southerland

ACCESIBLE EXHIBITION DESIGN

Mount small items no higher than 40 in (1015 mm) above the floor

Include closed captioning for audio aspects and alternative text for visual aspects of the design

Construct the top of a case no higher than 36 in (915 mm) above the ground

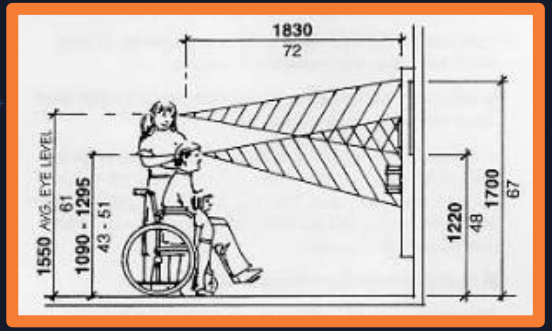


Figure 6 : Wall mounting

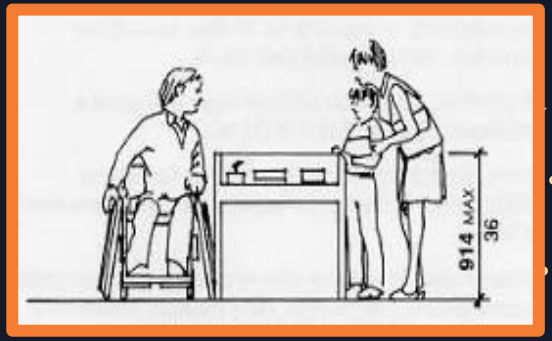
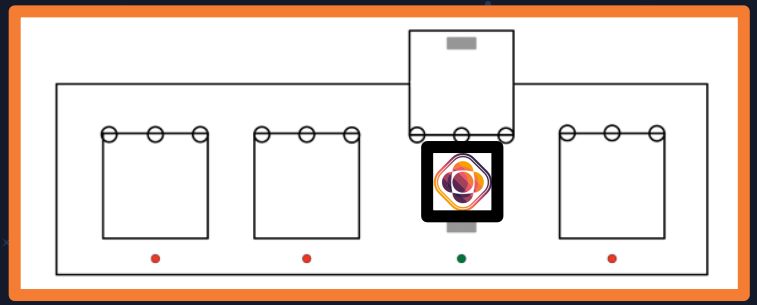


Figure 7: Table display

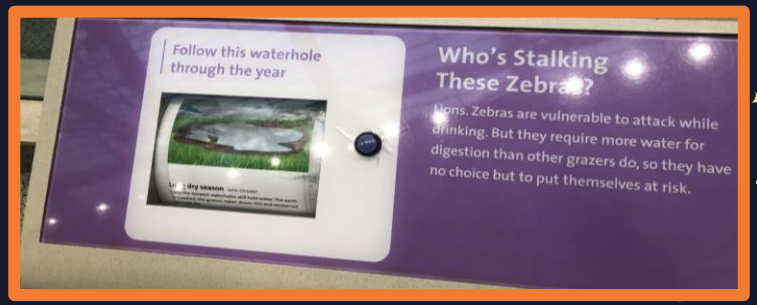
Presenter Name

Information Displays

Locked panels



Rotating information cylinder



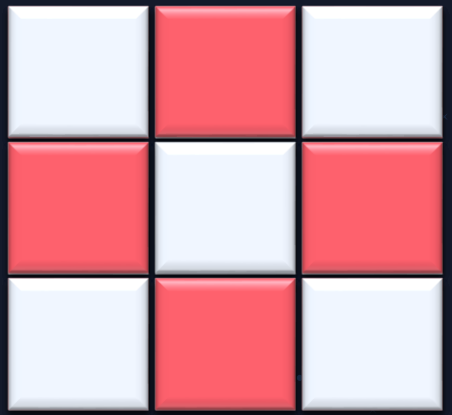
Garett Southerland

Interactive Aspects

Repeat the pattern or Simon Says game

Interact with IR sensors to unlock information panels

Rotate the asteroid using dance pads



Garett Southerland

References

"A mission to a Metal World," *Psyche Mission*, 21-Jul-2022. [Online]. Available: https://psyche.asu.edu/. [Accessed: 06-Oct-2022].

"Access smithsonian," *Access Smithsonian | Access Smithsonian*. [Online]. Available: https://access.si.edu/. [Accessed: 06-Oct-2022].

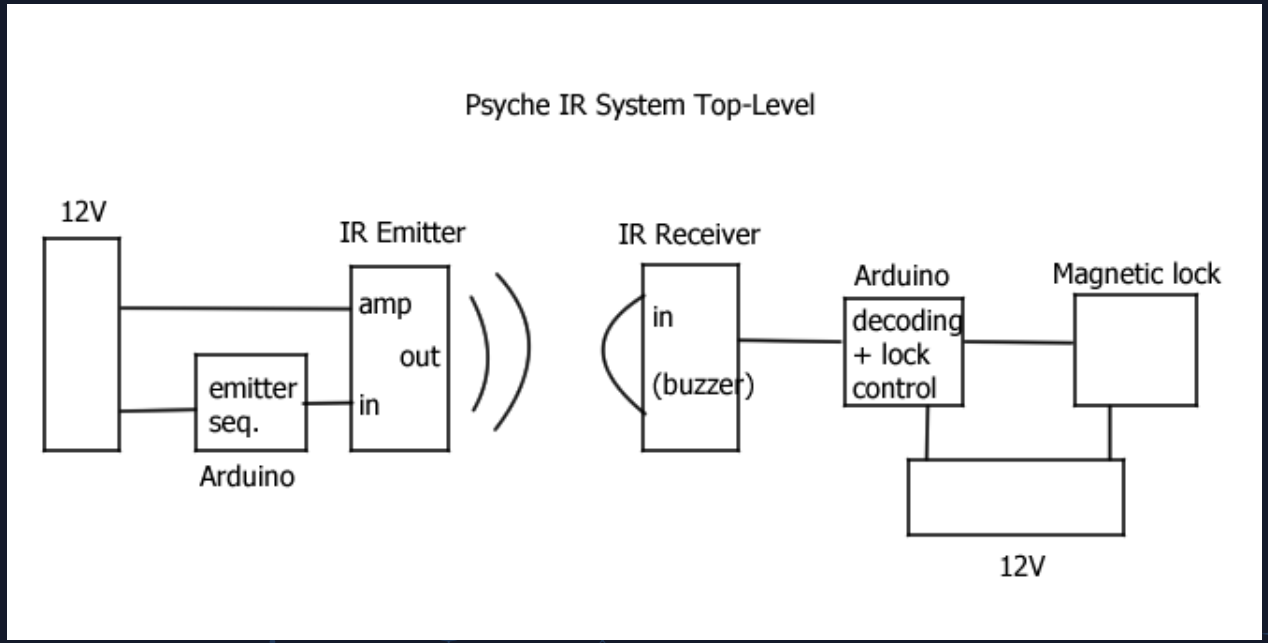
E. Asphaug, J. F. Bell, C. J. Bierson, B. G. Bills, W. F. Bottke, S. W. Courville, S. D. Dibb, I. Jun, D. J. Lawrence, S. Marchi, T. J. McCoy, J. M. G. Merayo, R. Oran, J. G. O'Rourke, R. S. Park, P. N. Peplowski, T. H. Prettyman, C. A. Raymond, B. P. Weiss, M. A. Wieczorek, and M. T. Zuber, "Distinguishing the origin of asteroid (16) psyche - space science reviews," *SpringerLink*, 12-Apr-2022. [Online]. Available: https://link.springer.com/article/10.1007/s11214-022-00880-9. [Accessed: 06-Oct-2022].

Summary

After going through the initial design phase and early prototyping, we are in the process of refining and fabricating our designs to make a fully functioning exhibit by 2/25/23.

Garett Southerland

IR System design



Education Integration

- Users see instructions that detail how the game is played
    - Instructions are encoded with the over-arching purpose of psyche (framing the IR game as the user operating the satellite to scan Psyche for information, and how)
- Users play the game and unlock additional information
    - These facts are also encoded with how important the psyche mission is
    - E.G. "good work, scientist! We these craters were likely formed by ____ … this can tell us a lot about how our planet Earth has been formed!"

Case studies

- Caleb, Age 8
    - Able to identify IR scanner as something to be picked up and pointed and DDR pad is to be stepped on.
    - Will likely not read the instructions or any facts on the placard unless his parents outwardly point it out.
    - Is likely to test the durability of the IR scanner and Dance pad, not with the intention of destroying it, but from enjoying the raw physical feedback of stomping and pressing buttons.
- Jacob, Age 14
- Scillia, age 6
- Ann, age 43

Case studies

- Caleb, Age 8
- Jacob, Age 14
    - Arrives with a group of friends and/or family friends. No adult supervision has he attends the exhibit with cohorts within his age group.
    - Will spend especially long exploring the features as each friend experiences the exhibit individually. They create dialogue about different aspects of the exhibit.
    - May act rowdy, due to negligence and preoccupation with other friends in group
- Scillia, age 6
- Ann, age 43

Case studies

- Caleb, Age 8
- Jacob, Age 14
- Scillia, age 6
    - Visiting with her parents, she is epileptic.
    - Has no prior exposure to videogames. Will not likely touch the IR scanner unless encouraged by parents, but she remains interested in the DDR pad.
    - May not know how to play the game properly but will still attempt to jump and toy with the DDR pad until her parents either instruct her or tell her to stop disrespecting the machine and leave.
- Ann, age 43

Case studies

- Caleb, Age 8
- Jacob, Age 14
- Scillia, age 6
- Ann, age 43

    - Visiting with her children (ages 4 and 7), only coming to be out of the house.

    - Helicopters the children – will only use the IR scanner long enough to placard out to them before quickly redirecting their attention, Will only let the children play with the dance pad until a completion metric is reached.

Psyche Story

How did Psyche get there?
There are three theories, but one leading formation of Psyche:
Psyche believe to be part of a differentiated body, meaning it is what remains of a once larger planet, and experienced iron volcanism.

Current mission?
Psyche is the only metallic core-like body we have discovered and can teach us a lot. The mission is to study using a spacecraft also named *Psyche.*

Future of the mission?
The most recent major update on the Psyche mission was in Feb 2020 when NASA awarded SpaceX the $117 million contract launch *Psyche. Psyche* is scheduled to launch no earlier than 2024.

Our role
Our objective is to raise awareness and interest in Psyche and to get the public excited about the future of the mission.

Presenter Name

Museum visitor experience

On average, families spend 1.6 minutes on an individual exhibit and non-families spend 1.1 minutes.

