Team 502: ASU/Psyche - ACCelerate Festival

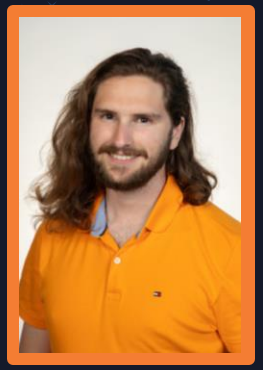
Team Members

Sara Bradley

Mechatronics Engineer

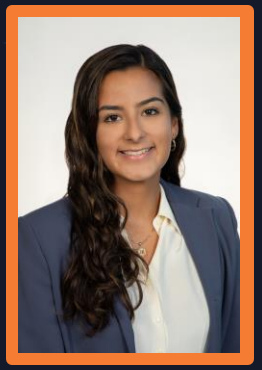
Connor Bishop

Electrical Engineer



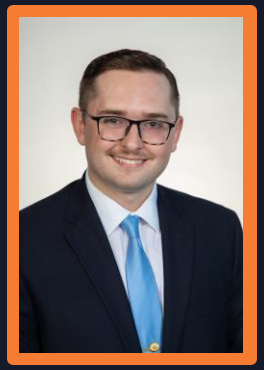
Spencer Martin

Electrical Engineer



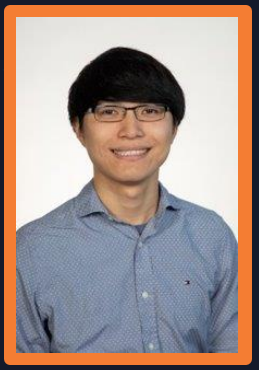
Mariam Medina

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

Objective

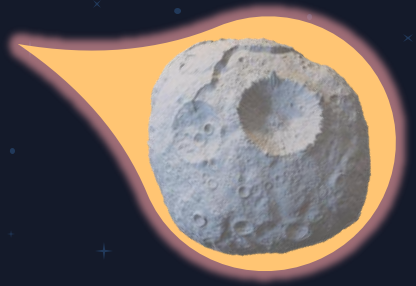
The objective of this project is to create interest in the Psyche Mission with an interactive exhibit.

Psyche Story

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.



About the Mission

Present

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

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

User responses are being processed now

Spent: 293.56
Allotted: 706.44

4 sentences that relate Psyche to Earth

Spencer Martin

Asteroid Design

3D Printed Craters

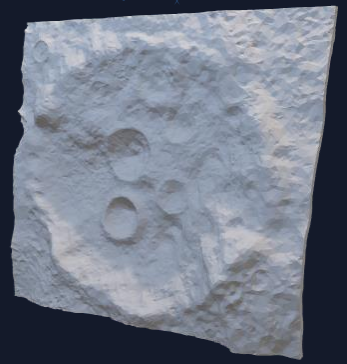
1 Large Crater

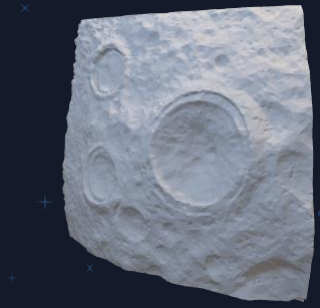
3 Smaller Details

Mariam Medina

Asteroid Design

3D Printed Craters





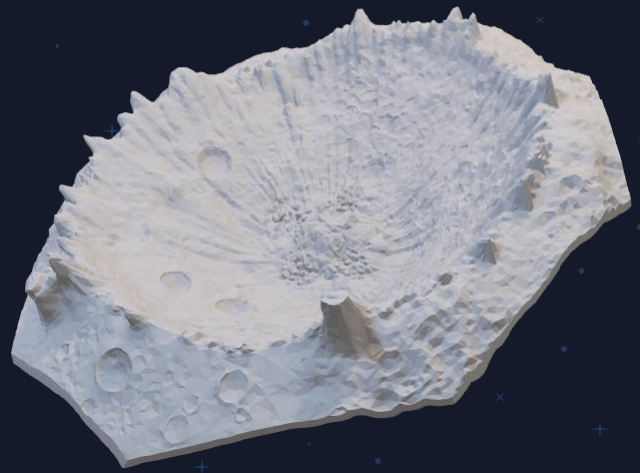
1 Large Crater

3 Smaller Details

Mariam Medina

Asteroid Design

3D Printed Craters



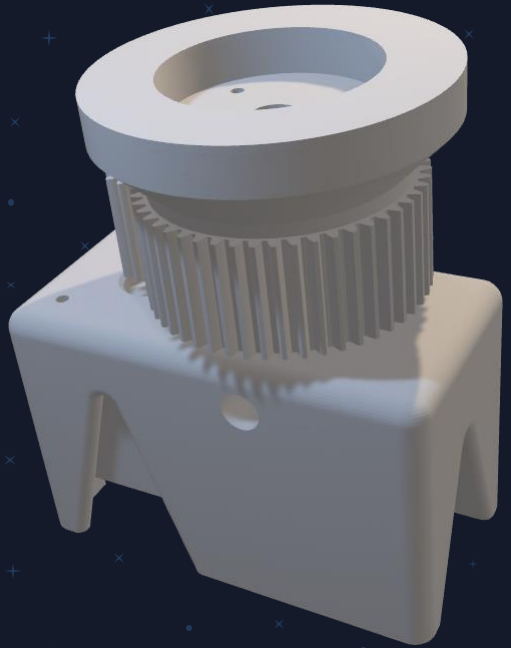
1 Large Crater

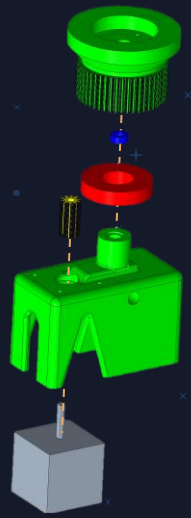
3 Smaller Details

Mariam Medina

Asteroid Design

Rotation

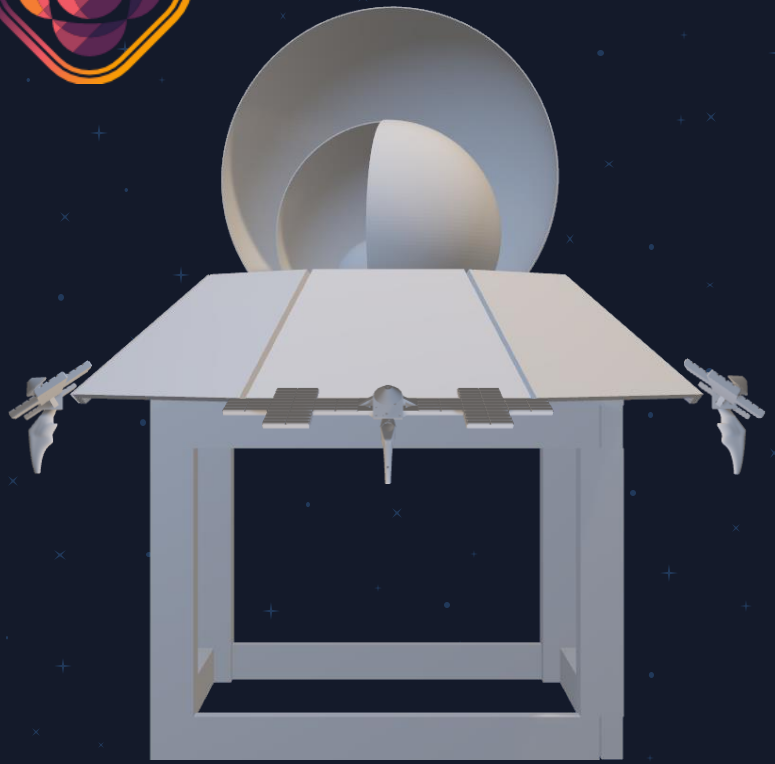




- Provides users a way to interact with the asteroid
- Allows wiring to pass through without tangling
- Ensures consistent and smooth rotation

Mariam Medina

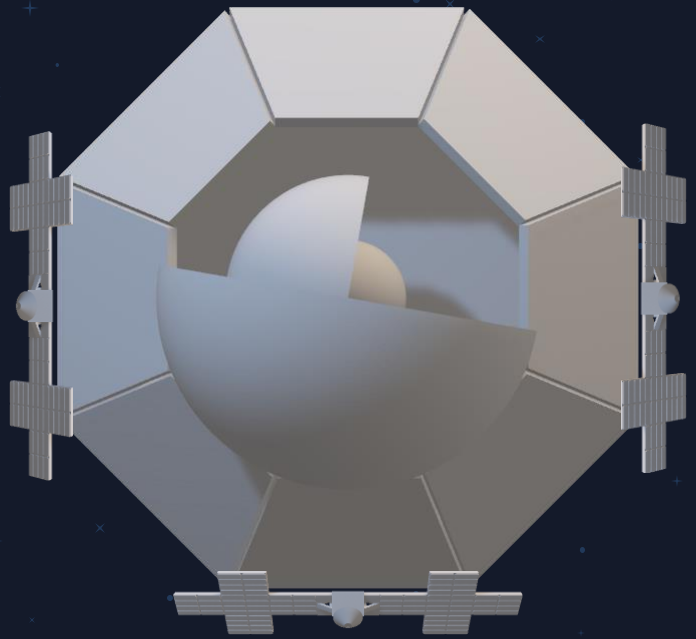
Structure Design



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

Mariam Medina

Structure Design



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

Mariam Medina

Design Overview

Blaster Design

Mariam Medina

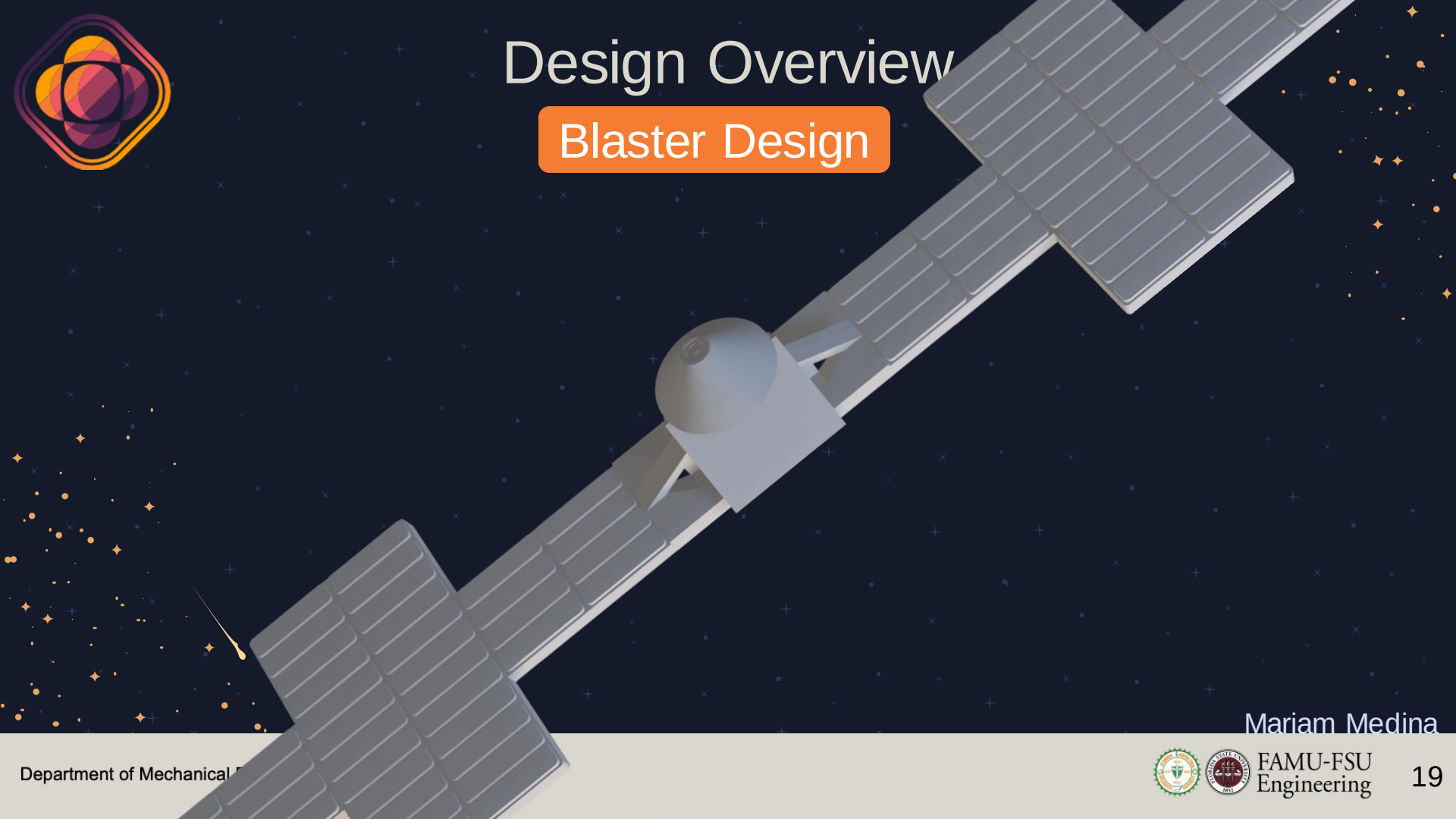
Design Overview

Blaster Design

Mariam Medina

Design Overview

Blaster Design



Mariam Medina

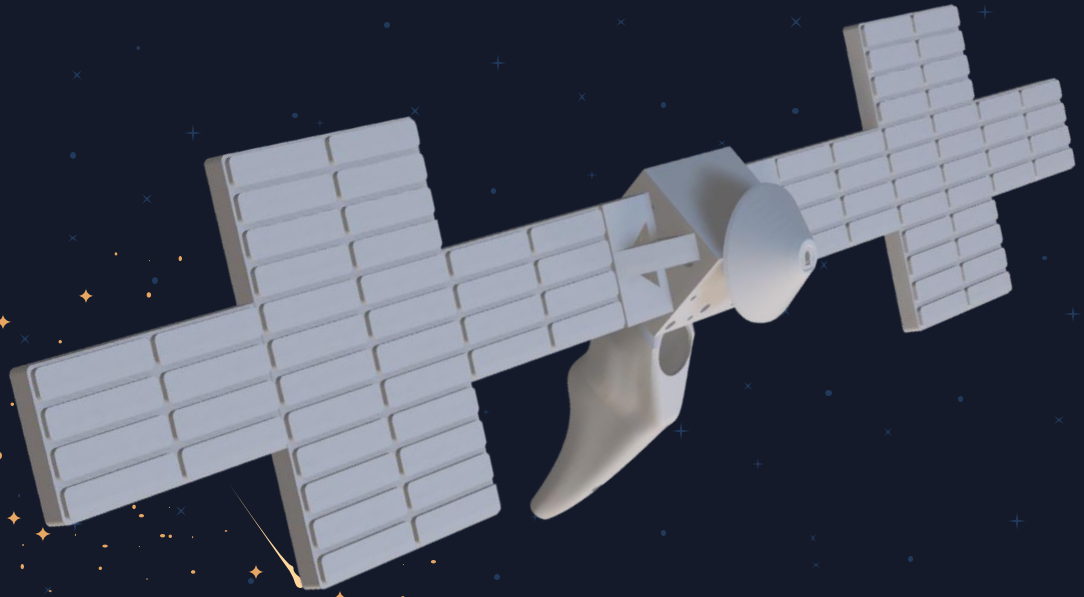
Design Overview

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

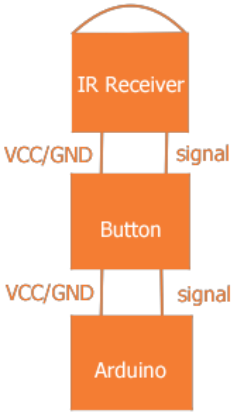
Made to a 1/16 scale with the Psyche spacecraft