Mean Time per Exhibit

	Family	Nonfamily	Average
Weekday	1.9[a]	0.9[a]	1.4
Weekend	1.3	1.2	1.3
Average	1.6	1.1	1.4

Note. All times are in minutes. Values are averaged over both exhibitions.
[a]These values are statistically different from one another.

Figure 8: Time spent at each interactive exhibit

Presenter Name

Customer Needs

The product has the ability to have a user interact with it.

The product has the ability to simulate the user's senses.

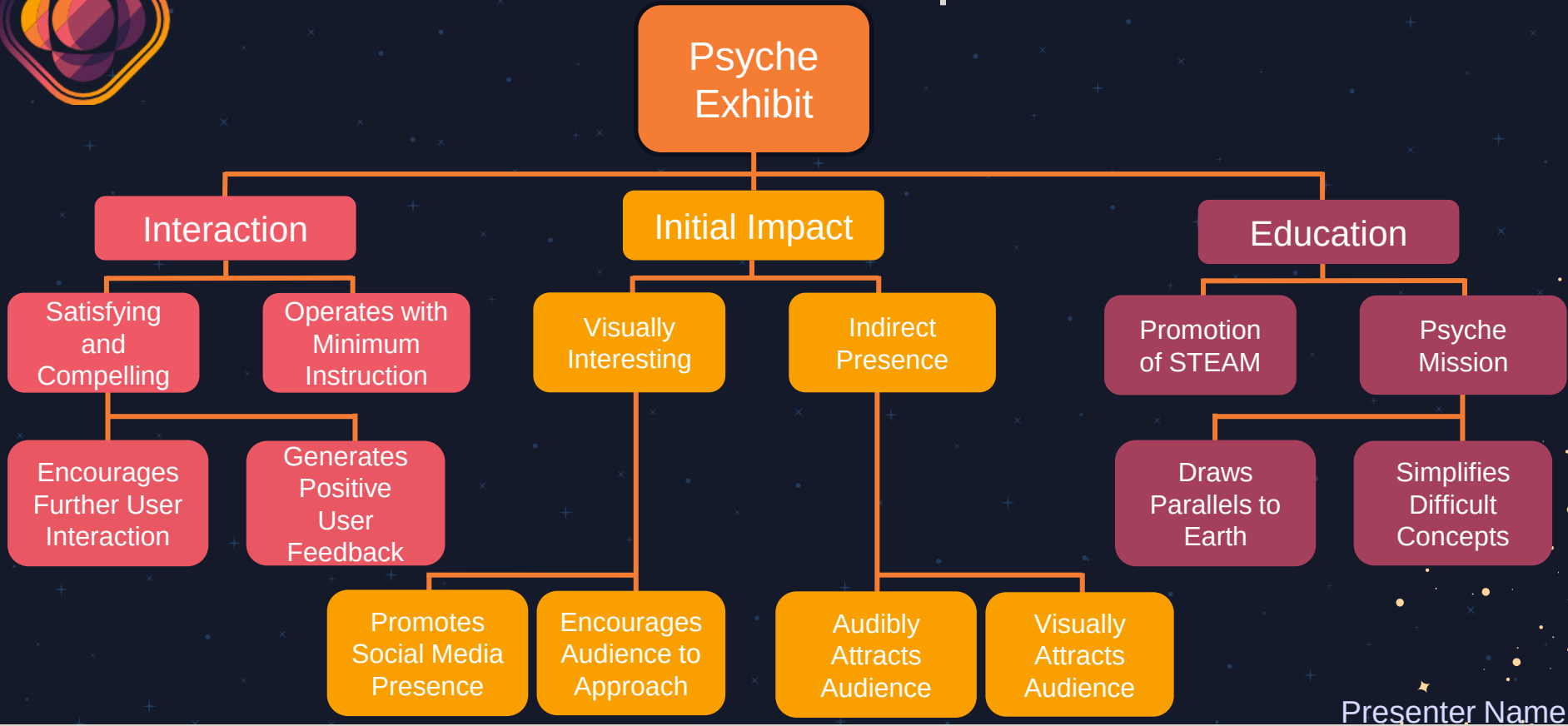
The product has the ability to run without a wall outlet if one is not availble.

The product should use little to no custom parts outside of parts that are 3D printable

The product has the ability to hide components that are not meant for the user to touch.

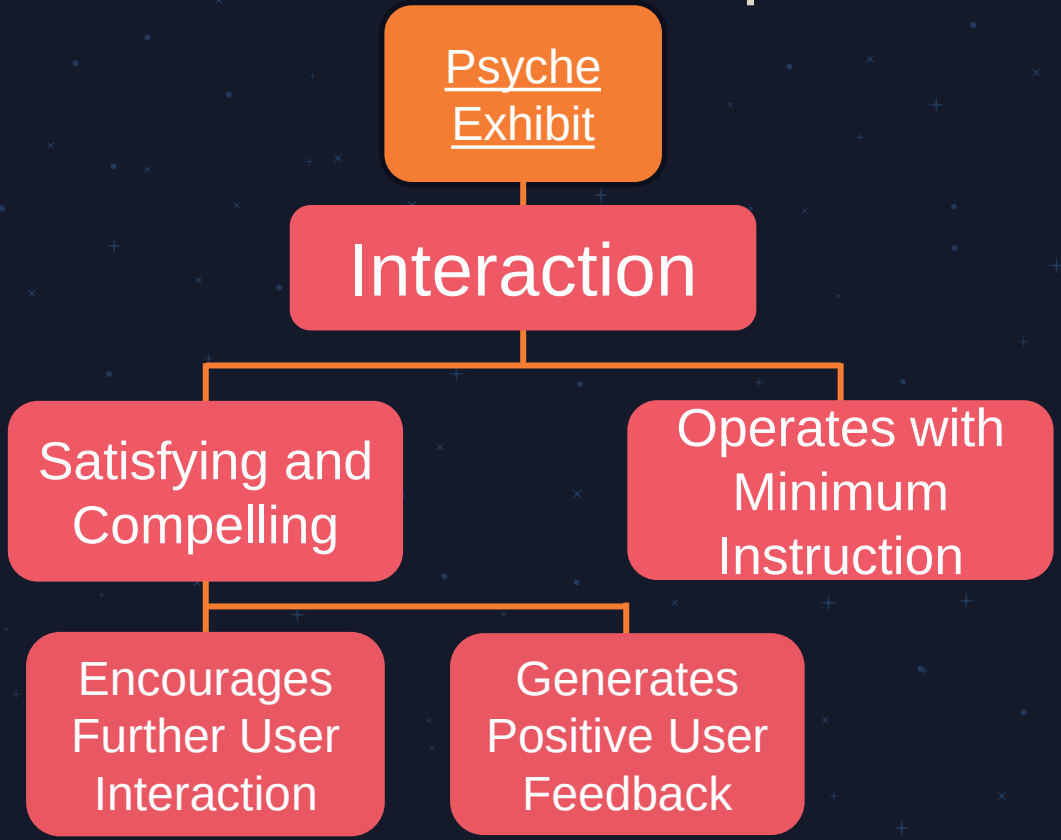
Presenter Name

Functional Decomposition



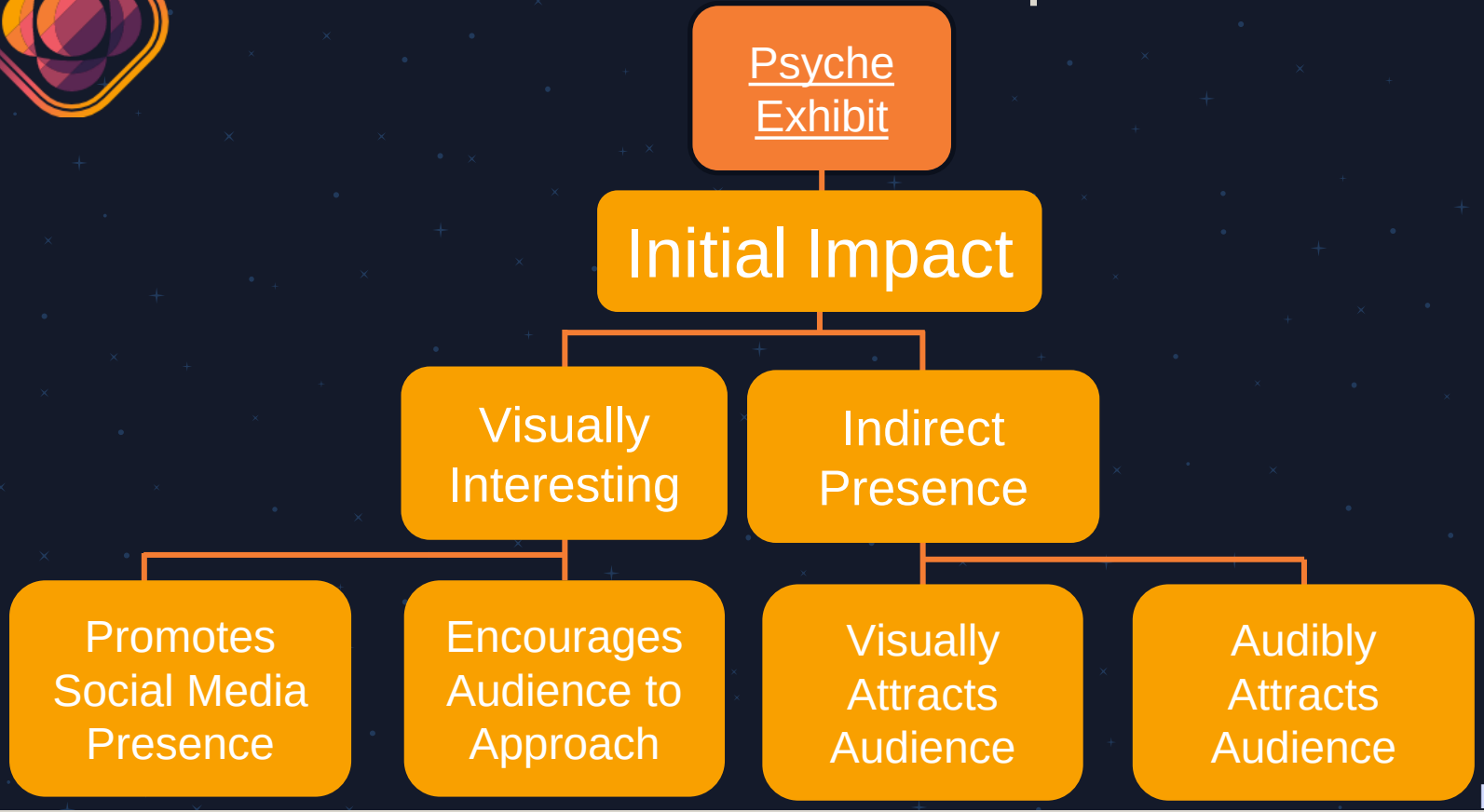
Presenter Name

Functional Decomposition



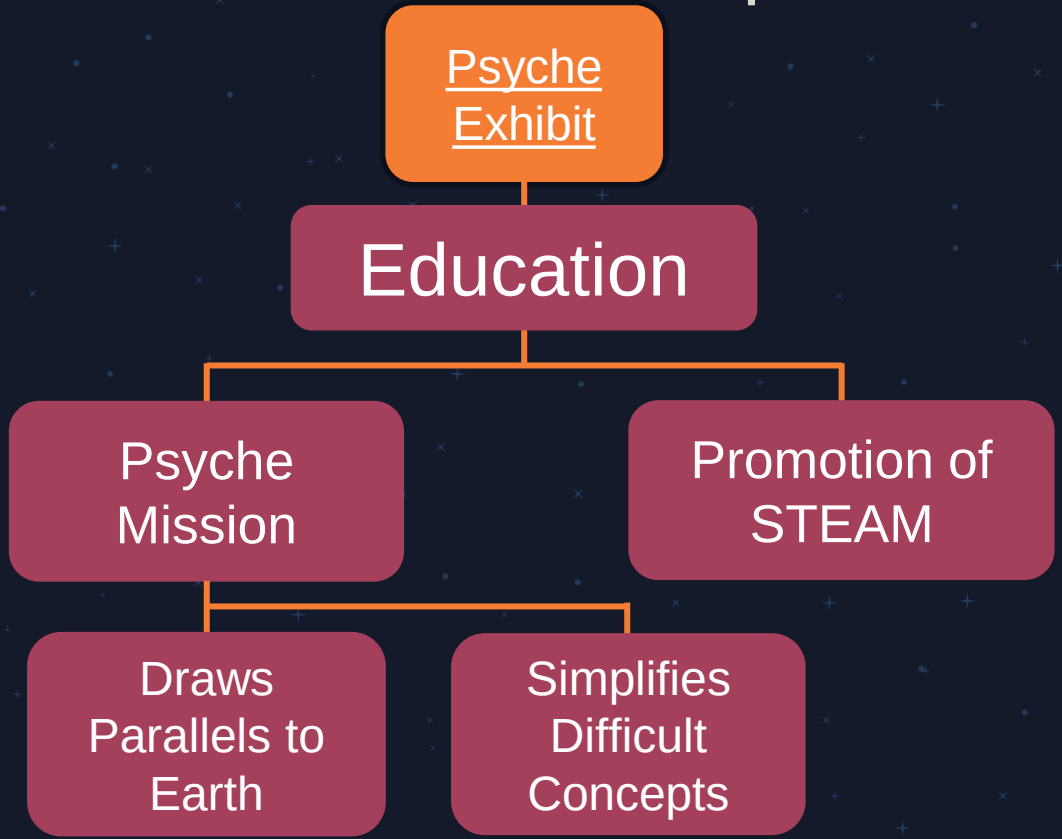
Presenter Name

Functional Decomposition



Presenter Name

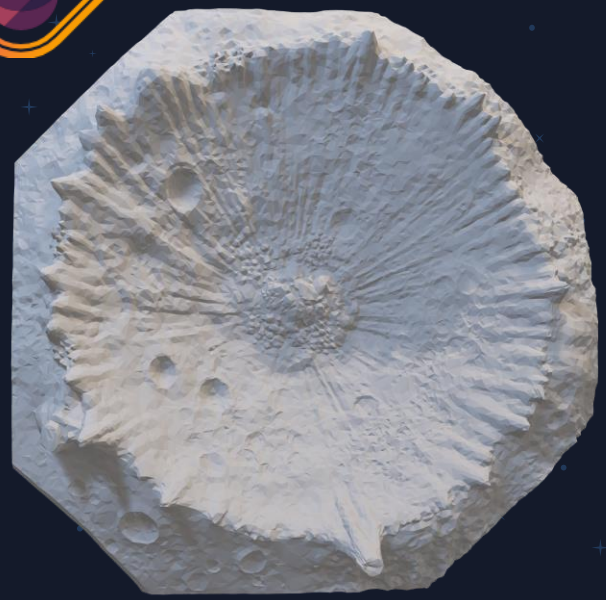
Functional Decomposition



Presenter Name

Asteroid Design

3D Printed Craters



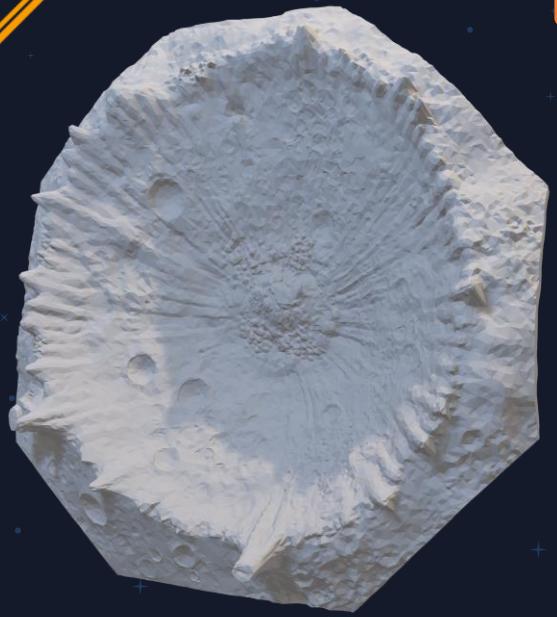
1 Large Crater

3 Smaller Details

Marjam Medina

Asteroid Design

3D Printed Craters



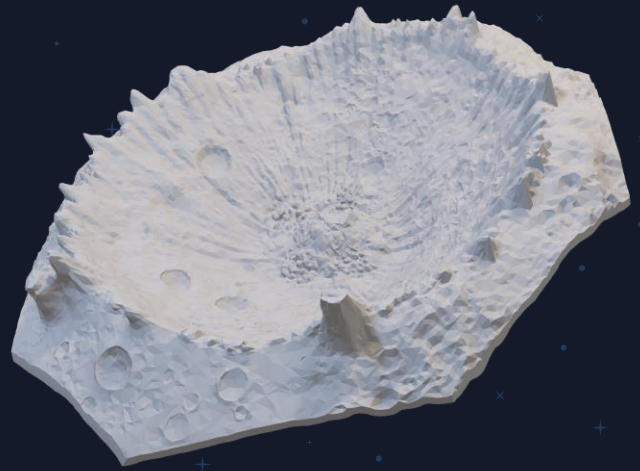
1 Large Crater

3 Smaller Details

Marjam Medina

Asteroid Design

3D Printed Craters

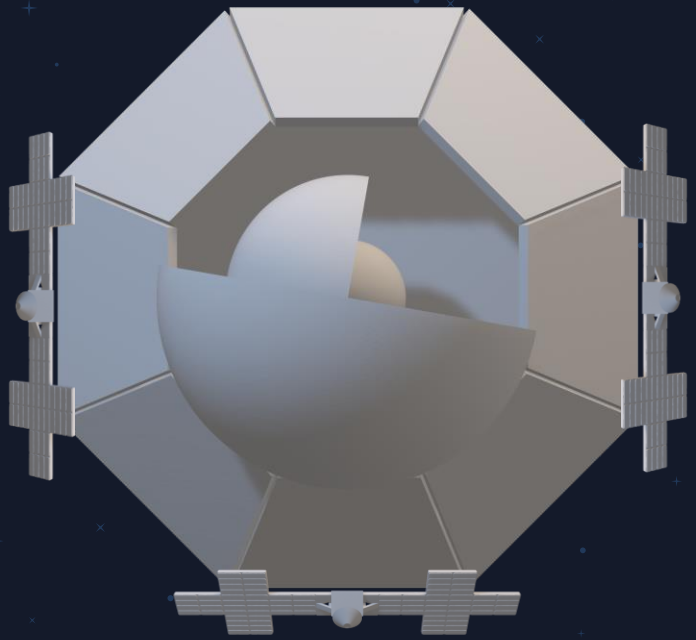


1 Large Crater

3 Smaller Details

Marjam Medina

Structure Design



- Octagonal panels
- Asteroid in the center
- Blasters holstered below panels

Marjam Medina