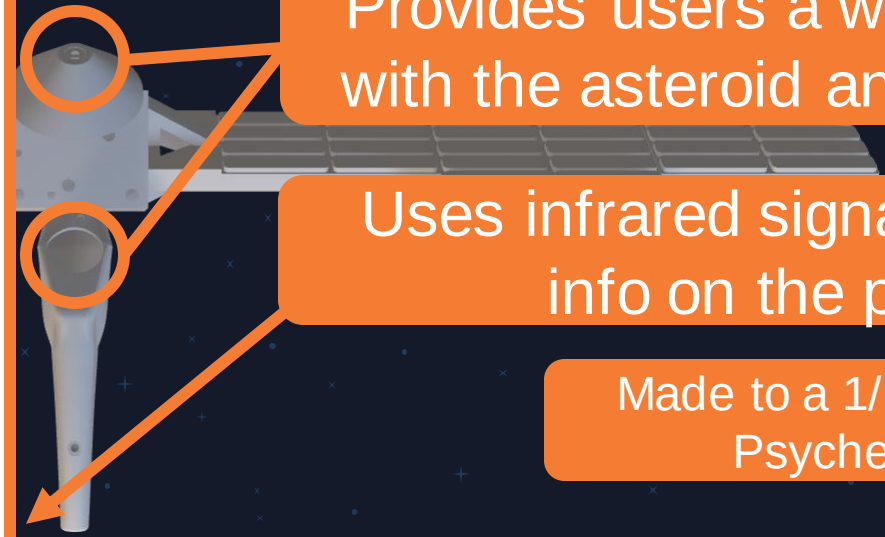
Mariam Medina

Design Overview

Blaster Design

Circuit Diagrams



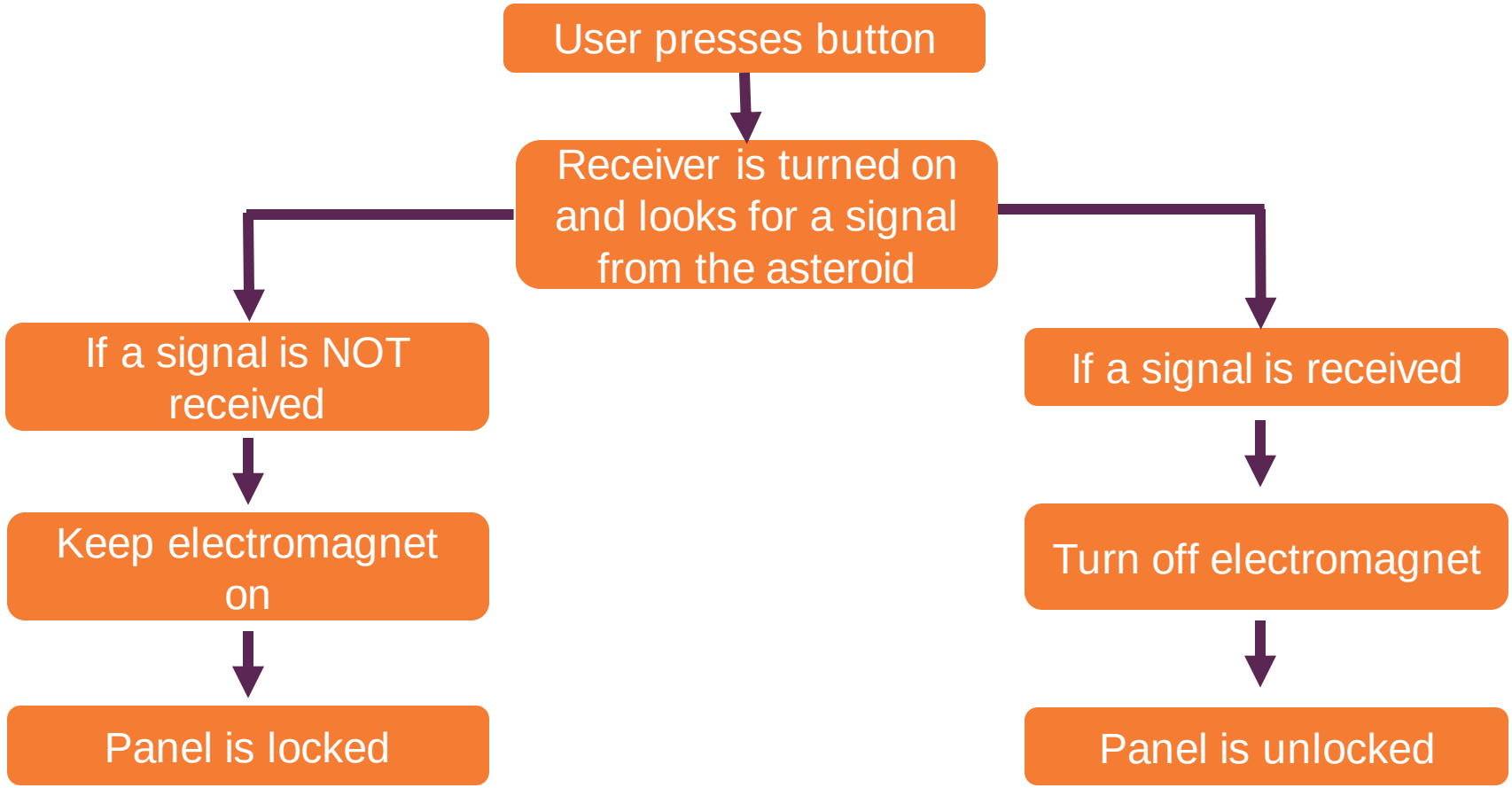


Provides users a way to interact with the asteroid and info panels

Uses infrared signals to unlock info on the panels

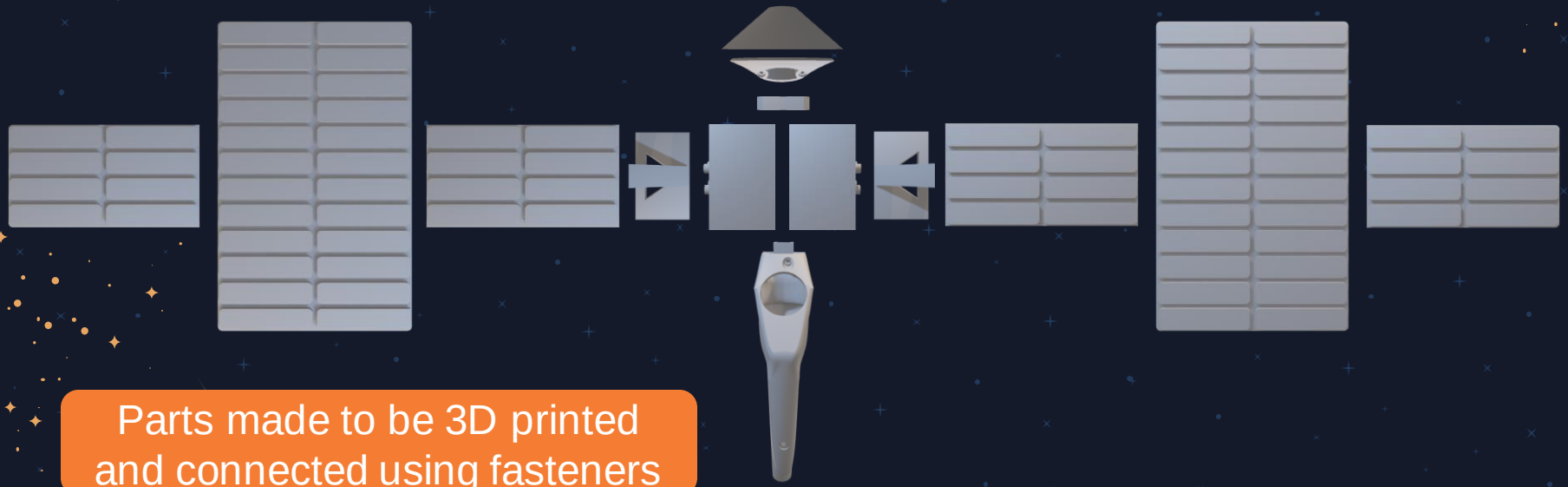
Made to a 1/16 scale with the Psyche spacecraft