Design Overview

Blaster Design

Mariam Medina

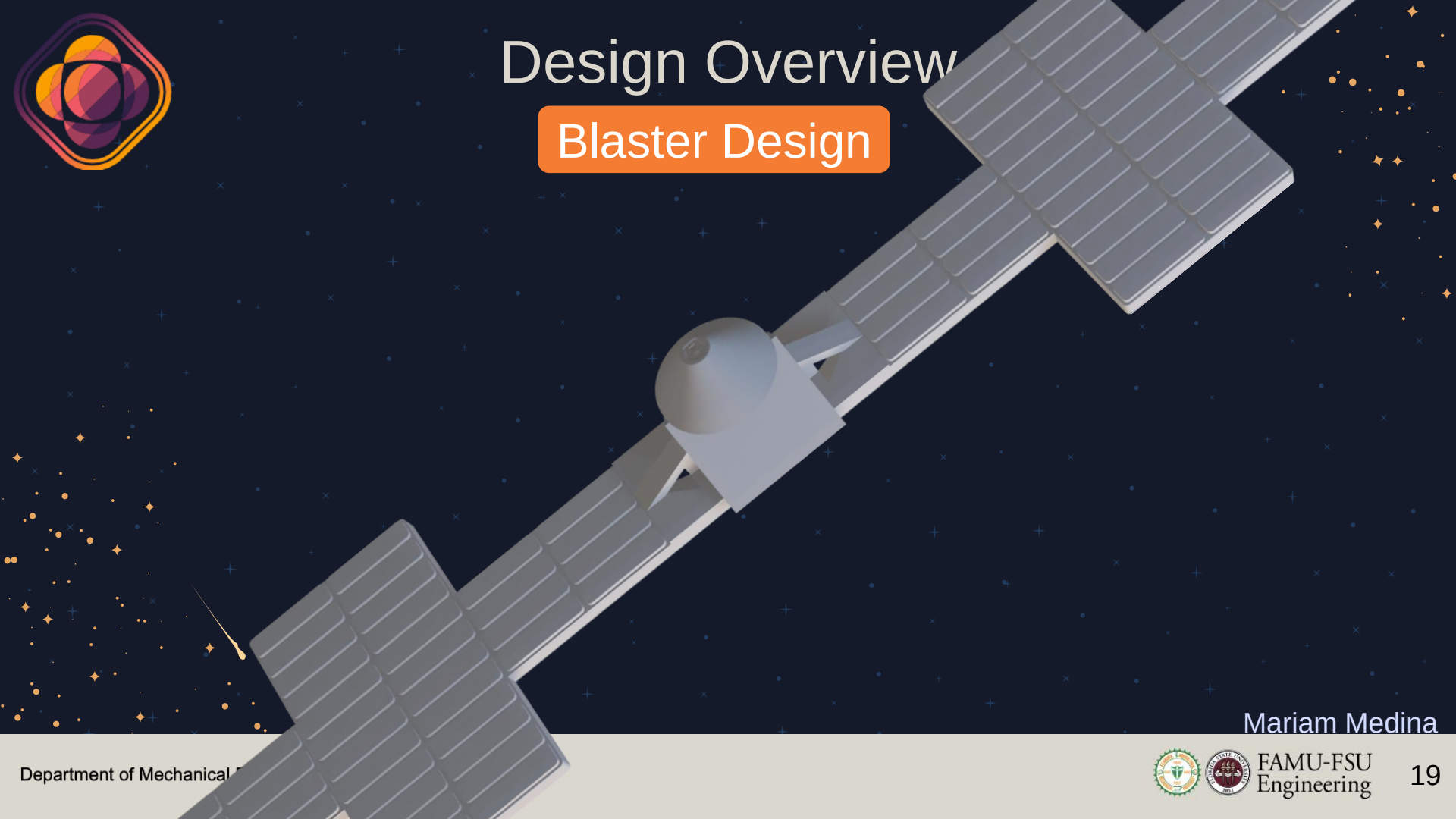
Design Overview

Blaster Design

Mariam Medina

Design Overview

Blaster Design



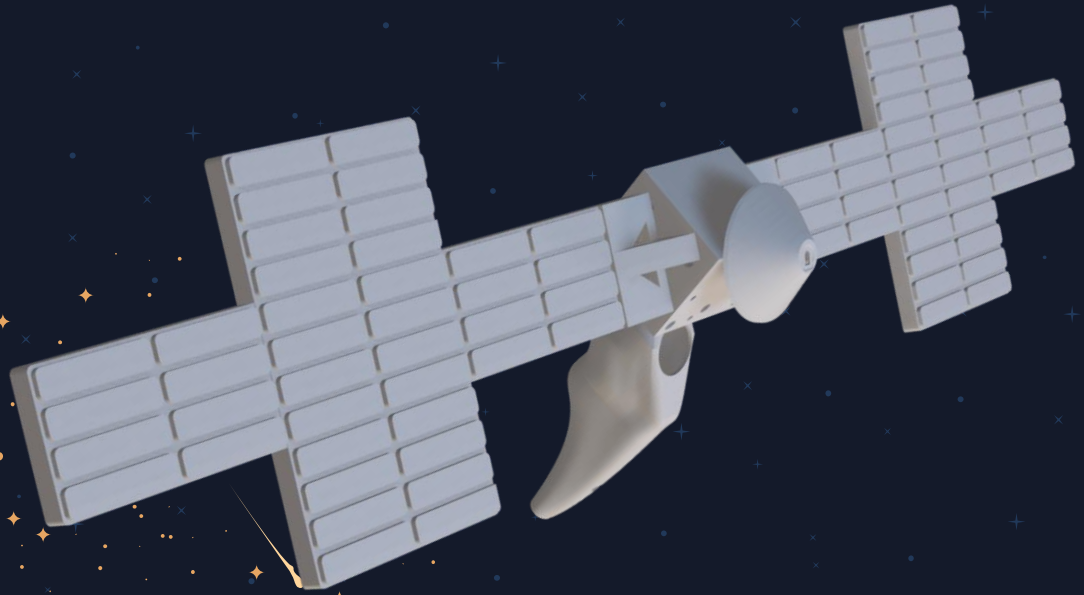
Design Overview

Blaster Design

Mariam Medina

Design Overview

Blaster Design



Provides users a way to interact with the asteroid and info panels

Uses infrared signals to unlock info on the panels

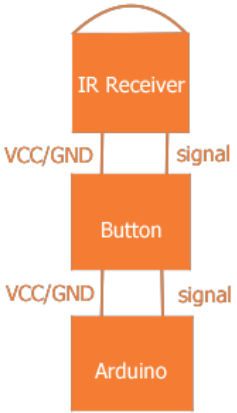
Made to a 1/16 scale with the Psyche spacecraft

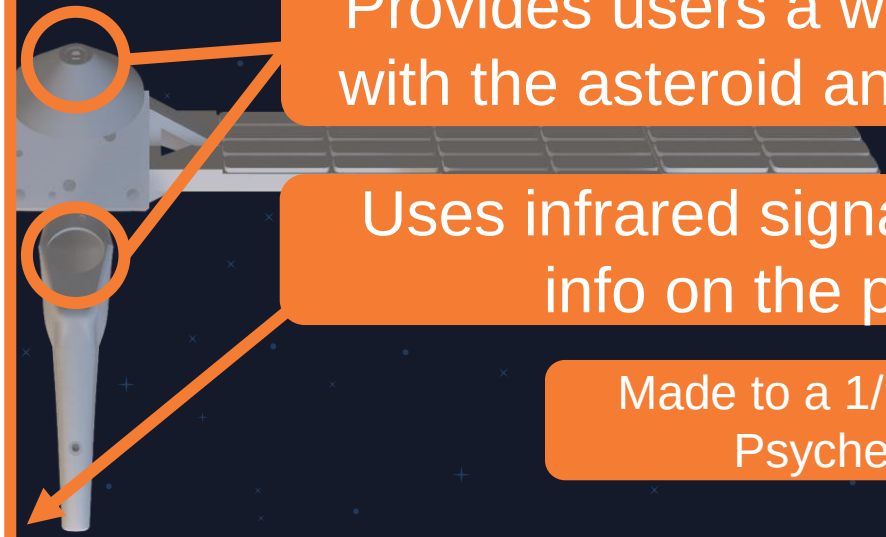
Mariam Medina

Design Overview

Blaster Design

Circuit Diagrams



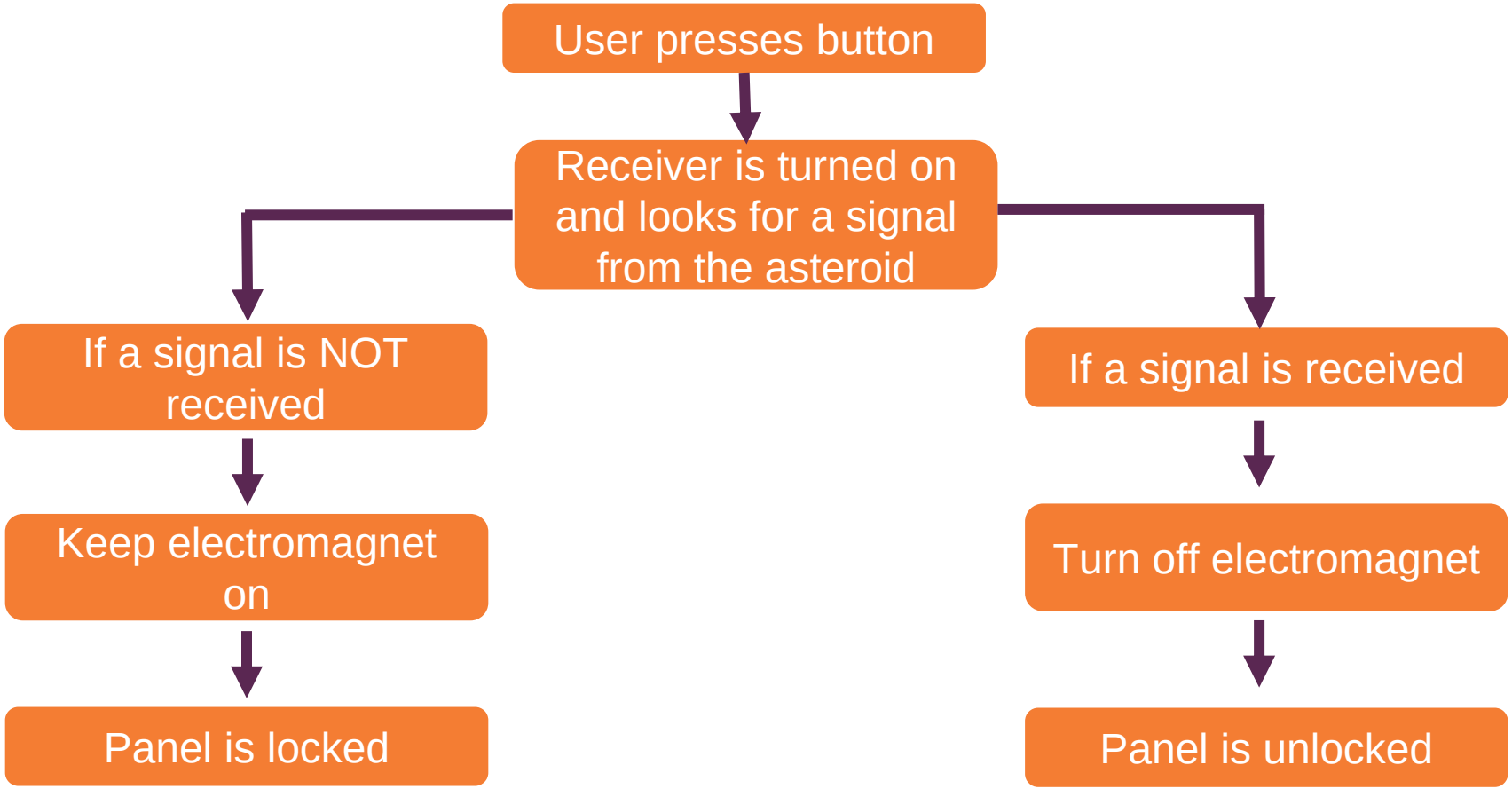


Provides users a way to interact with the asteroid and info panels

Uses infrared signals to unlock info on the panels

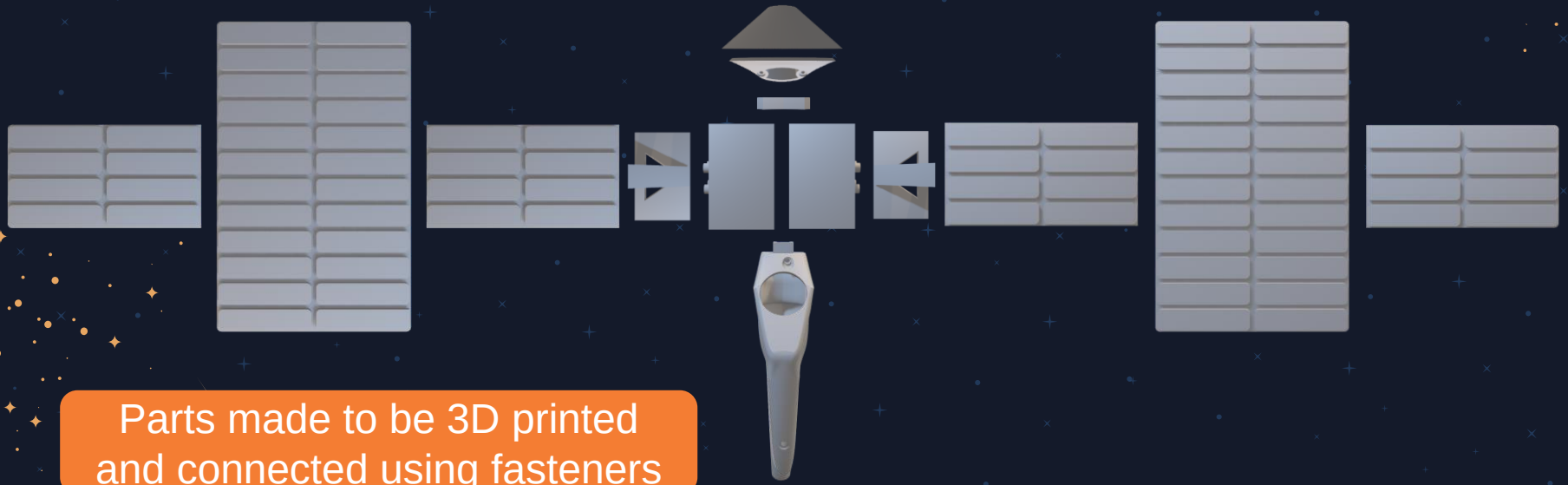
Made to a 1/16 scale with the Psyche spacecraft