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

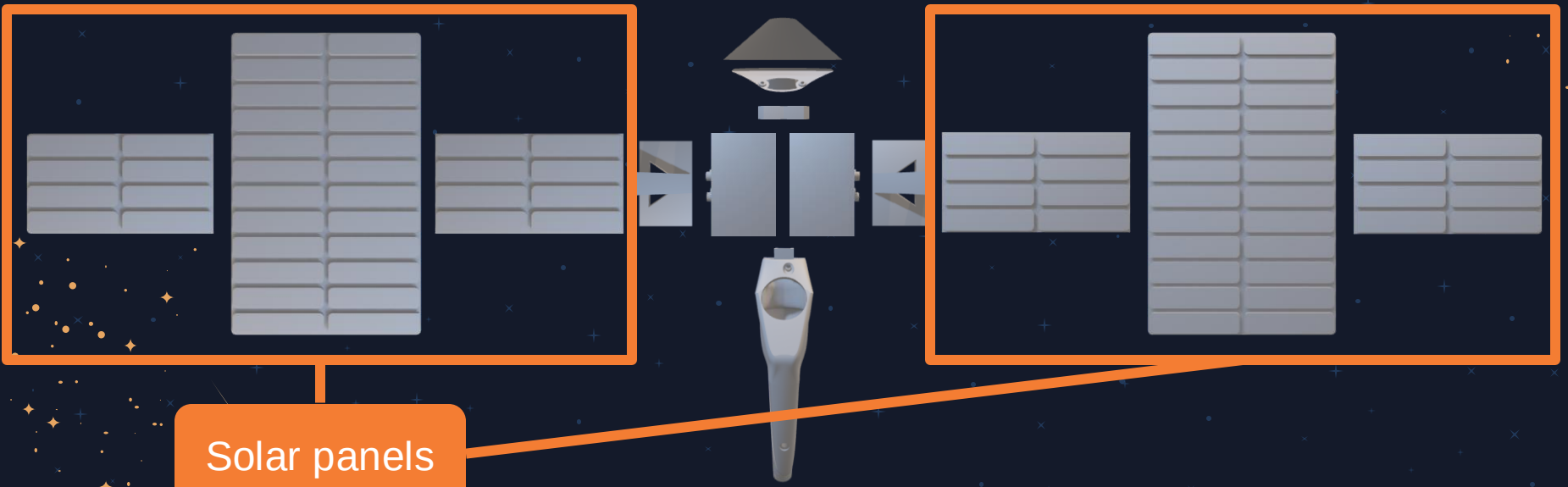


Parts made to be 3D printed and connected using fasteners

Mariam Medina

Design Overview

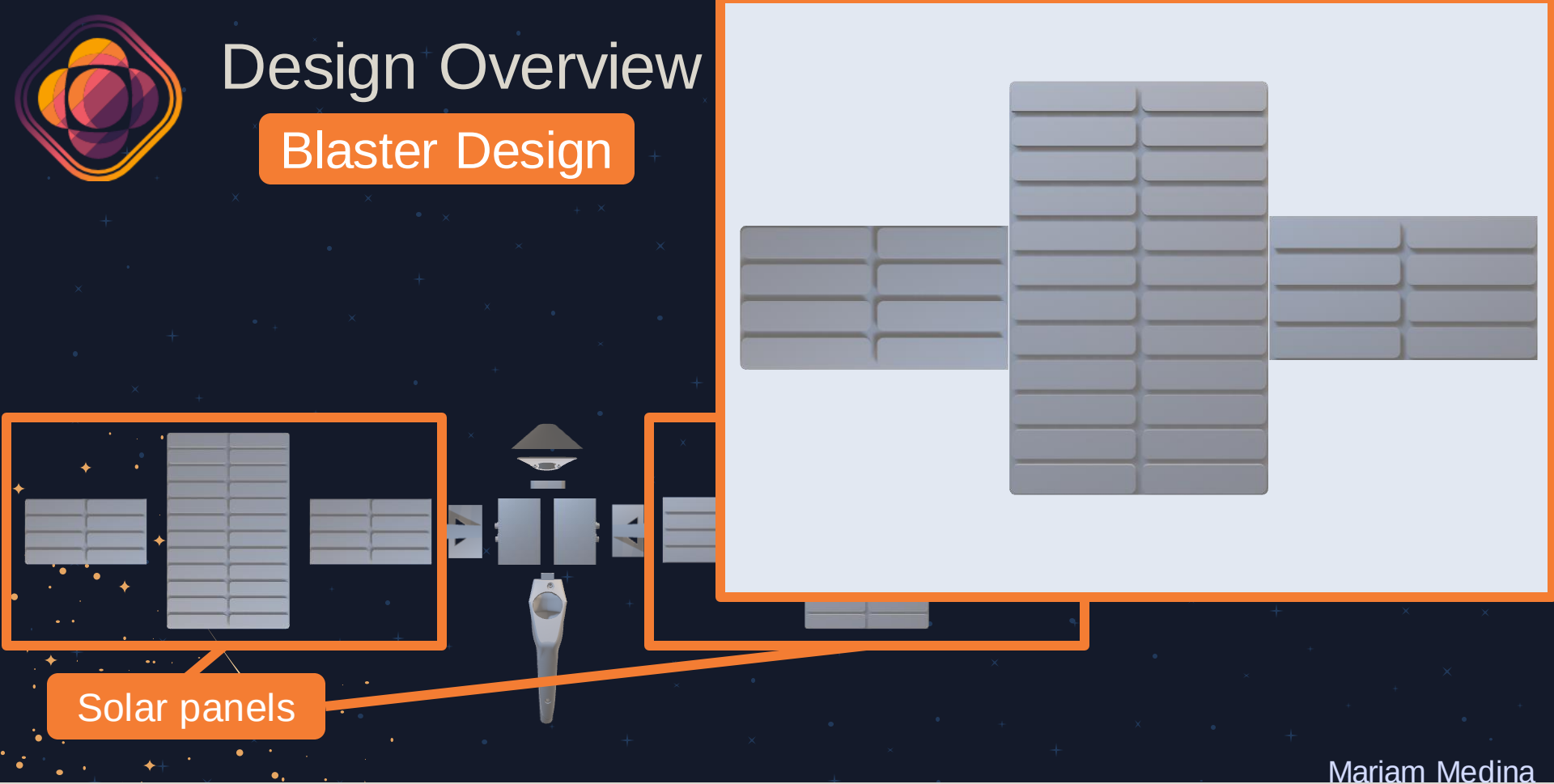
Blaster Design



Mariam Medina

Design Overview

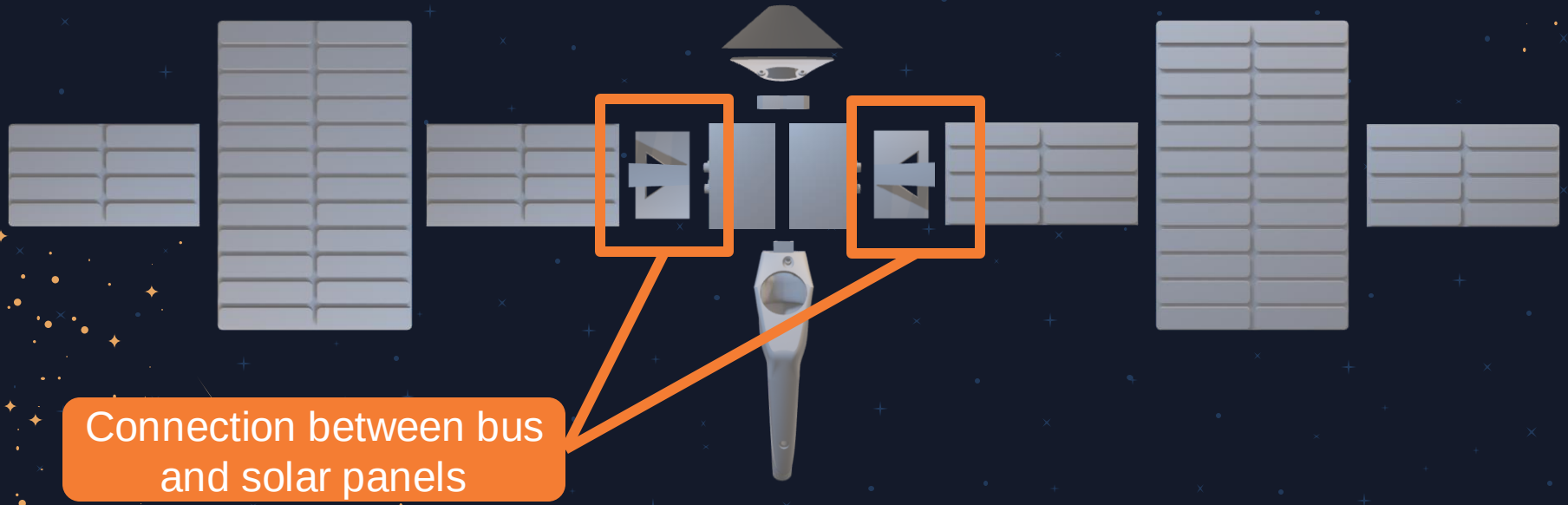
Blaster Design



Mariam Medina

Design Overview

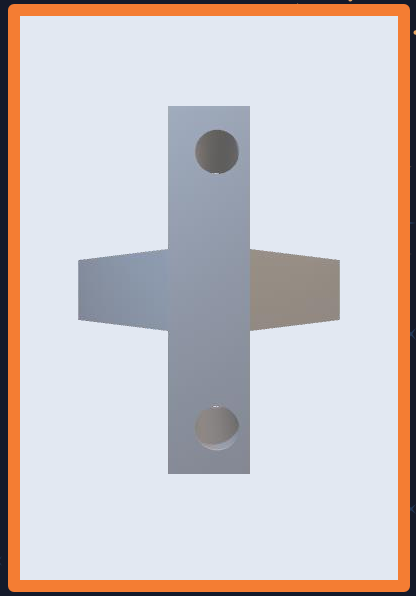
Blaster Design

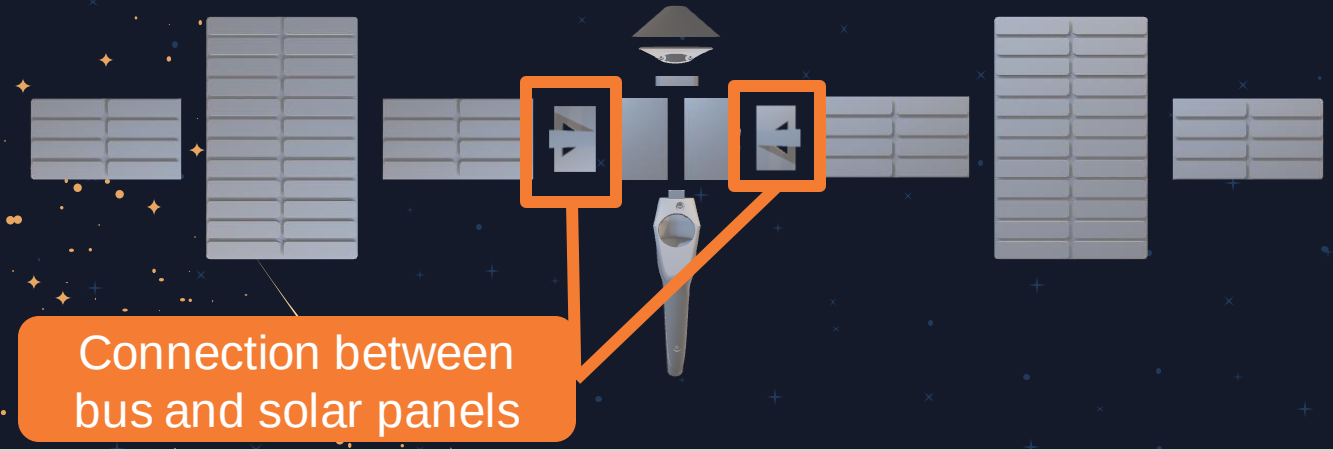


Mariam Medina

Design Overview

Blaster Design



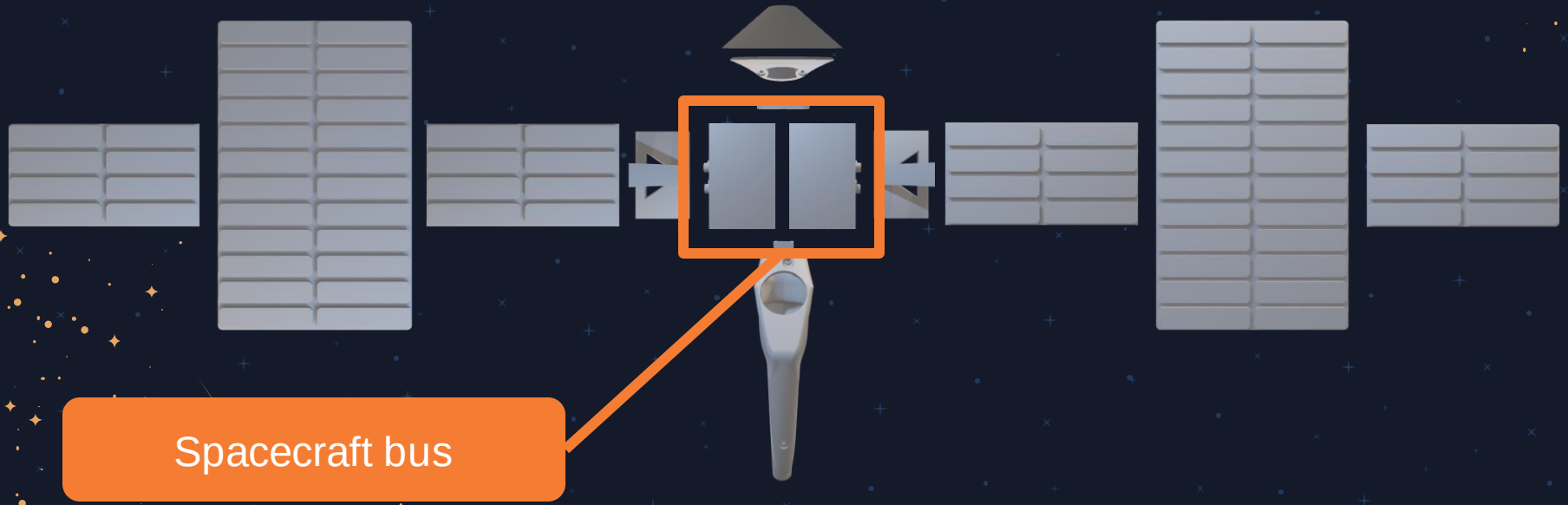


Connection between bus and solar panels

Mariam Medina

Design Overview

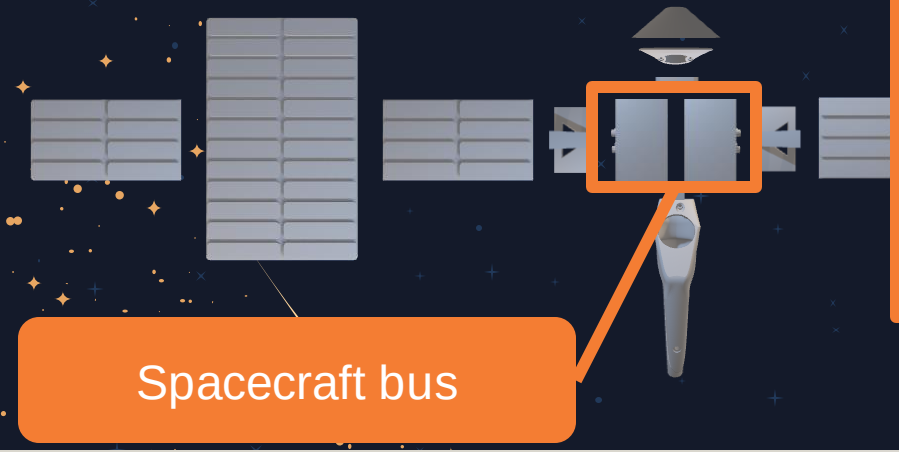
Blaster Design

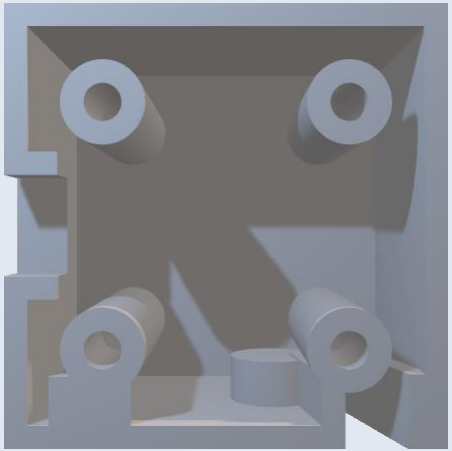


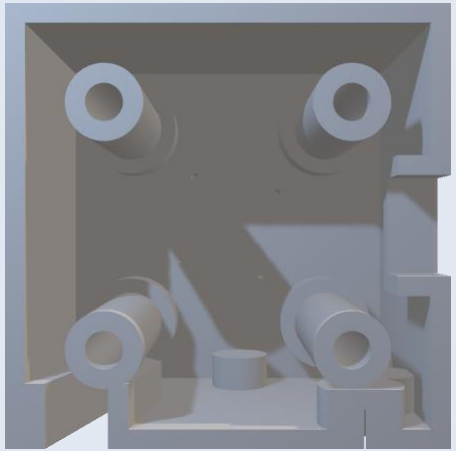
Mariam Medina

Design Overview

Blaster Design



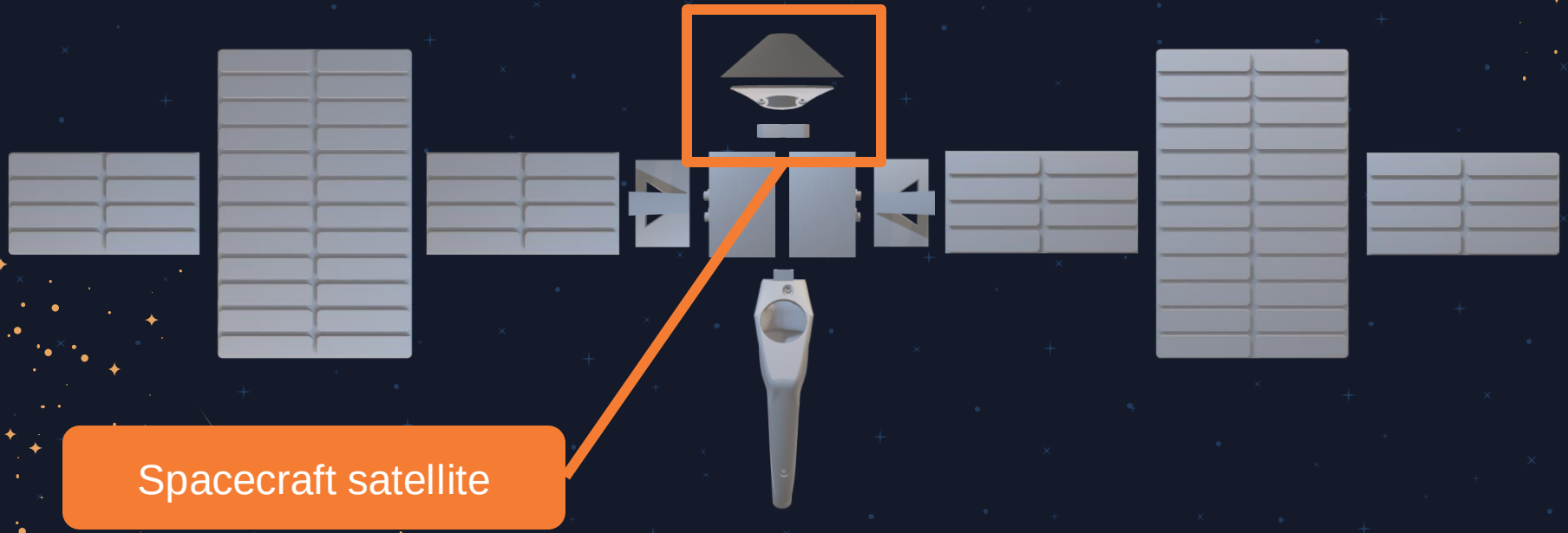




Mariam Medina

Design Overview

Blaster Design

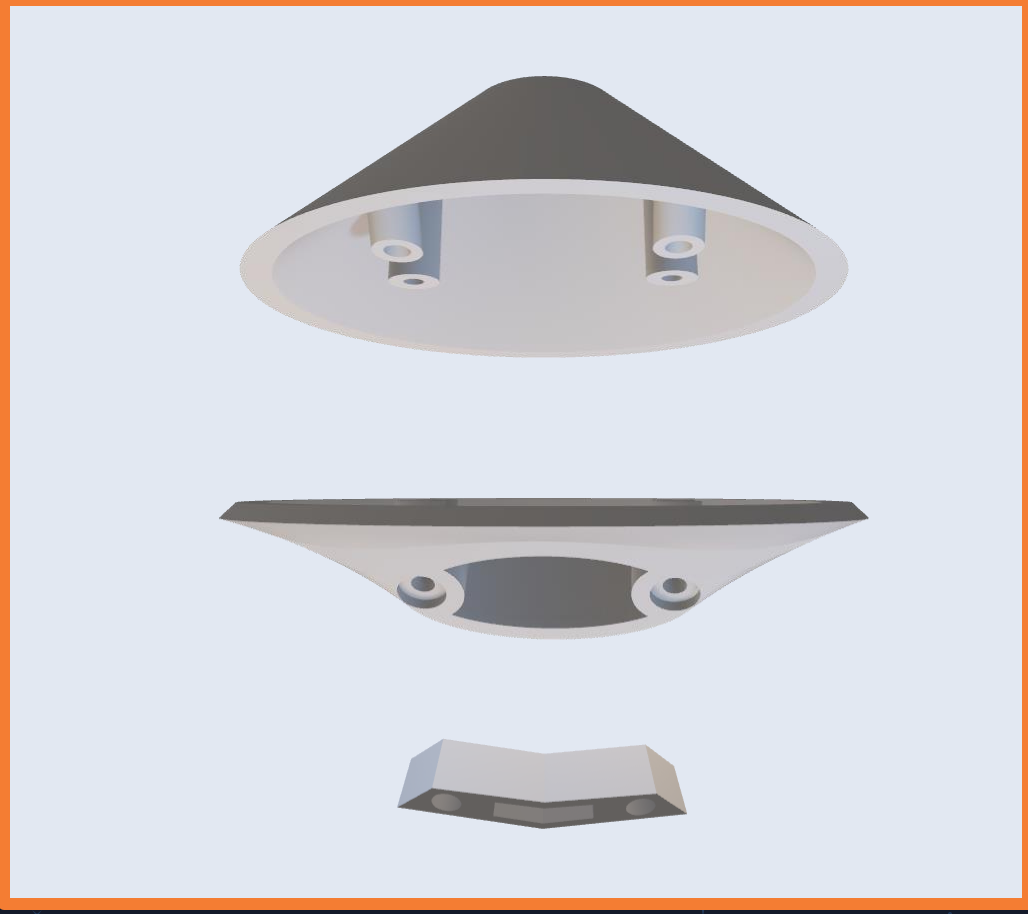


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

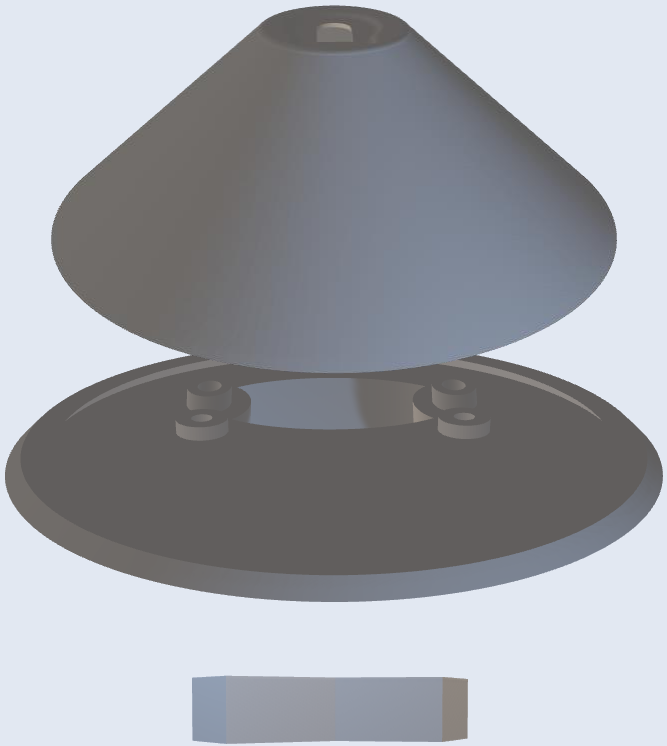


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

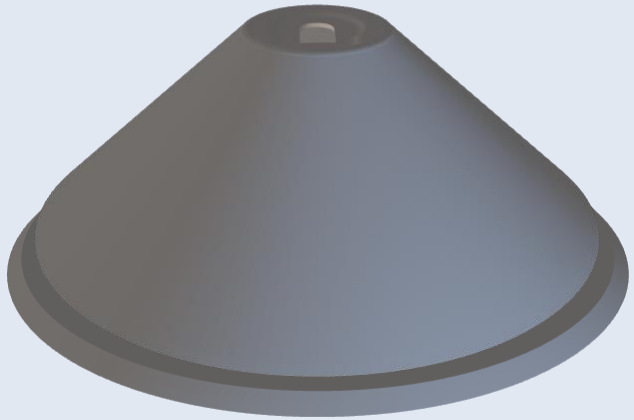


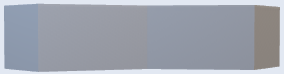
Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite



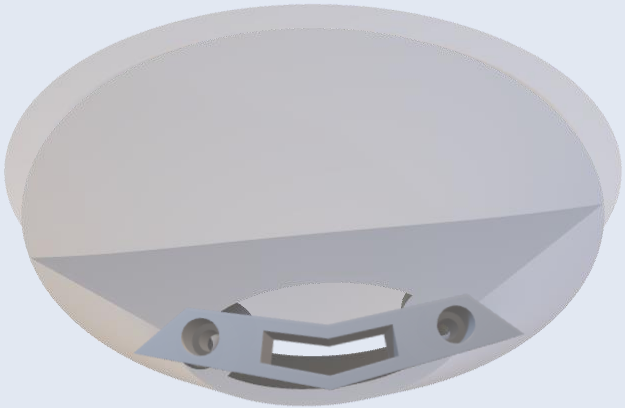


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

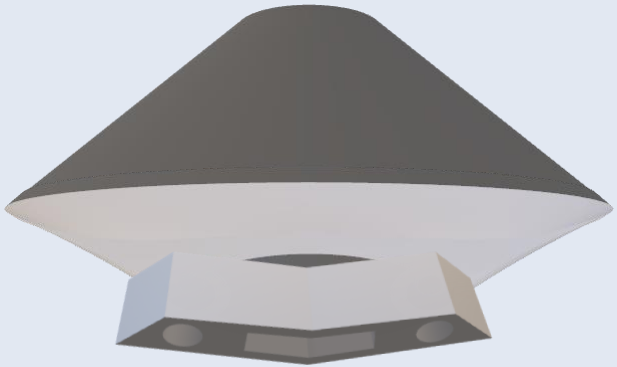


Mariam Medina

Design Overview

Blaster Design

Spacecraft satellite

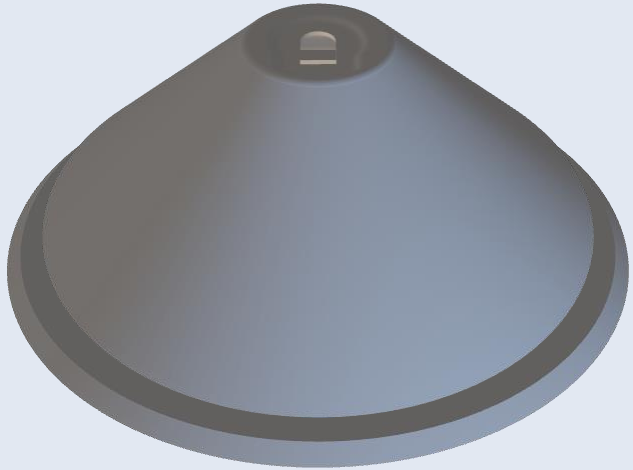


Mariam Medina

Design Overview

Blaster Design

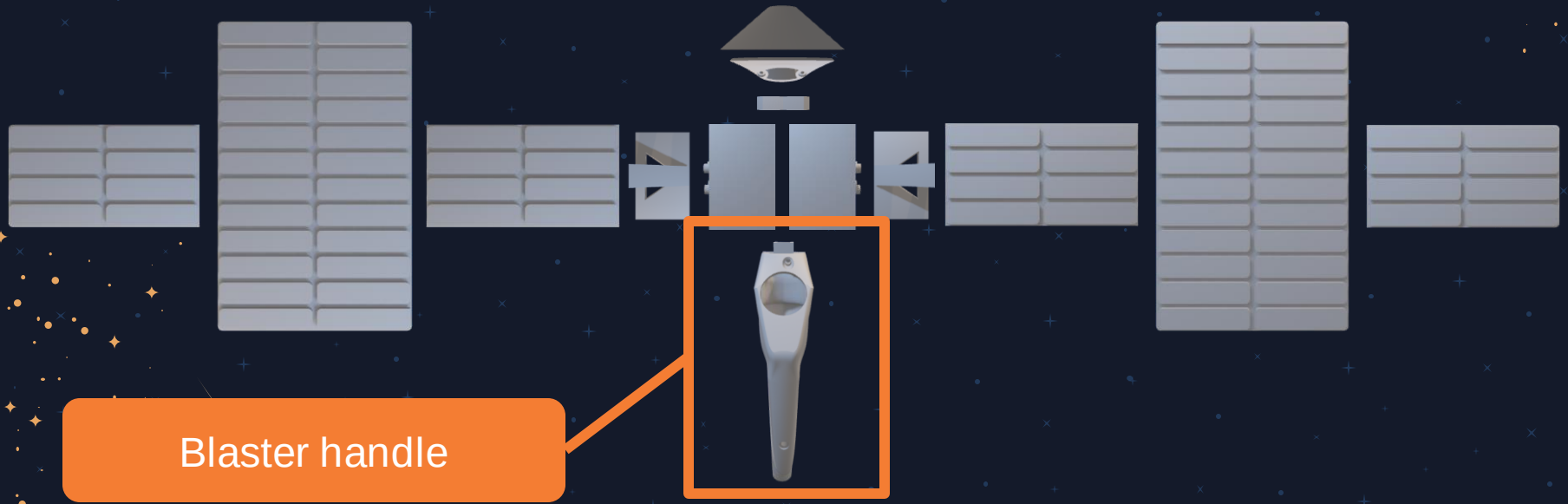
Spacecraft satellite



Mariam Medina

Design Overview

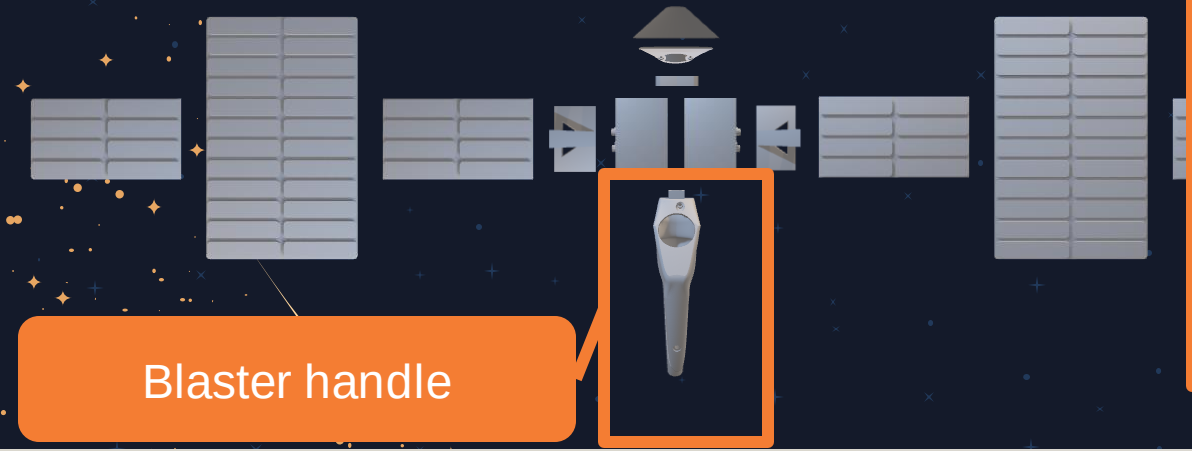
Blaster Design



Mariam Medina

Design Overview

Blaster Design

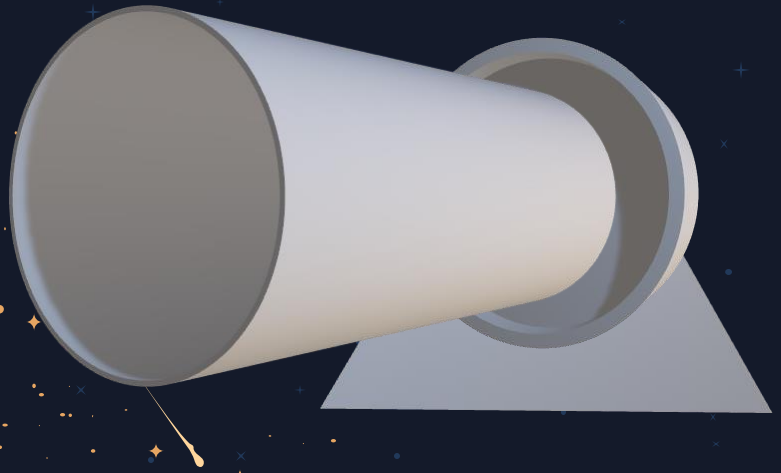


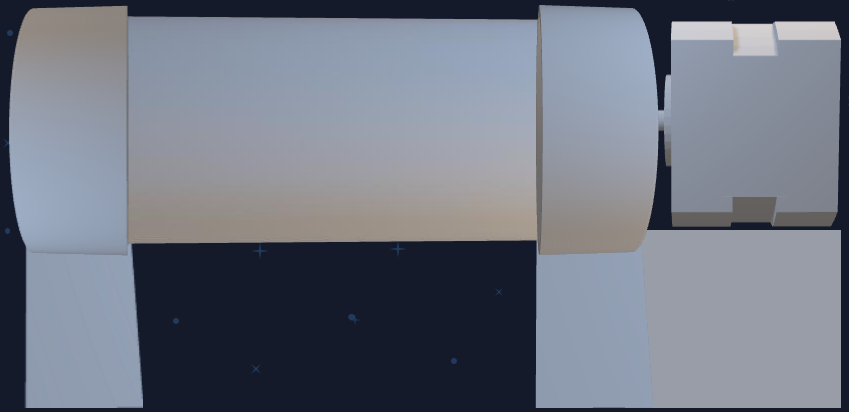
Blaster handle

Mariam Medina

Design Overview

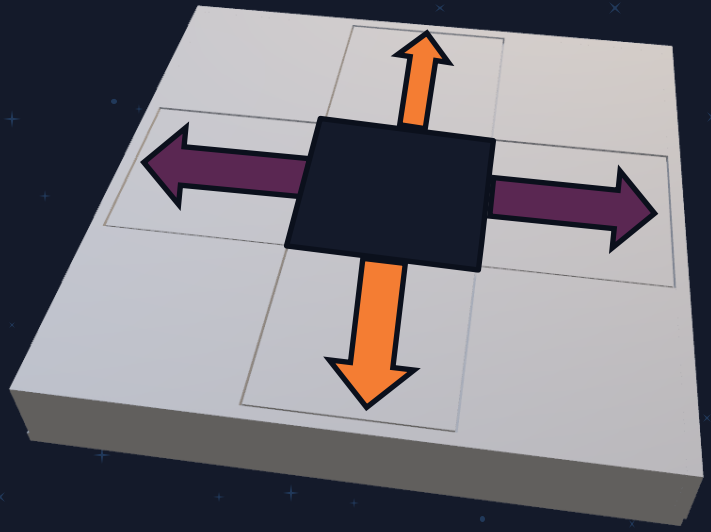
Solenoid Design





Connor Bishop

DDR Pad Design

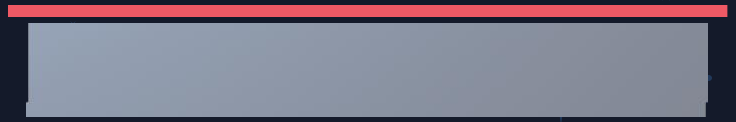


- 9 panels total
- Right and left rotate the asteroid
- Up and down control solenoid

Connor Bishop

DDR Pad Design

Using through beam detection to sense where the user steps



When the beam IS NOT broken, receiver reads a signal

Connor Bishop

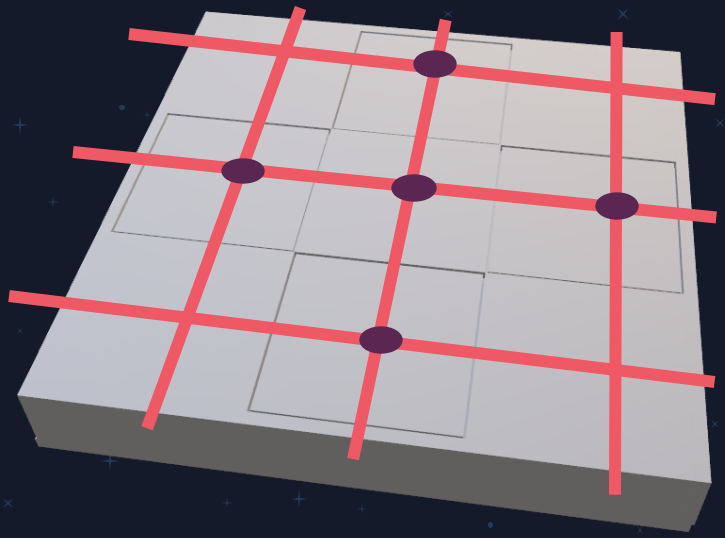
DDR Pad Design

Using through beam detection to sense where the user steps

When the beam IS broken, receiver reads no signal

Connor Bishop

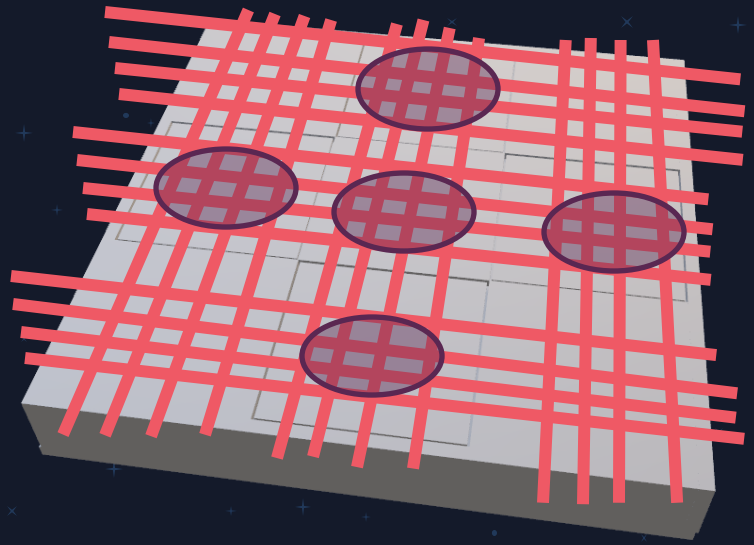
DDR Pad Design



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

Connor Bishop

DDR Pad Design



Increase number of beams to cover more of every panel

Connor Bishop

Full Design

*Designs not to scale with each other

Connor Bishop

Open House Demonstration

Systems were tested for their performance when operated by users

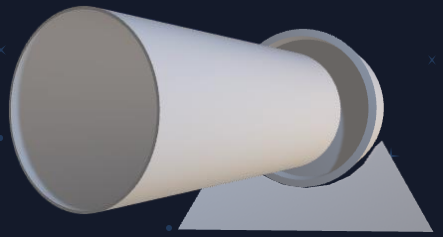
Additionally, the survey information retrieved will be used to improve the interactive elements