Mariam Medina


User presses button
Receiver is turned on and looks for a signal from the asteroid
If a signal is NOT received
Keep electromagnet on
Panel is locked
If a signal is received
Turn off electromagnet
Panel is unlocked

Design Overview

Blaster Design

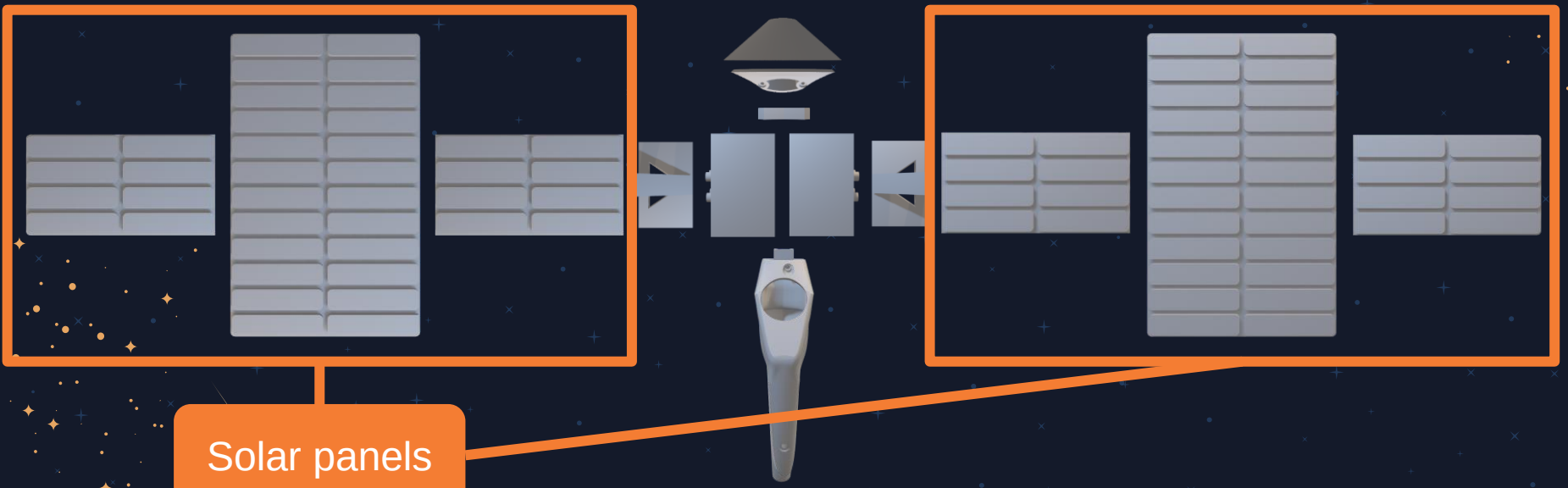


Parts made to be 3D printed and connected using fasteners

Mariam Medina

Design Overview

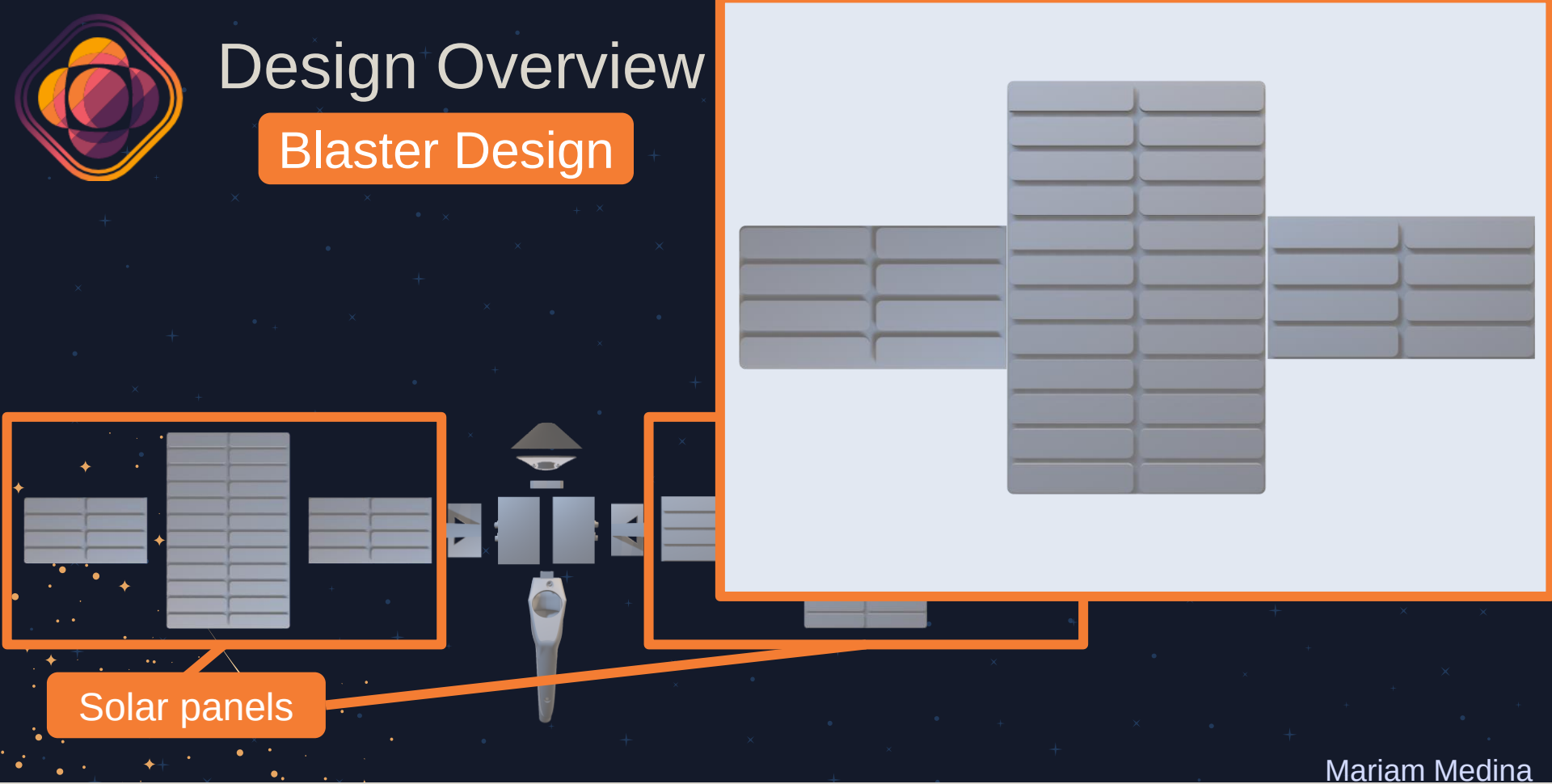
Blaster Design



Mariam Medina

Design Overview

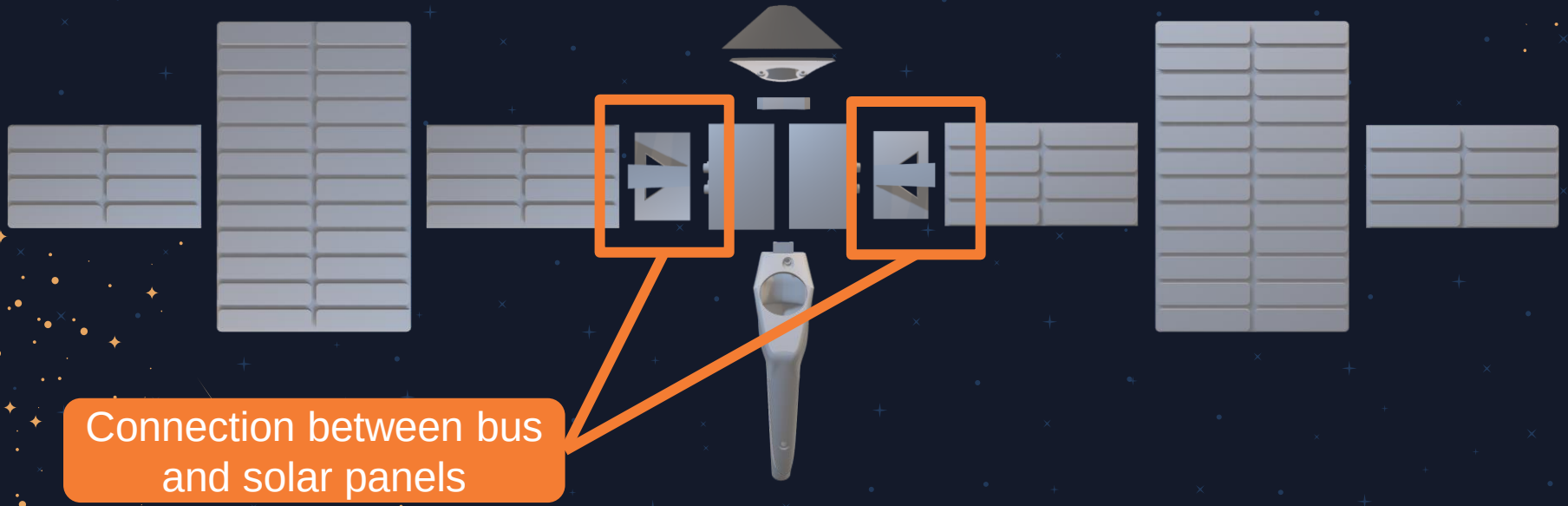
Blaster Design



Mariam Medina

Design Overview

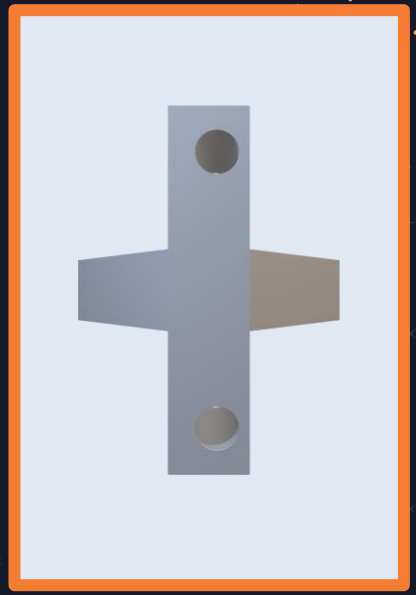
Blaster Design

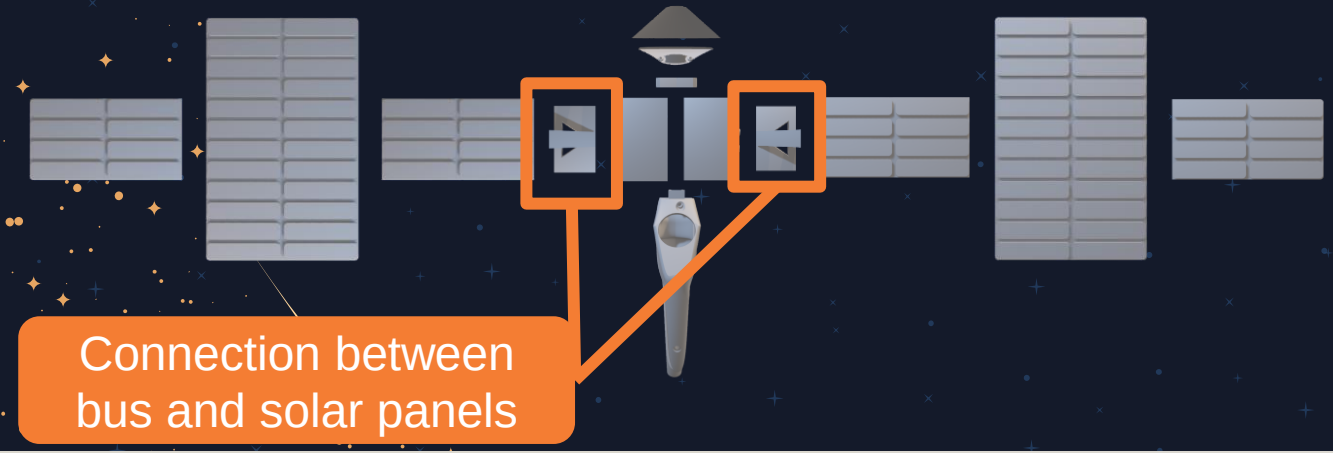


Mariam Medina

Design Overview

Blaster Design



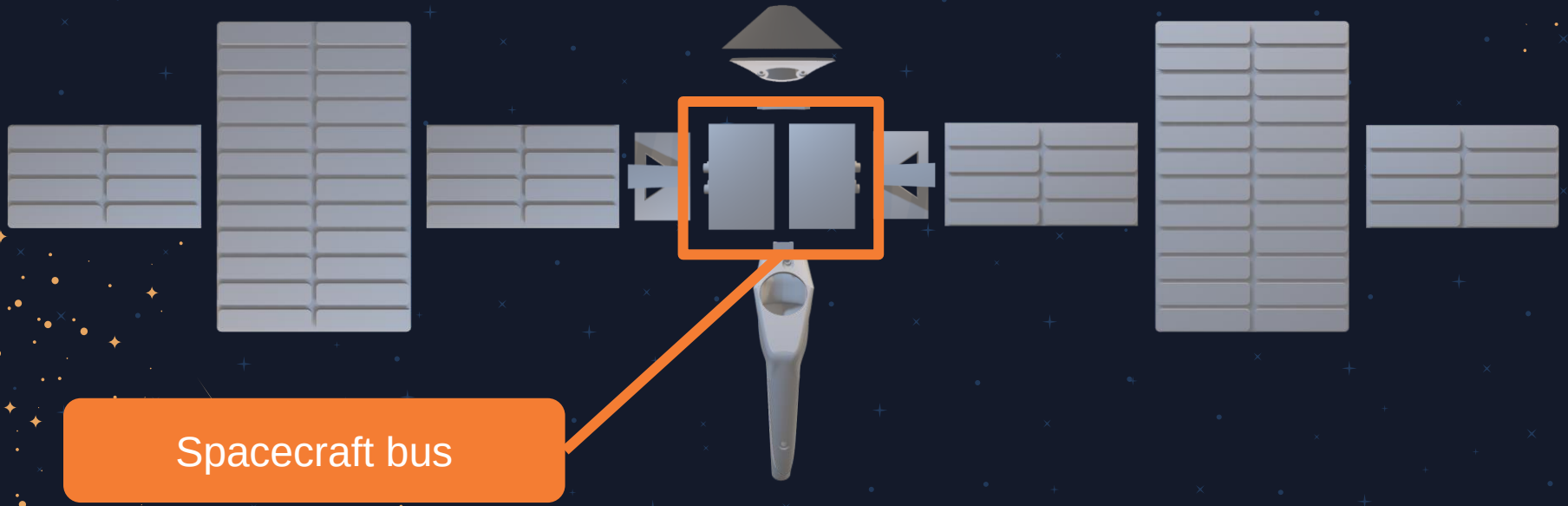


Connection between bus and solar panels

Mariam Medina

Design Overview

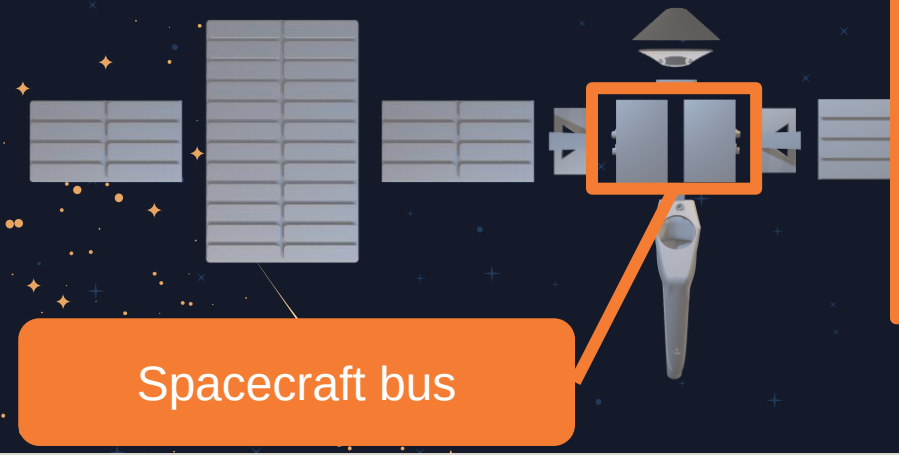
Blaster Design



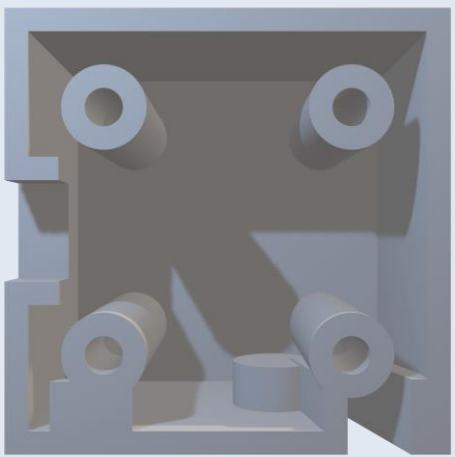
Mariam Medina

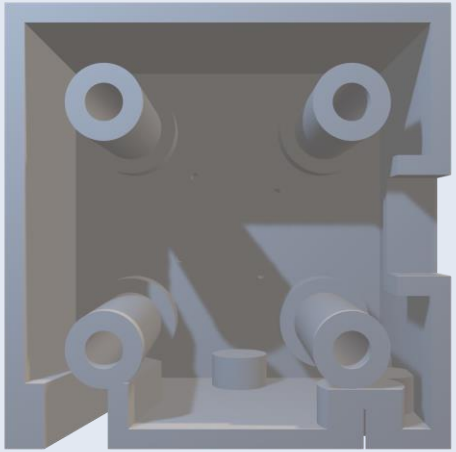
Design Overview

Blaster Design



Spacecraft bus

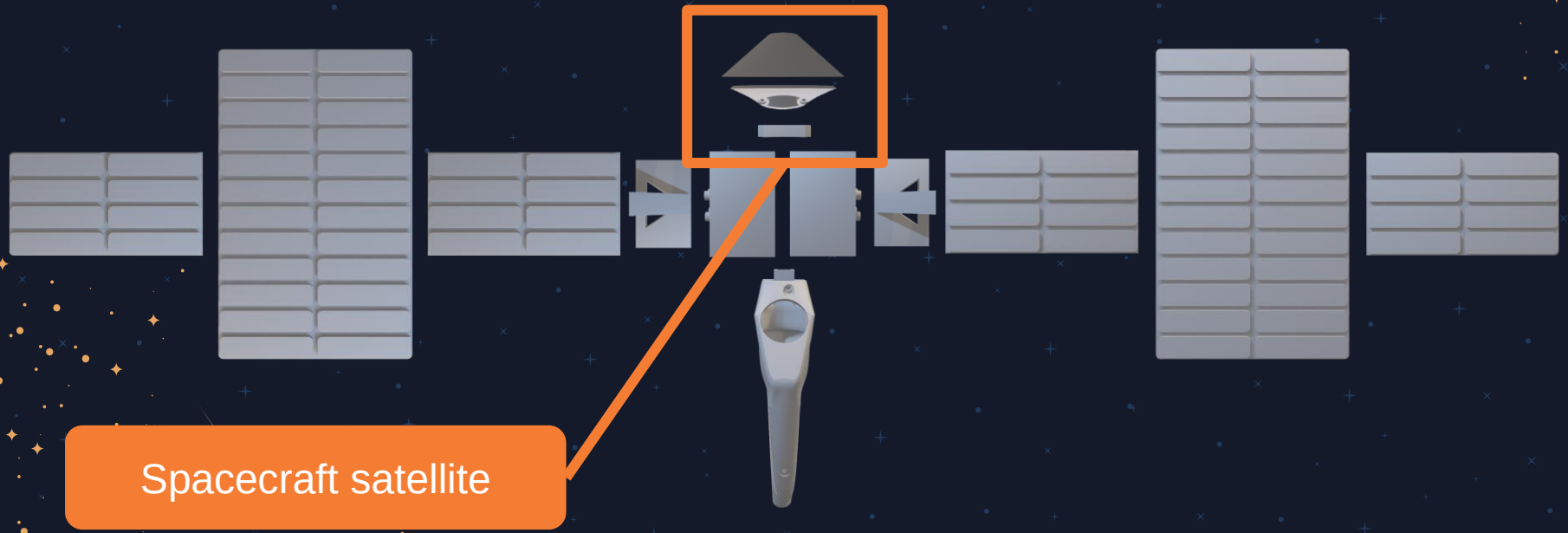




Mariam Medina

Design Overview

Blaster Design

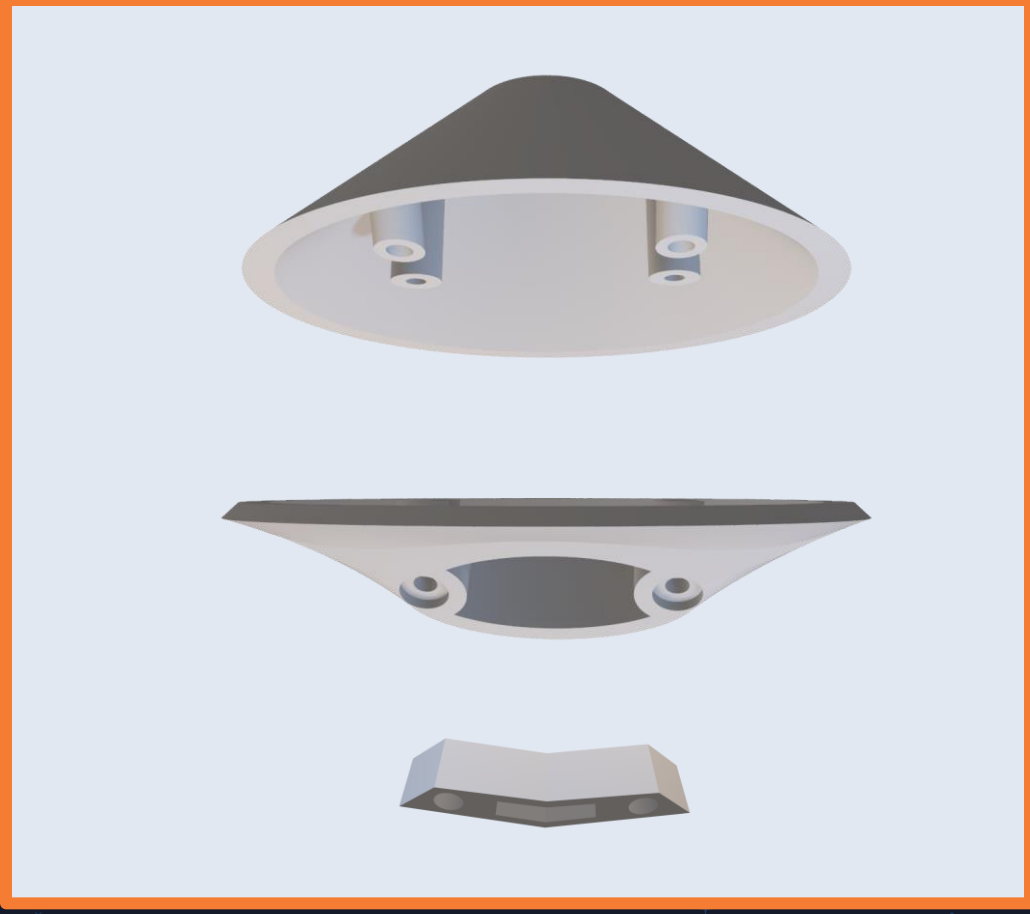


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

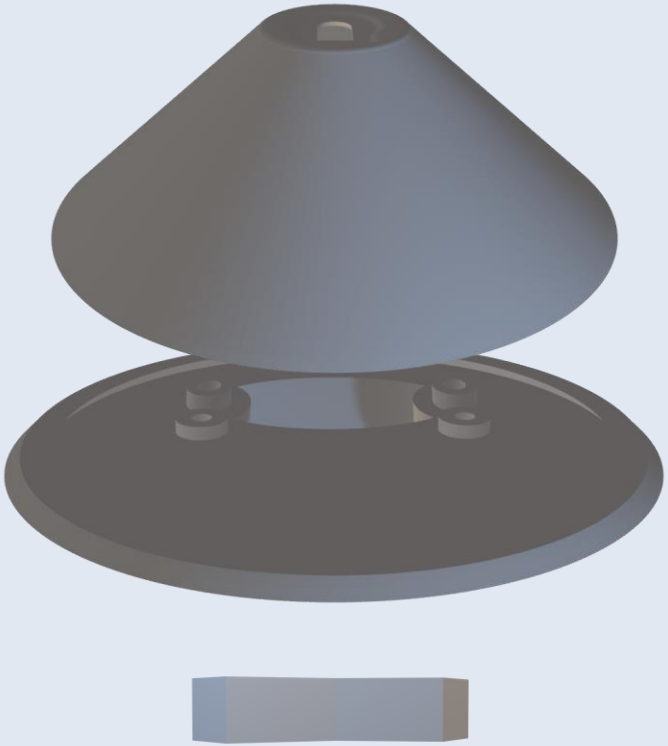


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

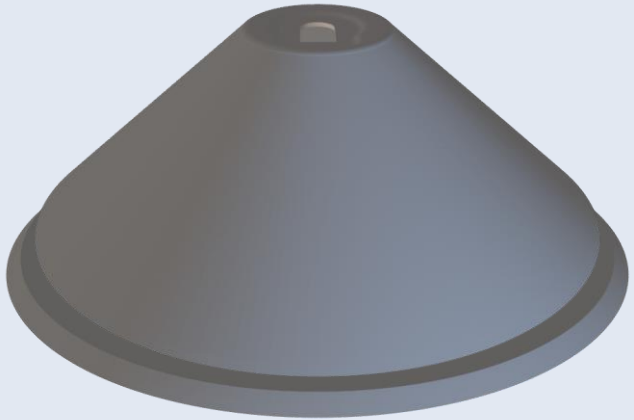


Mariam Medina

Design Overview

Blaster Design