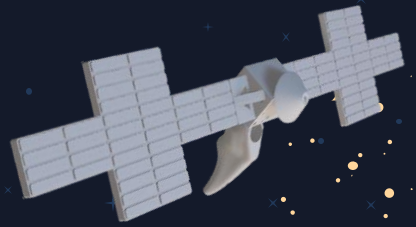
Connor Bishop

Survey Conclusions

Total of 17 completed surveys

First Feature Noticed (15)	Favorite Feature (9)	Favorite Panel (5)	Can Easily Identify IR Targets (14)





Connor Bishop

Survey Conclusions

Total of 17 completed surveys

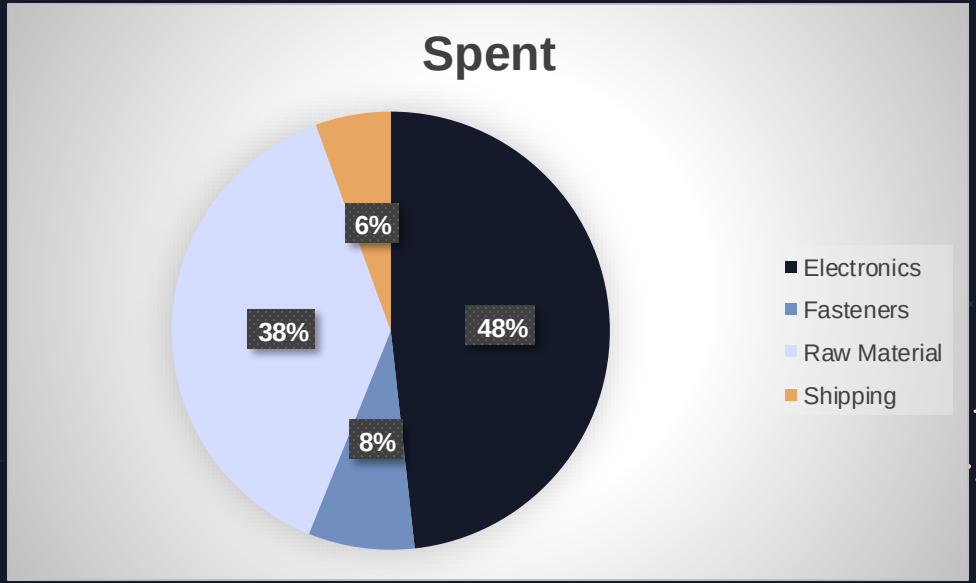
Age	Favorite Subject	Fact Learned	Positive Experience
Below age 11 (8)	Science (8)	Psyche is metallic (5)	Overwhelmingly Positive (15)
Above age 19 (7)	Math (6)	Size of Massachusetts (3)	

Connor Bishop

Budget

Allotted: $1000

Electronics	$141.66
Fasteners	$23.01
Raw Material	$112.58
Shipping	$16.31
Total spent	$293.56
Allotted	$706.44



Connor Bishop

Future Work

To Do					
Asteroid Design	Structure Design	Panel Design	Blaster Design	IR Design	DDR Design
Rotating plate	Adjust gaps	Print informational decals	Paint	Communicate with all Arduinos	IR sensors
LEDs	Paint	Integrate solenoids	Integrate electronics	Print PCBs	Implement with motor
IR sensors	Edit design for easier transportation	Electromagnets	Cable design	Wire organization	Memory game

Connor Bishop

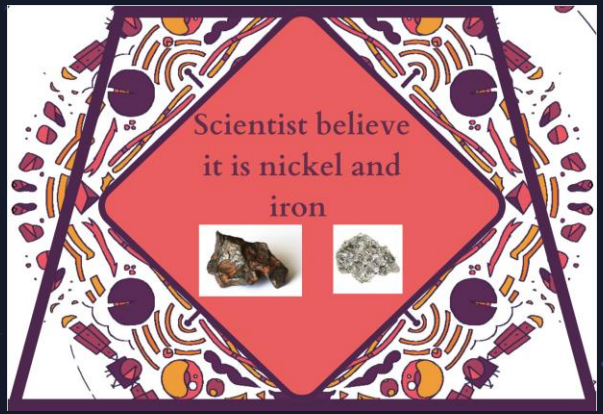
Additional Slides

Open House Demonstration

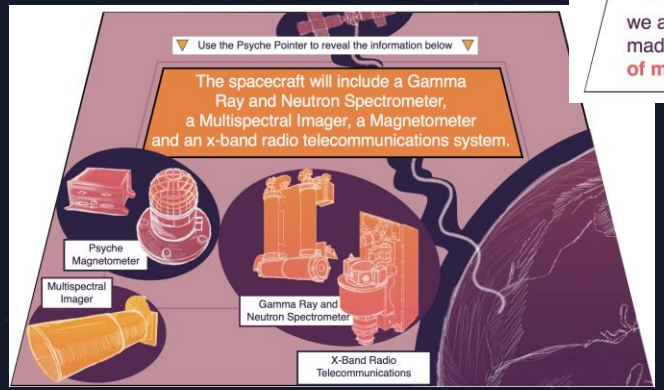
Survey data (17 surveys completed)
Features first noticed: Asteroid (15), panel flippers (1), panels (1)
Favorite panel: Cylinder (5), Psyche orbit (4), Mission (2)
blaster panel (1), name/origin (1)
Favorite feature: Asteroid (9), blasters (4), cylinder (1)
Positive interaction: yes (15), no (1)
Easy 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



Panel Designs



Team 502: ASU/Psyche - ACCelerate Festival

Project Overview

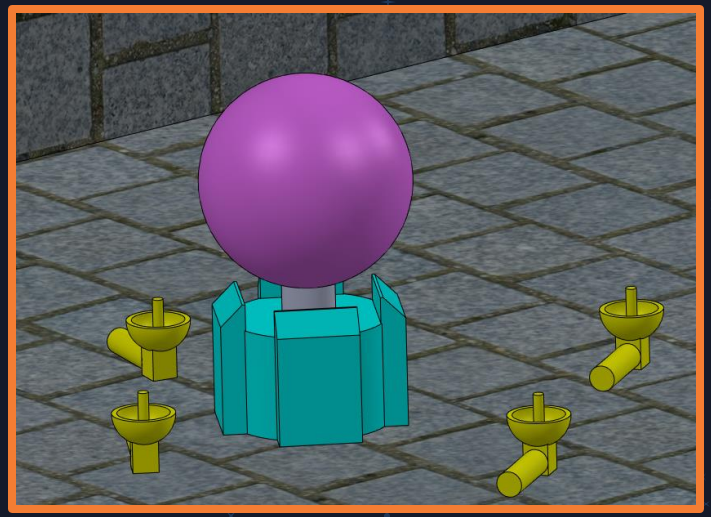
It is believed that Psyche is the remains of a planetesimal with an iron-nickel core that experienced many violent collisions.

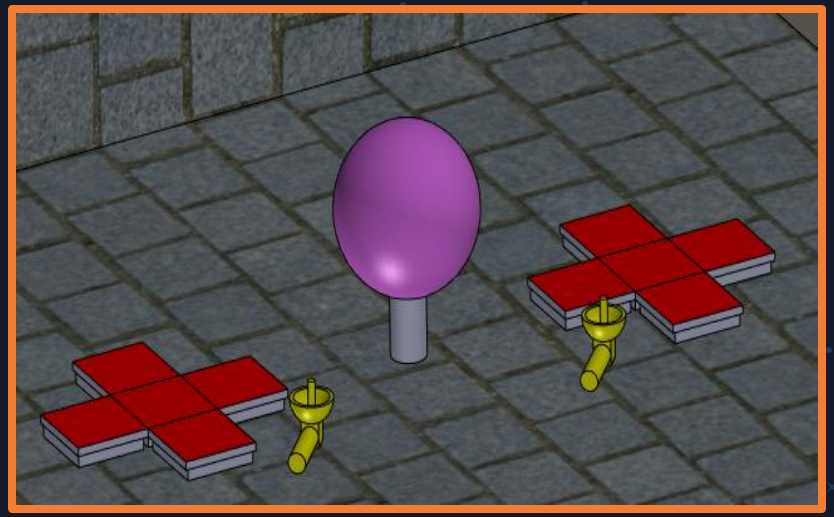
The problem is ensuring a lasting interest in the Psyche Mission and Science, Technology, Engineering, Art, and Math (STEAM).

Kenneth Zhou

Original Final Concept

IR pointer game + spacecraft controls





Kenneth Zhou

Asteroid Design

Fully 3D printed

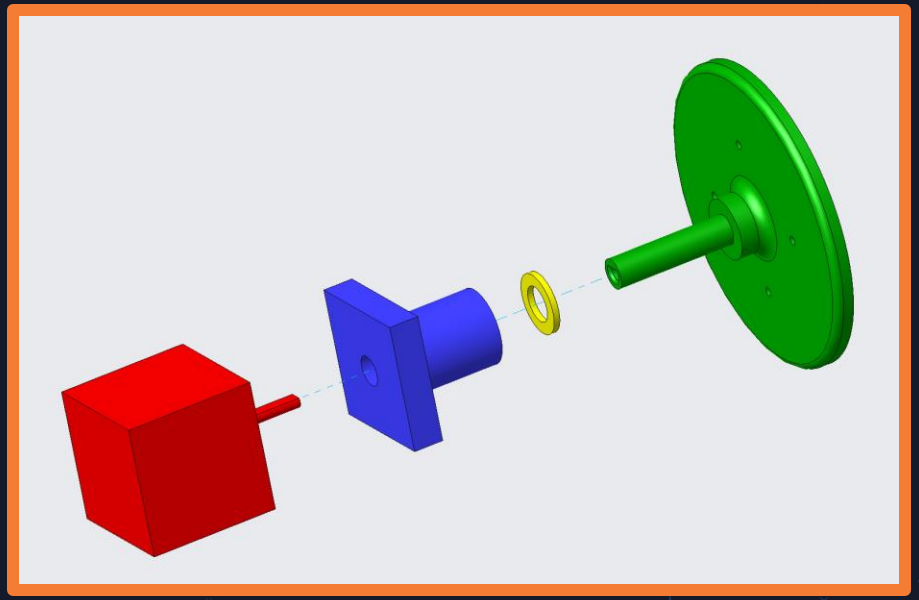
Fully paper mâché

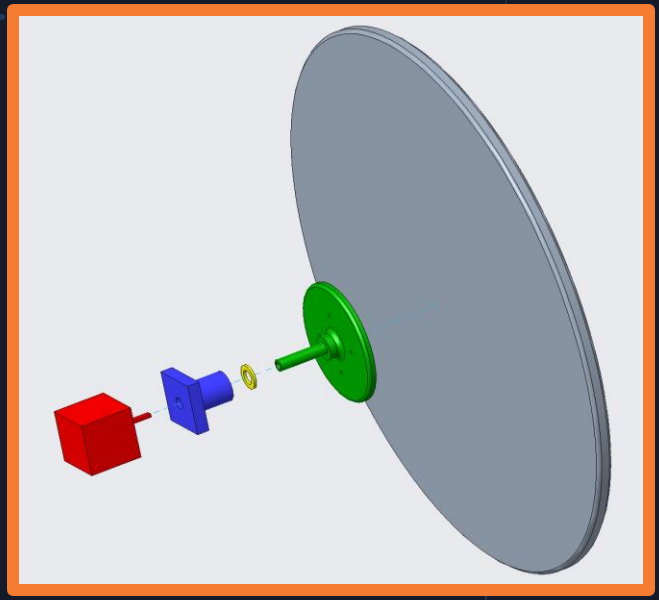
Mix of paper mâché and 3-D printed pieces

Kenneth Zhou

Future Asteroid Work

Rotating Asteroid Model





Kenneth Zhou

Future Asteroid Work

Integrate IR emitters

Adding texture and sculpting other asteroid features

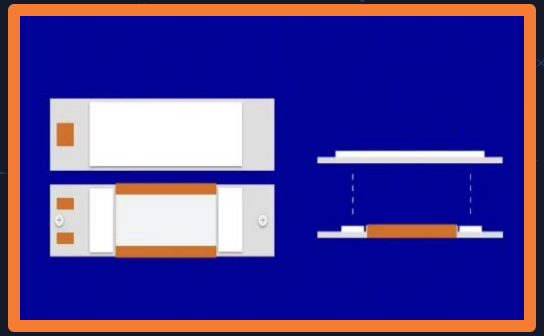
Painting (add more)

Kenneth Zhou

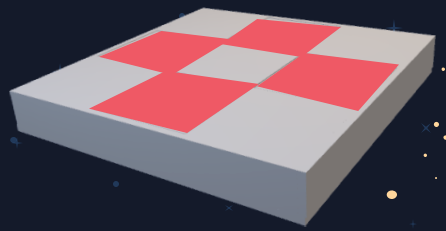
DDR Design

Capacitive Sensor

Contact Sensor



Wood Structure + Polycarbonate Panels



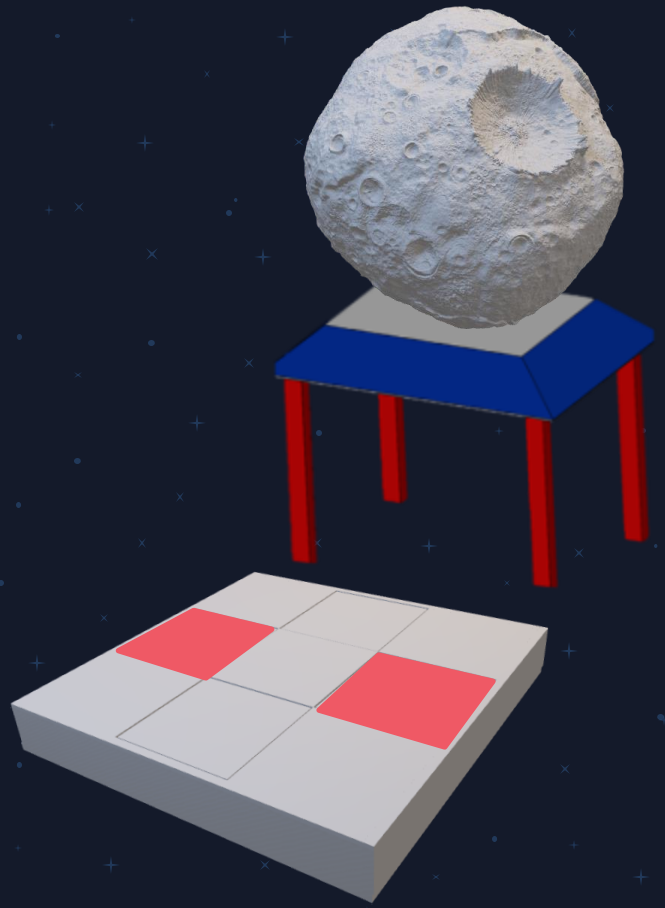
Kenneth Zhou

DDR Design Future Work

- Testing
- Addition of a second DDR pad
- Connection to the asteroid model

Kenneth Zhou

Connection to the asteroid model



Kenneth Zhou

IR Design

Psyche asteroid IR sending code

Hardware prototyping for the communication network

IR scanner receiving code

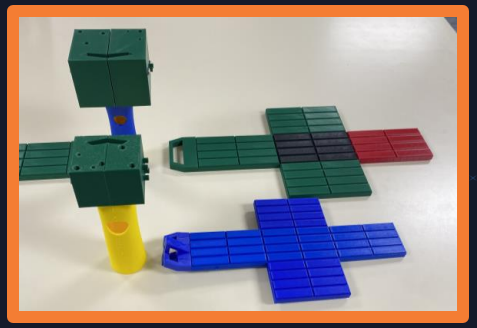
Sara Bradley

IR Design Future Work

- Integrate into Psyche asteroid design
- Integrate into IR scanner design
- Implementation of the information displays