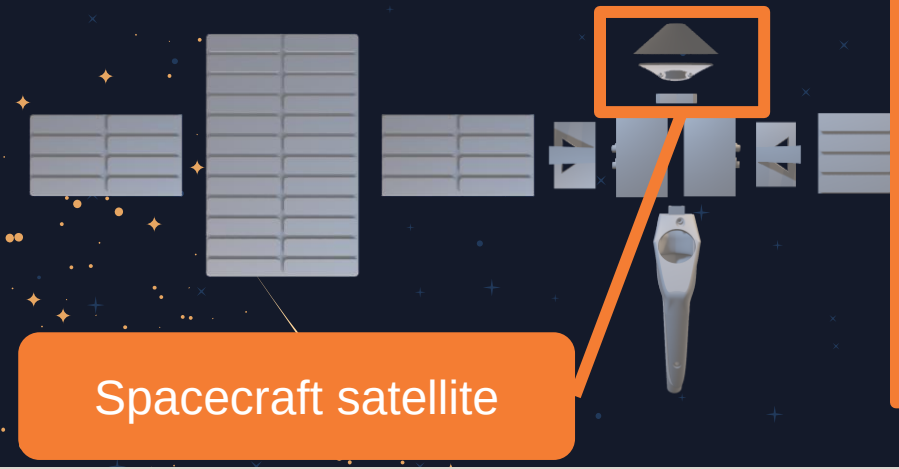
Spacecraft satellite



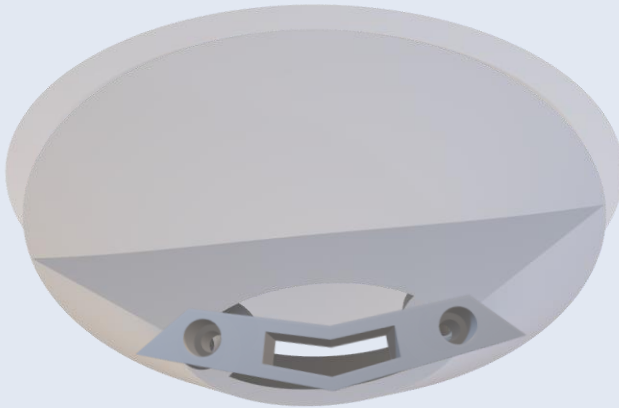
Mariam Medina

Design Overview

Blaster Design



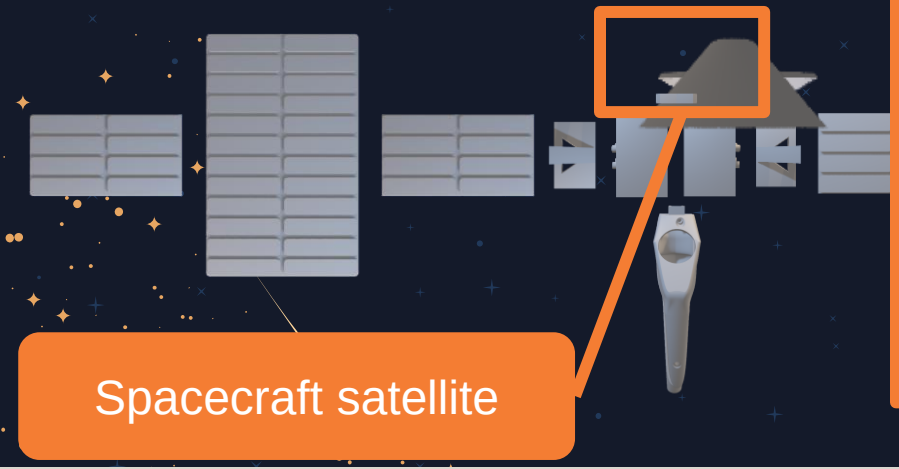
Spacecraft satellite



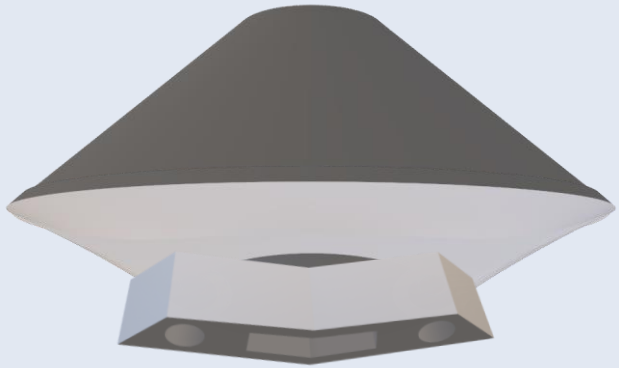
Mariam Medina

Design Overview

Blaster Design



Spacecraft satellite

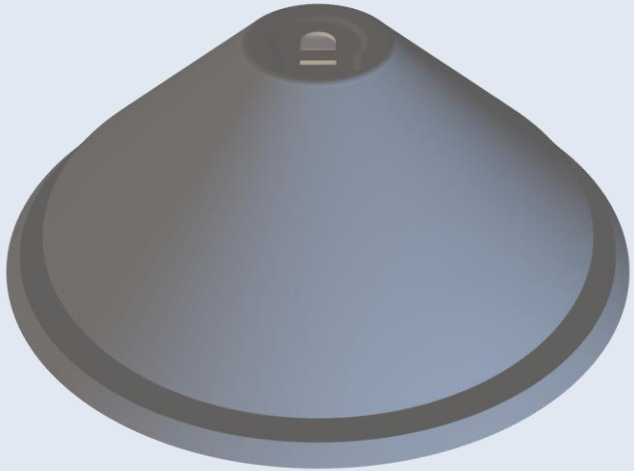


Mariam Medina

Design Overview

Blaster Design

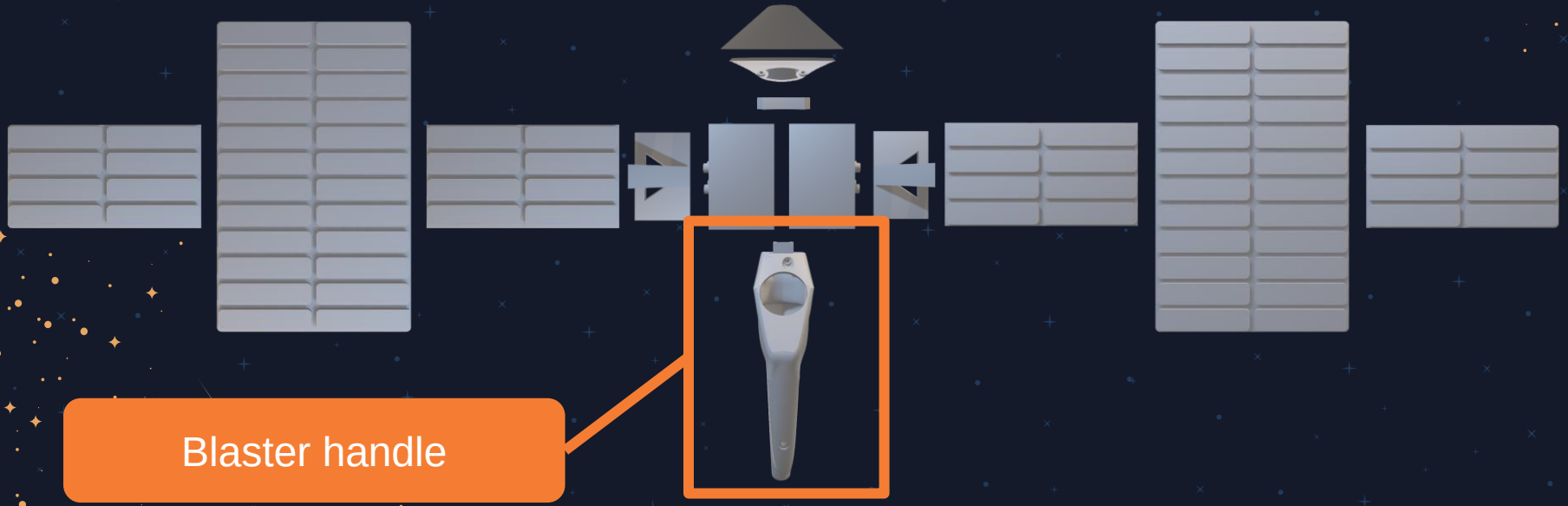
Spacecraft satellite



Mariam Medina

Design Overview

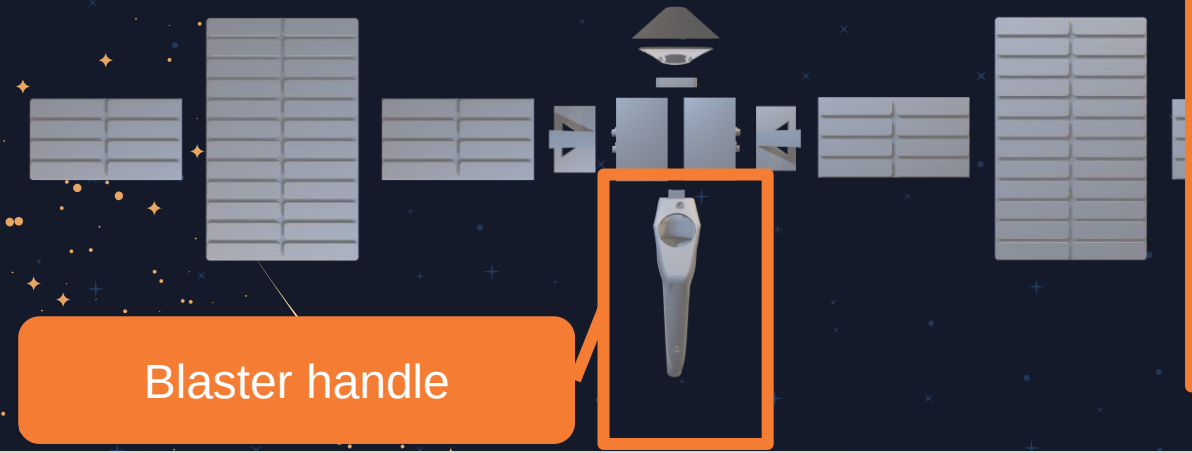
Blaster Design



Mariam Medina

Design Overview

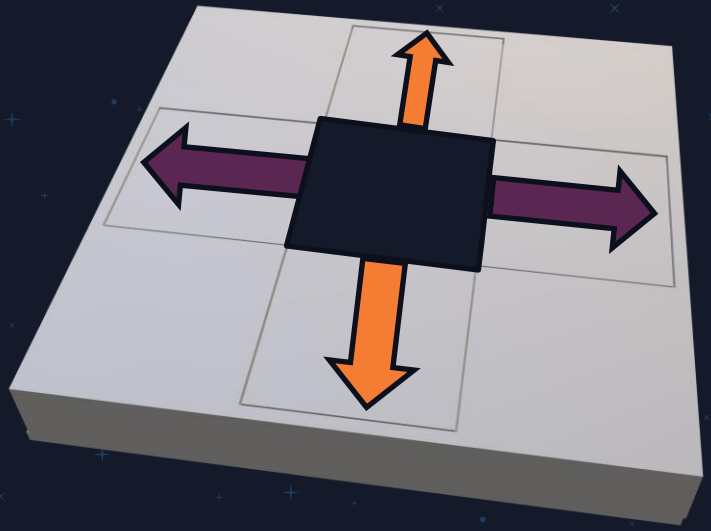
Blaster Design



Blaster handle

Mariam Medina

DDR Pad Design