Sara Bradley

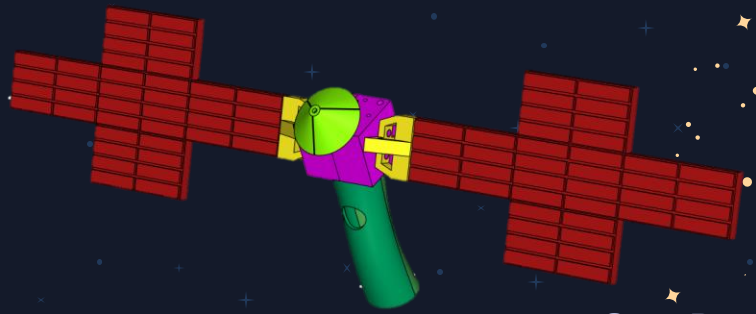
Blaster Design



Fully 3D printed exterior

1:16 scale with the actual spacecraft

Button used to actuate a receiver works individually



Sara Bradley

Blaster Design Future Work

Test durability and gather feedback on ergonomics of design

Modify design and reprint parts as feedback is given

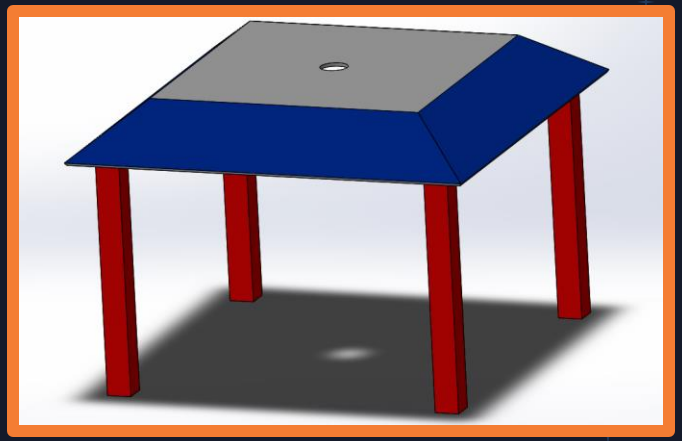
Integrate button and receiver into blaster

Sara Bradley

Structure Design

Made of wood 4x4's and sheathing panels

Design not final- needs to be easier to build



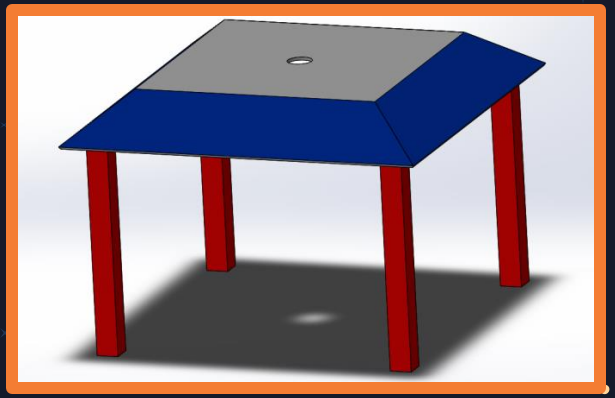
Garett Weatherland

Accessibility Considerations

Height of text panels

Ease of use for people in wheelchairs

Angle of text panels



Garett Sutherland

Structure Design Future Work

Simplify fabrication

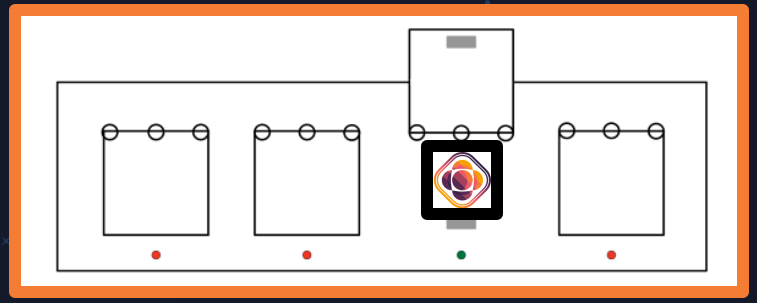
Design and integrate electrical components

Split panels into smaller ones

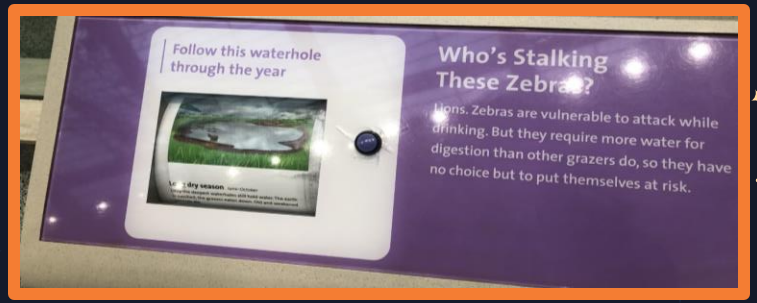
Garett Sutherland

Information Displays

Locked panels



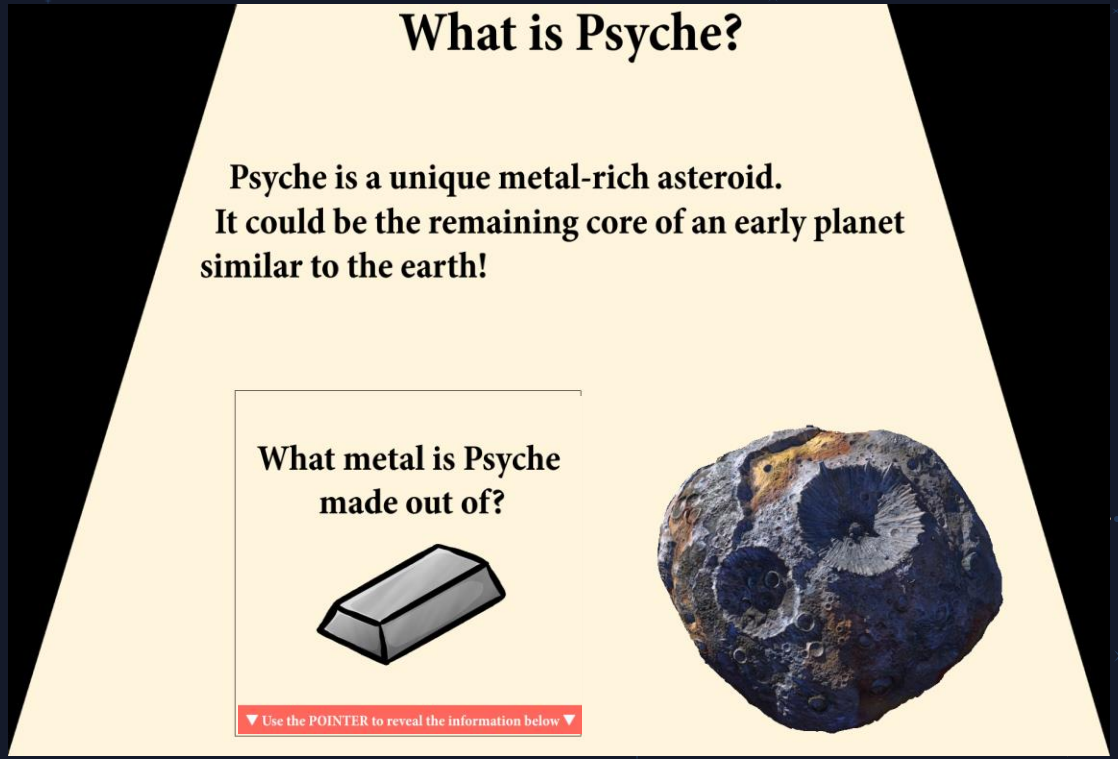
Rotating information cylinder



Garett Sutherland

Information Displays

Locked panels

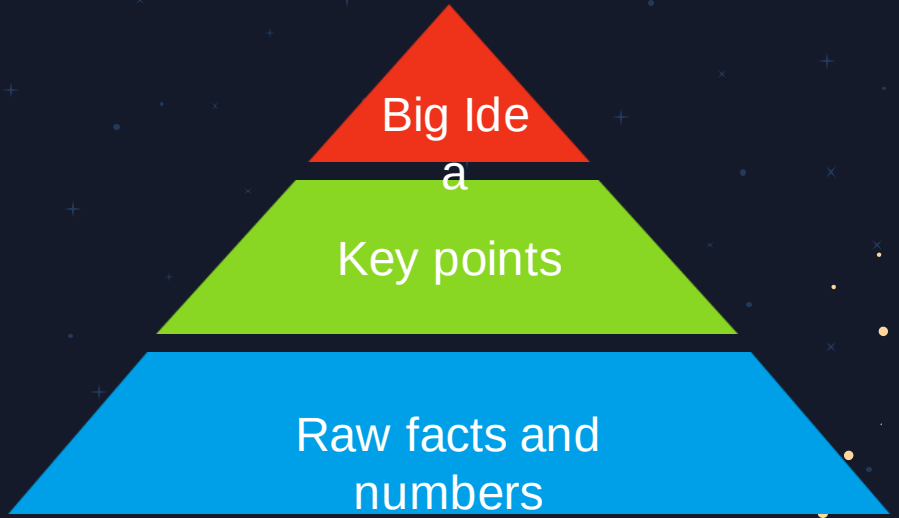


Garett Sutherland

Information Displays

All text panels are written with the Big Idea in mind

Big Idea:
Psyche is a unique metal asteroid that can teach us a lot.

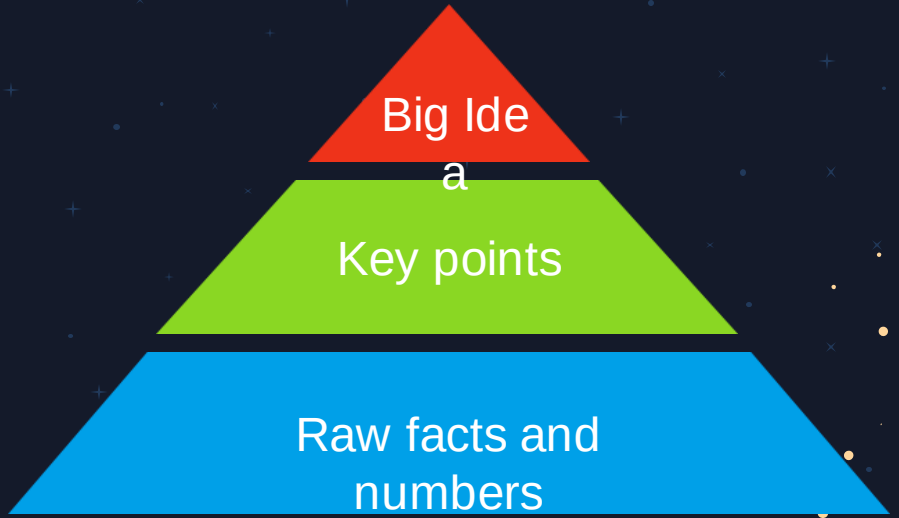


Garett Weatherland

Information Displays

Key points are addressed to get the Big Idea across

Key points highlight what we can learn from the Psyche mission



Garett Weatherland

Information Displays

Key points are addressed to get the Big Idea across

Key points highlight what we can learn from the Psyche mission

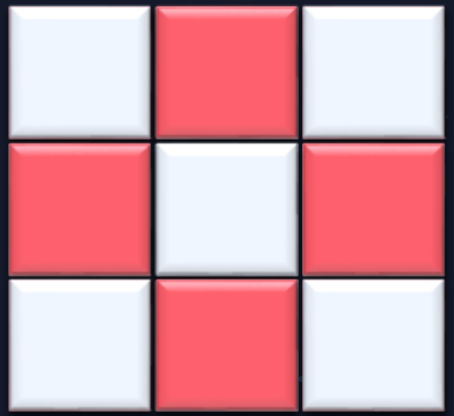
Garett Weatherland

Interactive Aspects

Repeat the pattern or Simon Says game

Interact with IR sensors to unlock information panels

Rotate the asteroid using dance pads



Garett Sutherland

Interactive Aspects Future Work

Integrate the games with elements on the exhibit

Integrate electromagnets into display panels

Integrate the rotating asteroid with dance pad

Garett Sutherland

Interactive Aspects Future Work

Integrate the games with elements on the exhibit

Integrate electromagnets into display panels

Integrate the rotating asteroid with dance pad

Garett Sutherland

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

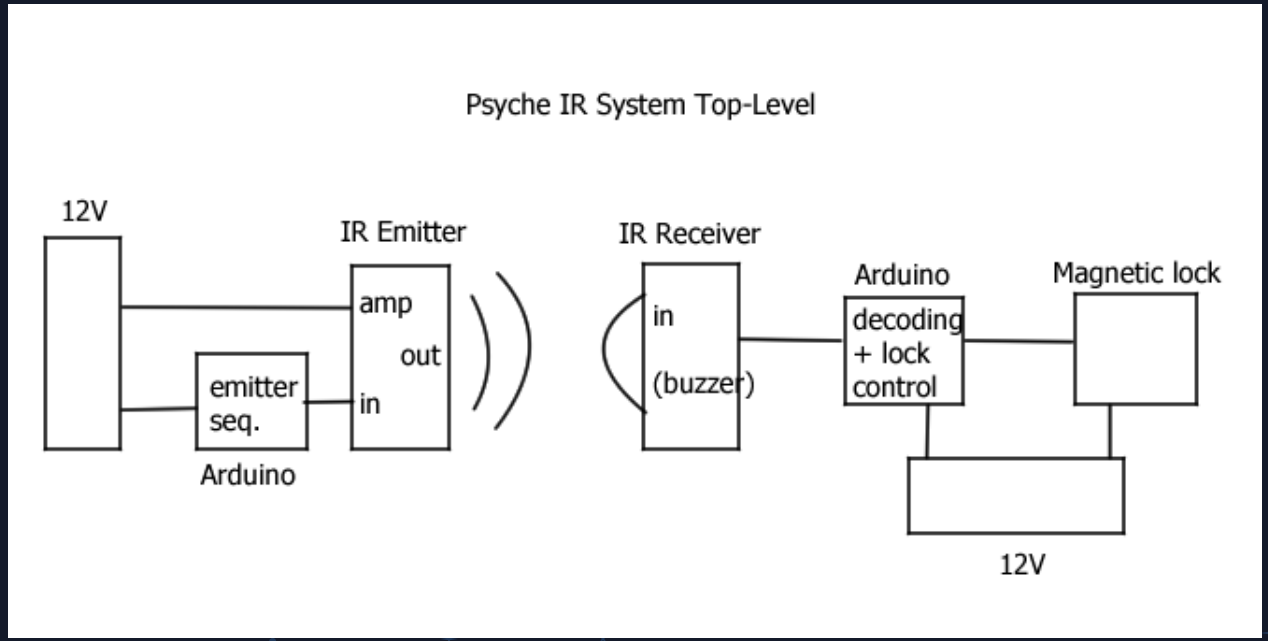
After going through the initial design phase and early prototyping, we are in the process of refining and fabricating our designs to make a fully functioning exhibit by 2/25/23.

Garett Sutherland

Additional Slides

PUT extra stuff in the slides after this

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.

Accessibility Considerations

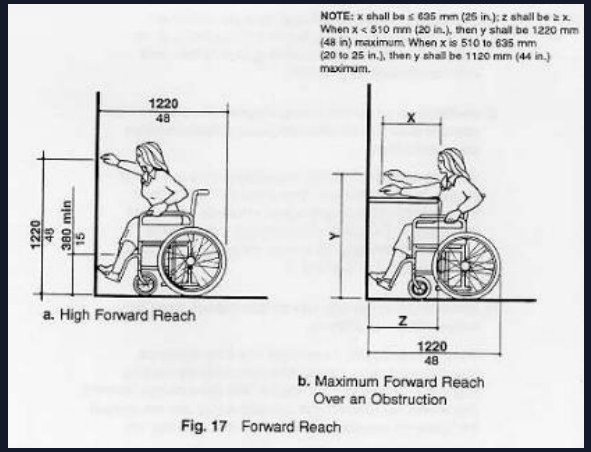


Fig. 17 Forward Reach

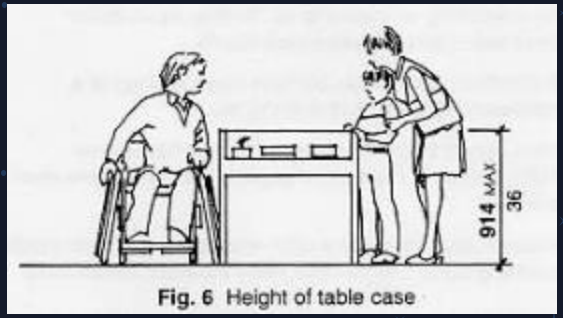


Fig. 6 Height of table case

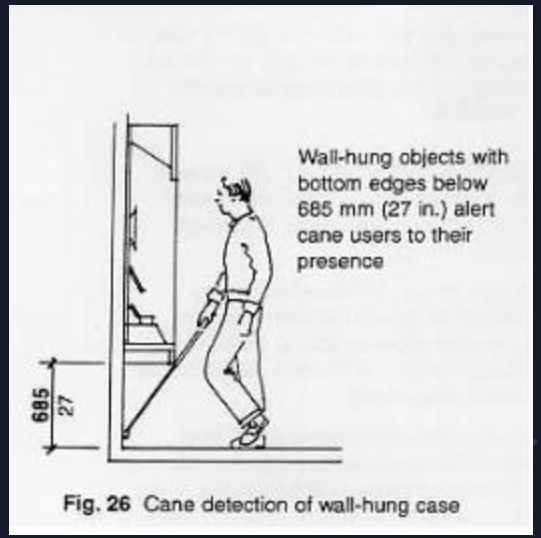


Fig. 26 Cane detection of wall-hung case

Garett Sutherland

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

Psyche Story

Figure 1

What is Psyche?

A large asteroid the size of Massachusetts!

The leading hypothesis of the formation:

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

Presenter Name

Psyche Story

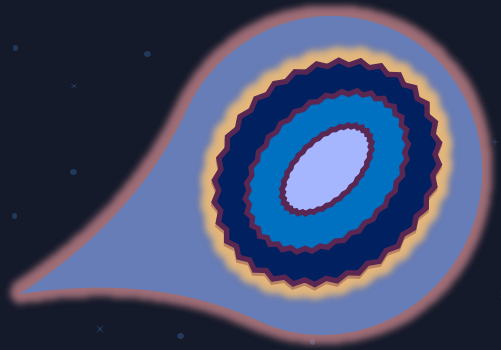


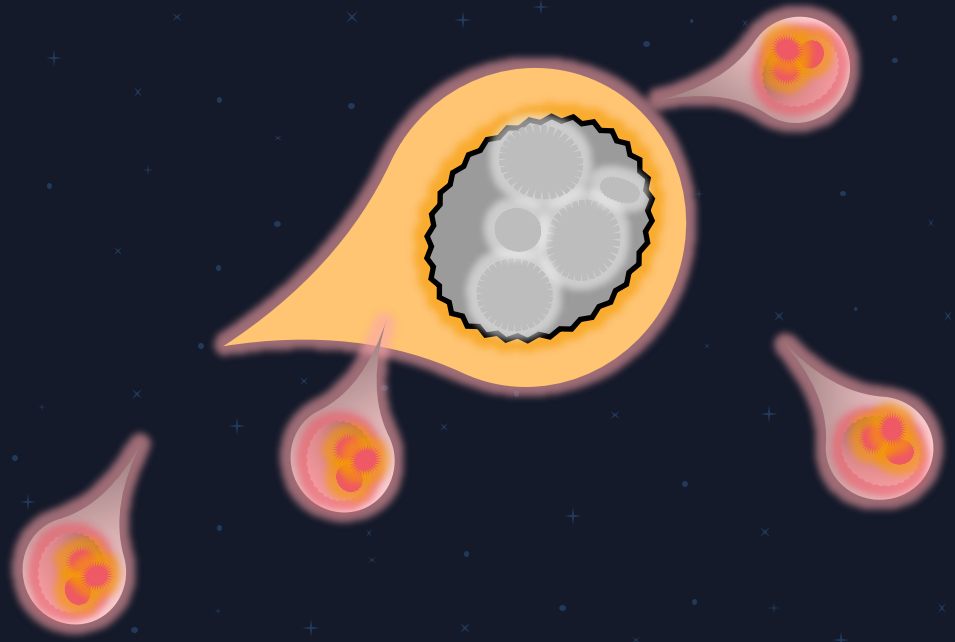
Figure 3: inside of the rocky layer as it cools

Presenter Name

Psyche Story

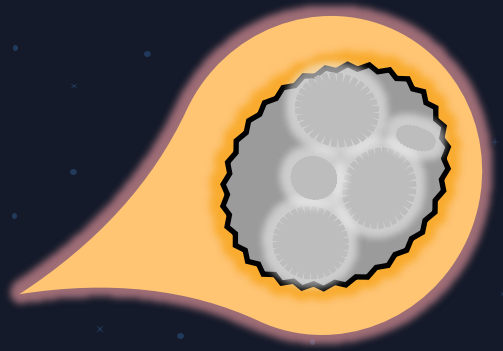
Presenter Name

Psyche Story



Presenter Name

Psyche Story

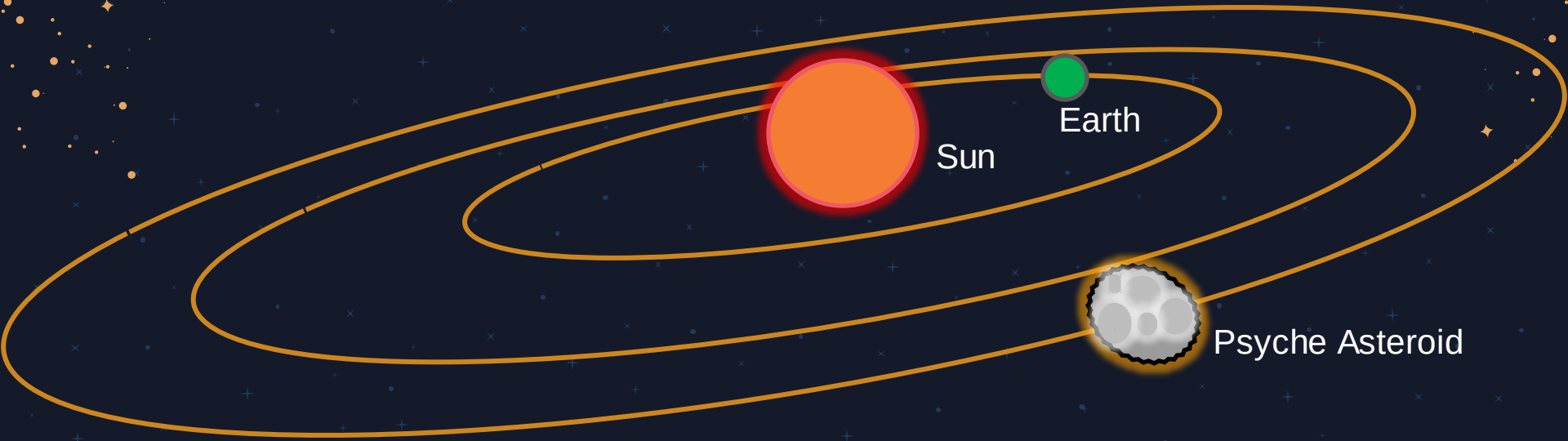


A Metal World?

By observing Psyche from a distance, it is currently believed that Psyche is made of mostly metal because it gives off many reflections.