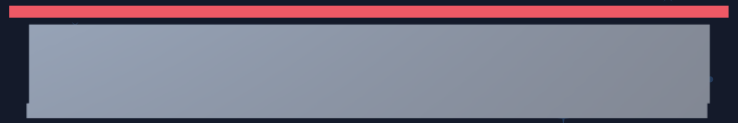


- 9 panels total
- Right and left rotate the asteroid
- Up and down control solenoid

Garett Southerland

DDR Pad Design

Using through beam detection to sense where the user steps



When the beam IS NOT broken, receiver reads a signal

Garett Southerland

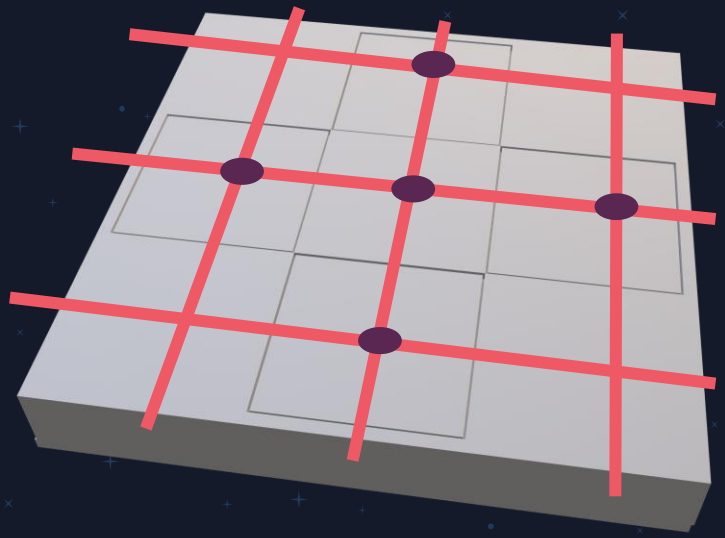
DDR Pad Design

Using through beam detection to sense where the user steps

When the beam IS broken, receiver reads no signal

Garett Southerland

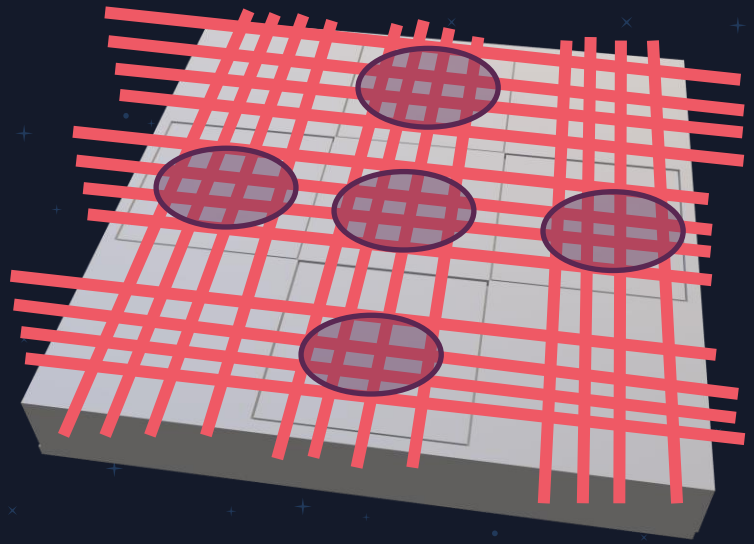
DDR Pad Design



Create a grid pattern to determine which panel is being stepped on

Garett Southerland

DDR Pad Design



Increase number of beams to cover more of every panel

Garett Southerland