Presenter Name

Where is Psyche



Presenter Name

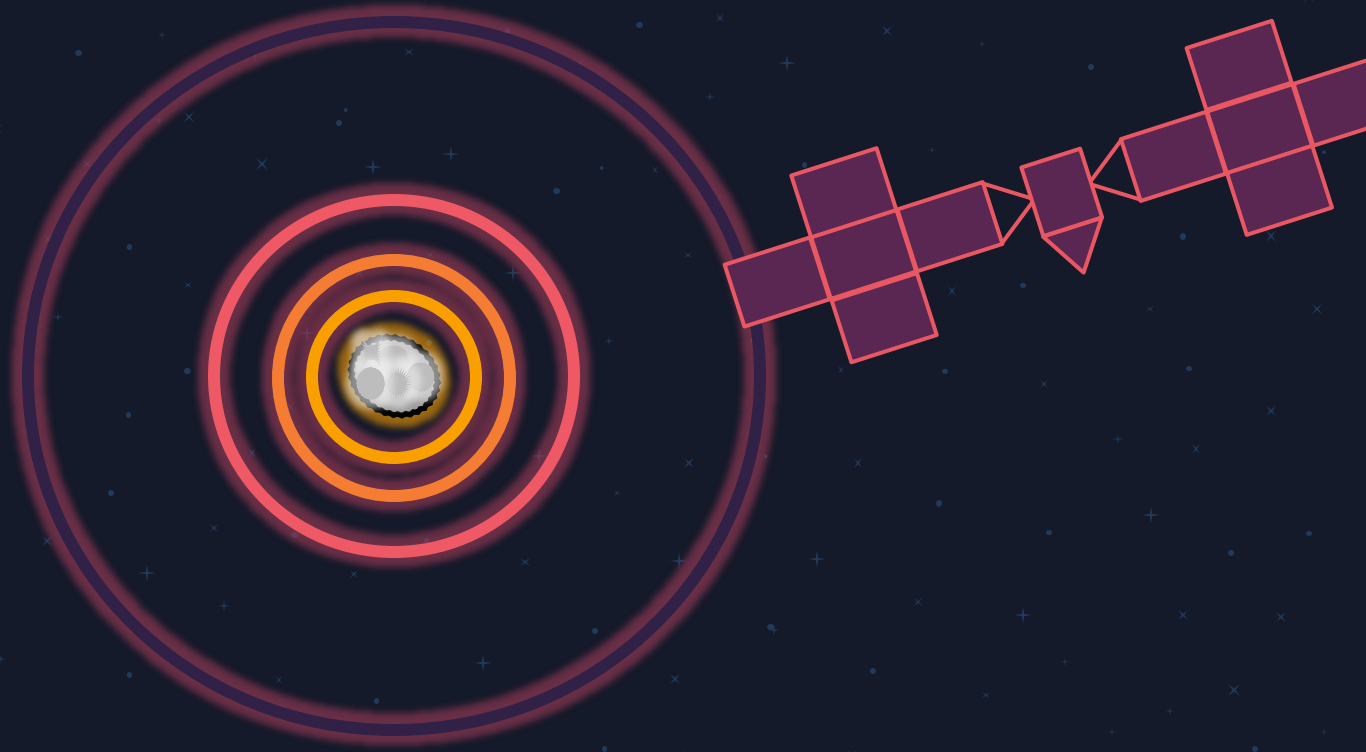
About the Mission

Present

Launch a spacecraft to travel to Psyche to further study

Presenter Name

Reaching Psyche

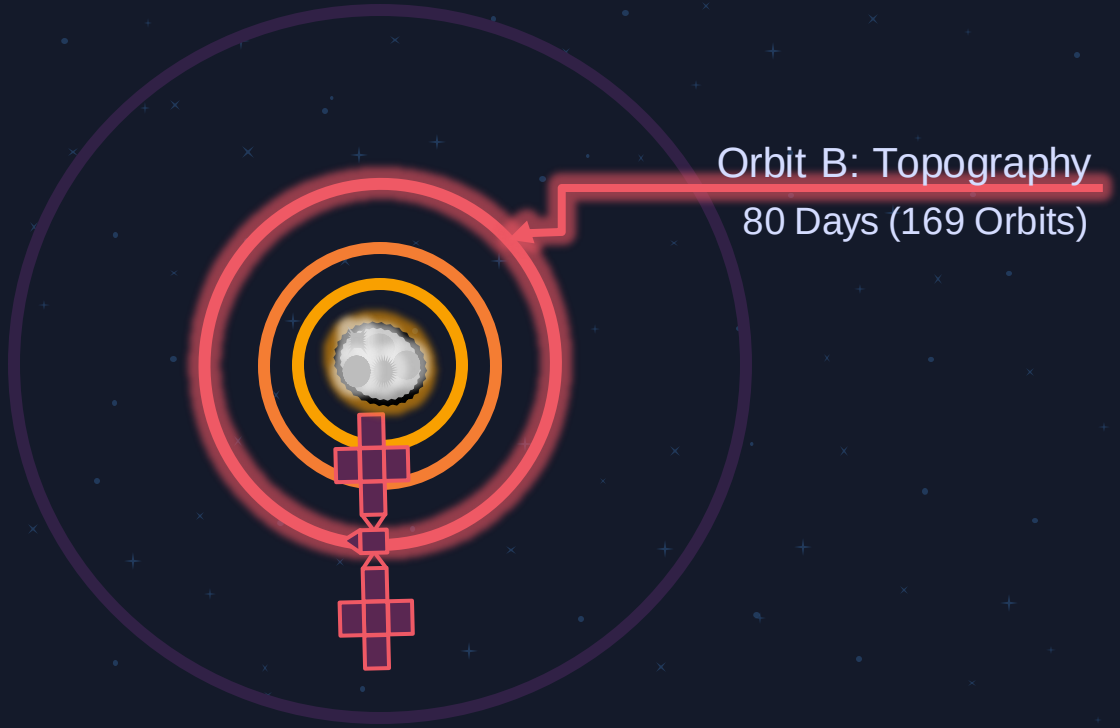


Presenter Name

Reaching Psyche

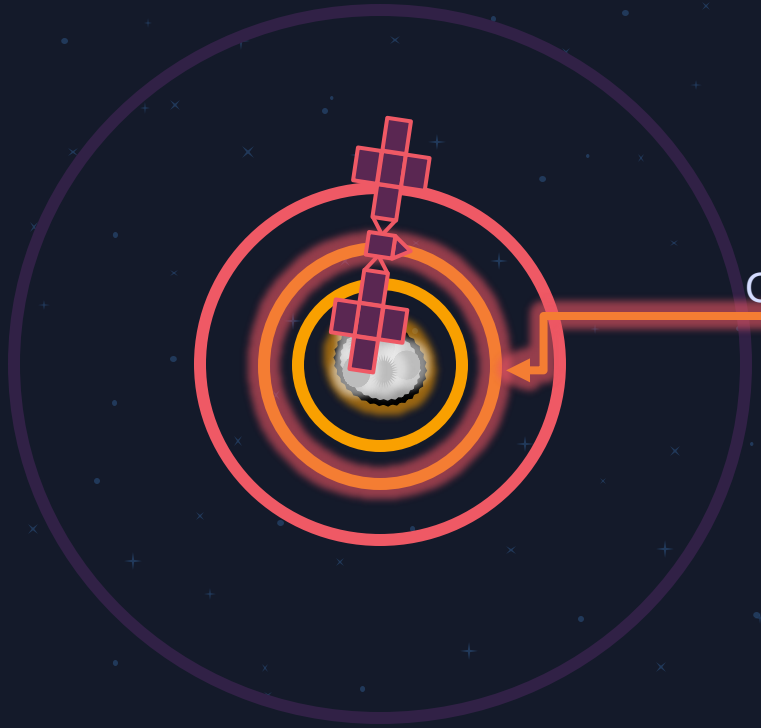
Presenter Name

Reaching Psyche



Presenter Name

Reaching Psyche



Orbit C: Gravity Science

100 Days (362 Orbits)

Presenter Name

Reaching Psyche

Orbit D: Elemental Mapping

100 Days (684 Orbits)

Presenter Name

Preliminary Research

Accessible Exhibition Design

Museum Visitor Experience

Previous ACCelerate Submissions

Presenter Name

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

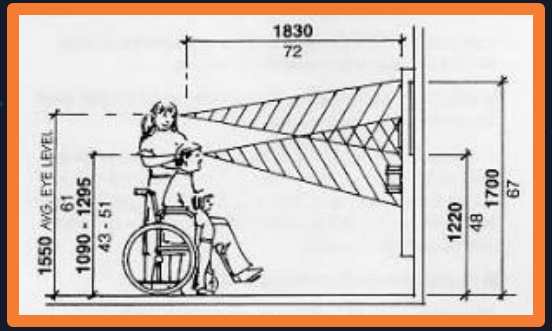


Figure 6 : Wall mounting

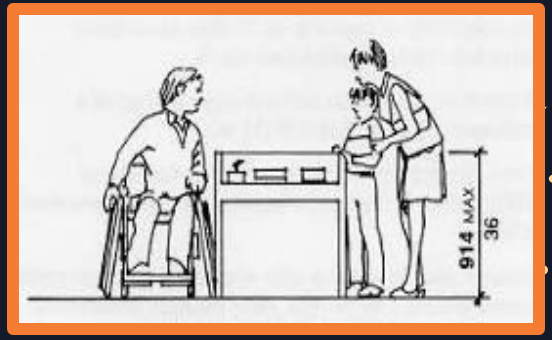


Figure 7: Table display

Presenter Name

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

Current Research

Survey on Target Audience

Social Media Interaction

Presenter Name

Assumptions

- Power Source Access
- Eighth Grade Level Concepts
- Low-Cost Fabrication

Key goals

Interactive and Informative

Affordable

Durable

Presenter Name

Markets

Museums

Planetarium

Academia

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.

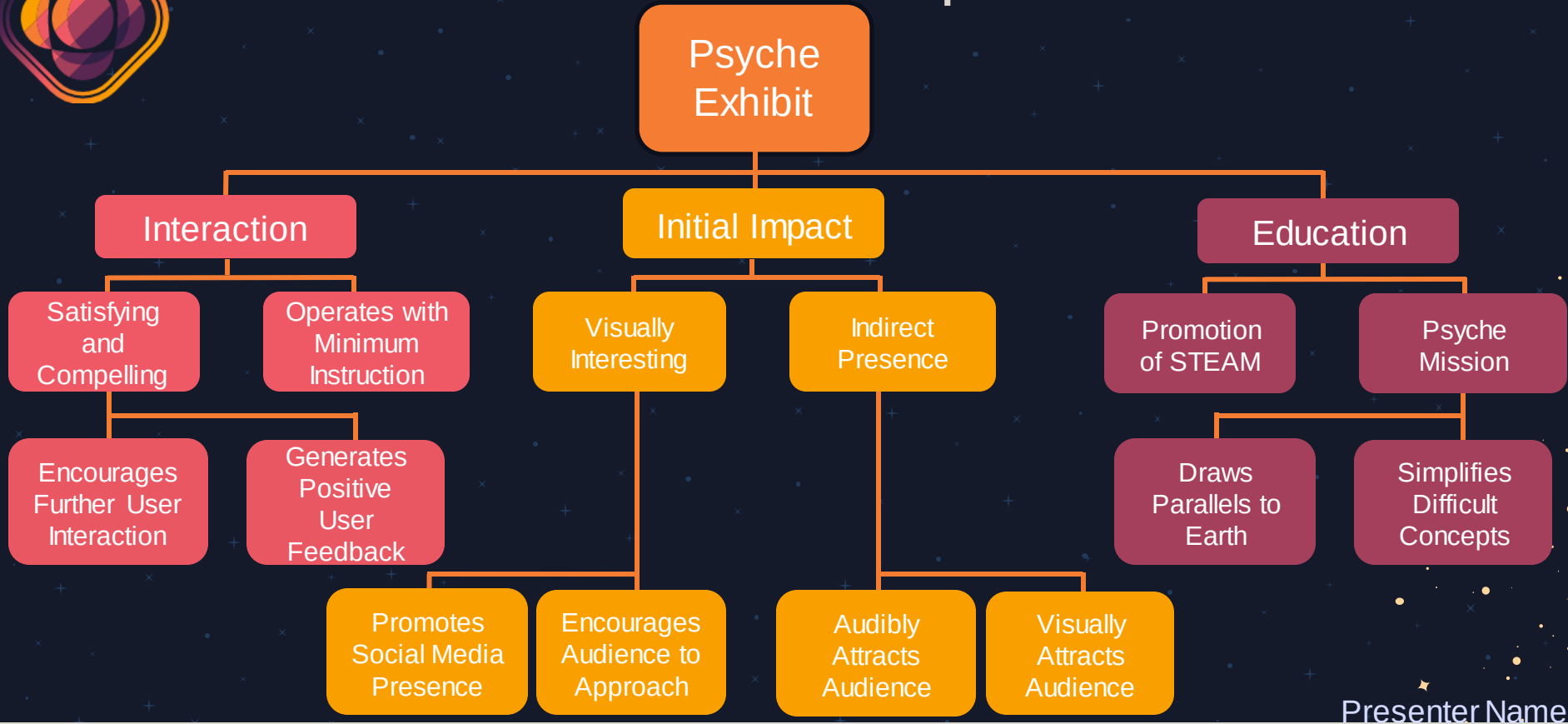
The product has the ability to run without a wall outlet if one is not availble.

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.

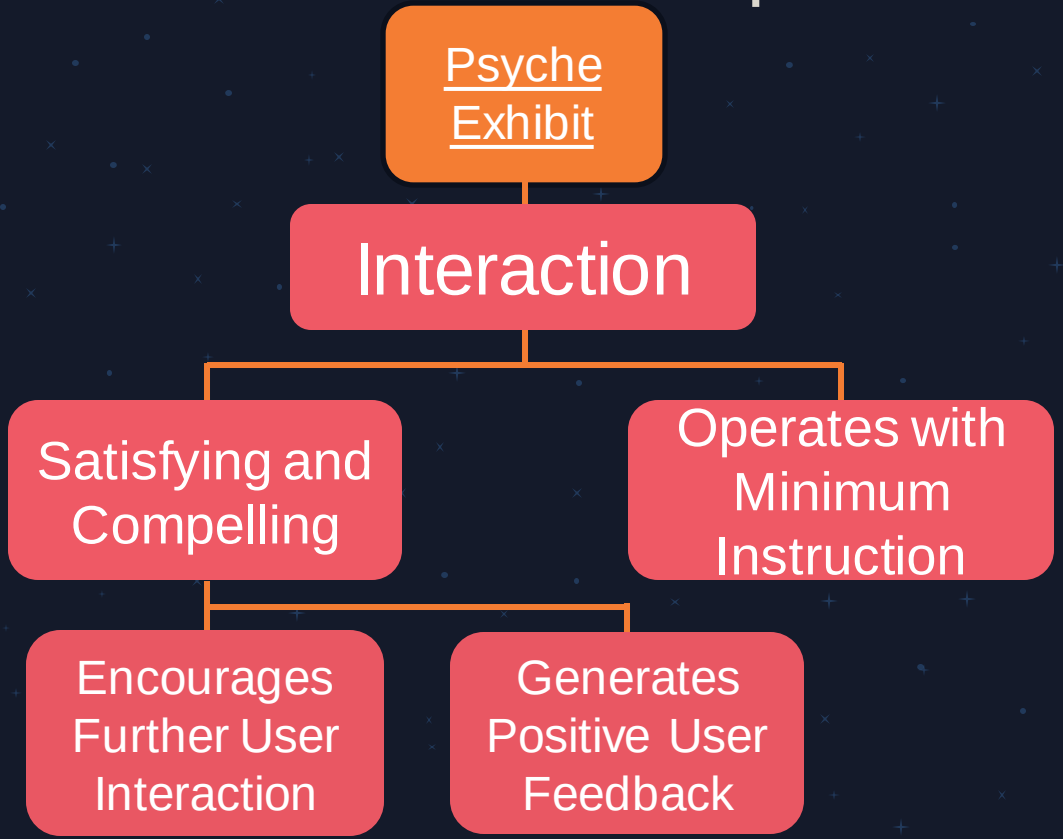
Presenter Name

Functional Decomposition



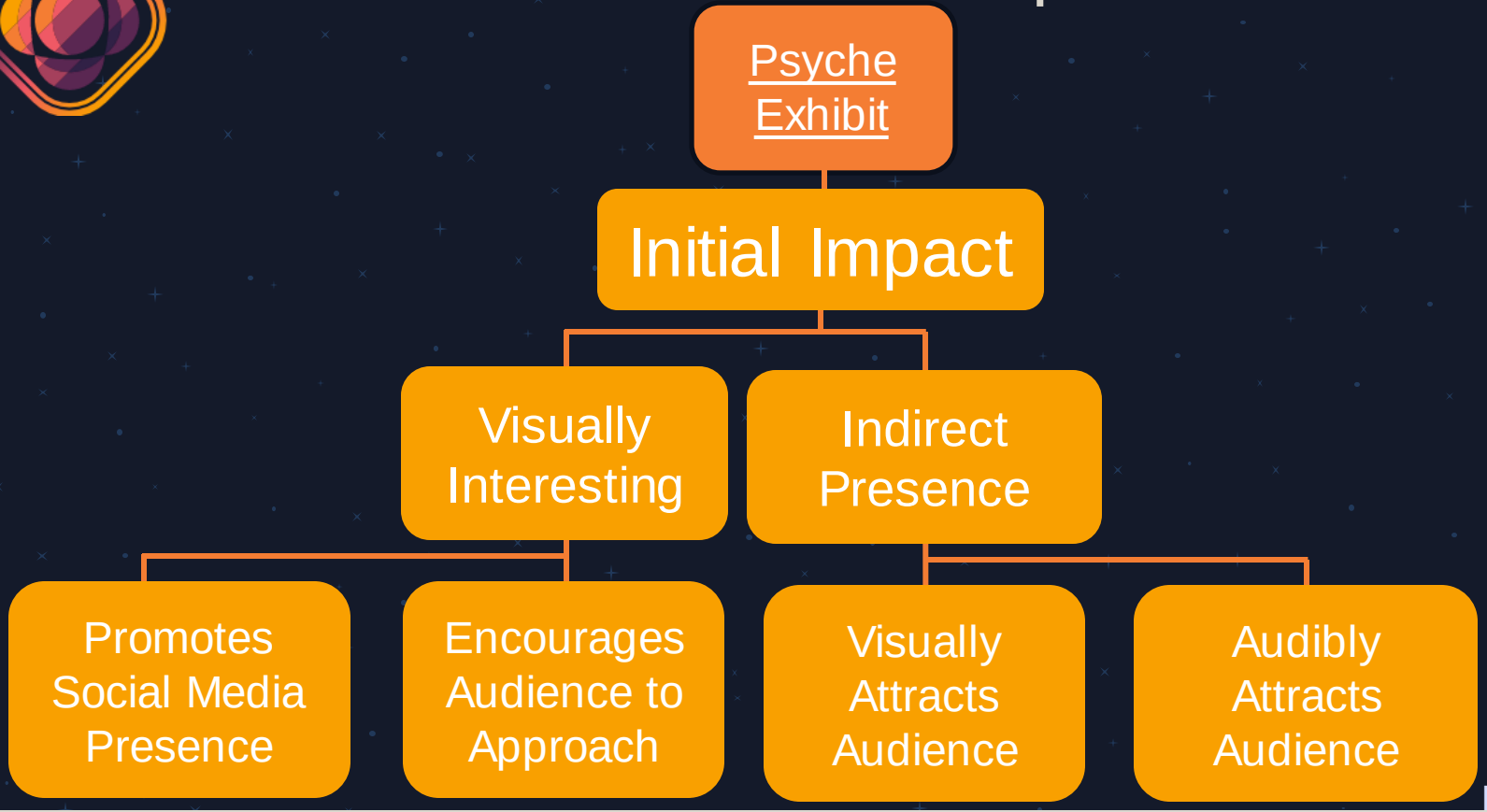
Presenter Name

Functional Decomposition



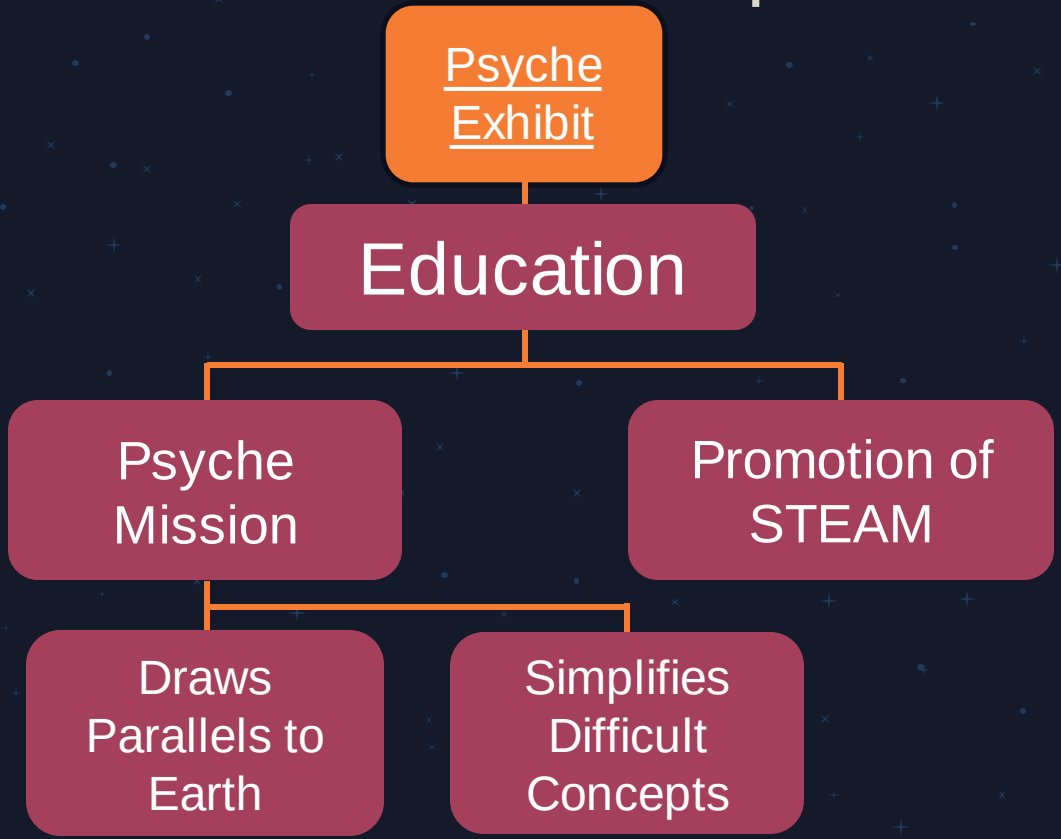
Presenter Name

Functional Decomposition



Presenter Name

Functional Decomposition



Presenter Name

Extra Blaster Images