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Team 502: ASU/Psyche – ACCelerate Festival

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Abstract

~~Psyche is a unique metal rich asteroid that can teach us a a lot of valuable information; this is the big idea we are conveying with our project.~~ For this project, ~~W~~we designed and ~~made~~fabricated an interactive and reproduceable museum exhibit, with the purpose of spreading key ~~ideas regarding~~ideas regarding the Psyche mission ~~to middle schoolers~~and to promote STEAM (science, technology, engineering, art, and mathematics) to middle schoolers. The Psyche mission is important as we have never explored a world made of metal. ~~One key idea is that the~~The Psyche asteroid is a unique metal rich object within our solar system that scientists can observe to ~~teach us~~discover new information about how the earth's and ~~the~~ other planets' cores were~~as~~ formed. The interactive exhibit design incorporates the following features: a spacecraft-themed dance pad to get users to physically engage~~d~~ with the exhibit by stepping or jumping on its buttons, a model of the Psyche asteroid, and a spacecraft-themed pointer to ~~get~~ give curious users to ~~look~~explore the Psyche model and search for ~~for~~ more ~~information, and a model of the Psyche asteroid. Users~~information. Users interact with the dance pad and pointer to learn about the Psyche Mission. Important topics about the Psyche Mission include scientific investigations and instruments about Psyche, information on the Psyche spacecraft, properties of the Psyche asteroid, and orbits the spacecraft will make around Psyche for experimentation. The end goal of the project is to send the exhibit to the ACCelerate Festival and Arizona State University (ASU)

to be put on display. The ACCelerate Festival is an exhibition, providing universities in the Atlantic Coast Conference to promote student led exhibits exploring STEAM concepts. A manual will also be made, describing how to make the exhibit step-by-step, so that other museums can feature our exhibit ~~as well~~.

Keywords: Psyche, 16 Psyche, Psyche Mission, ACCelerate, Interactive

Disclaimer

The content is solely the responsibility of the authors and does not necessarily represent the official views of ASU or NASA.

Acknowledgement

These remarks thanks those that helped you complete your senior design project. Especially those who have sponsored the project, provided mentorship advice, and materials. 4

- Paragraph 1 thank sponsor!
- Paragraph 2 thank advisors.
- Paragraph 3 thank those that provided you materials and resources.
- Paragraph 4 thank anyone else who helped you.

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Notation

ASU	Arizona State University
NASA	National Aeronautics and Space Administration
CAD	Computer Aided Design
IR	Infrared Emitter

Chapter One: EML 4551C

1.1 Project Scope

1.1.1 Project Description

The objective of the project is to create an interactive exhibit that educates individuals about Psyche, a metal asteroid orbiting the sun between Mars and Jupiter. The exhibit should capture the interests of children and adults alike. This can be achieved by using moving parts, vibrant colors, or hands-on activities. The project should be suitable for a museum environment. The exhibit design should account for frequent use with little to no explanation required to operate. The exhibit is available to interact with after another user is done with it. The project should be interactive, to create a unique experience for the user. Finally, the project should be replicable; markets around the country should be able to recreate the design with reasonable ease. This project is being funded by Arizona State University as a part of a larger mission to educate the public about the Psyche Mission.

1.1.2 Key Goals

The goals for this project were determined using information from the project description. The primary goal for this project is to design an interactive and informative display that showcases the concepts about the ASU Psyche Mission to a museum audience and can be

understood at an eight-grade level. This exhibit should be affordable for museums to implement, be composed of off-the-shelf components for repairability, and durable to withstand interaction from children and adults.

1.1.3 Market

Through obtaining a base idea of the project and establishing goals, the~~There are multiple markets our design is targeting. The~~ primary markets for the project are museums, planetariums, schools, and libraries. Businesses in the education sector will find use in our product to gain an understanding of the Psyche mission and encourage participation in the STEM field. The secondary markets targeted are enthusiasts who want an exhibit they could create themselves for personal enjoyment in learning about the asteroid and outer space.

1.1.4 Assumptions

It is assumed the primary and secondary markets will ~~It is assumed that the project will~~ have access to a power source and the person assembling the final product will have the ability to access and follow an assembly manual. The concepts being conveyed will be understood by individuals at an eighth-grade level and above. The information being displayed will be simple enough for an older individual to explain to younger kids in elementary schools and below. The device will be occasionally cleaned and maintained at the museum. Assume that stakeholders

and targeted market will be able to afford or access low-cost fabrication equipment, such as 3D printing and basic hand tools.

1.1.5 Stakeholders

The stakeholders that will aid the development of the exhibit are Dr. Cassie Bowman, Dr. Chiang Shih, and Dr. Shayne McConomy.

1.2 Customer Needs

1.2.1 Project Statement

The objective of this project is to create interest in the Psyche Mission with an interactive exhibit. The primary market would be museums, planetariums, schools, libraries, and businesses in the education sector. Ideally, the final design would be easy and inexpensive so that museums and science centers are able to replicate and display the exhibit.

1.2.2 Interpreted Needs

In order to properly proceed with the development of our project, it is important to gain a better understanding of the customer's vision for the project. This meant that it was necessary for us to ask the customer, in this case Dr. Cassie Bowman, to answer a set of questions for us to

further define the scope of this project and get a better idea as to how we will solve our problem. We created a set of nine questions that would further define the guidelines for our project and based on the responses from our mock customer, we developed a list of interpreted needs statements. These interpreted needs statements take what the customer said they desired and change the wording to have a more technical interpretation that can be evaluated through engineering characteristics. Table 1 lists the questions we asked the customer, their responses, and the interpreted needs statements we created.

Table 1: Customer Needs

Question/prompt	Customer Statement	Interpreted Need
What did you like about previous projects?	Buttons, moving things, lights, sounds	The product has the ability to have a user interact with it.
		The product has the ability to stimulate the users senses.
What did you dislike about previous projects?	Do not touch when expected to touch	The product has the ability to hide components that are not meant for the user to touch.
Should we account for exhibits being outdoors? Weather resistant?	Expect that it will not be used outside	The product will be used inside.
Is there a size limit?	Around the same size as other exhibits	The product is a similar size to other exhibits.

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Will we have access to a power supply?	Power could be a problem. But if critical, it is ok. Consider batteries (look at using rechargeable batteries)	The product has the ability to run without a wall outlet if one is not available.
Will maintenance be done, or will the exhibit be left unattended for a long time?	Expect that if anything looks broken or is not functioning as it should, then someone will fix it. Also, in the case that something does break, it should be able to be fixed by someone with minimal skills or have easy to replace parts	The product can be troubleshot easily and requires no custom tools to repair.
How much should we expect this to cost?	It depends, but you might want to submit two separate projects for me and for the festival. A simpler version for me and a more advanced version for the festival	The product should use little to no custom parts outside of parts that are 3D printable.

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1.2.3 Explanation of Results

The product specifications have been narrowed down into the following: The product has the ability to stimulate the user with interactive and sensory activities, while hiding components

not meant for touching. The product will be the size of an average exhibit, used inside, function without a wall outlet, be easy to fix with common tools, and have little to no custom parts (outside of 3D printable parts).

The appropriate needs were formed using the customer statements. In order to interpret the statements, definite or vague wording was removed and replaced with non-restrictive statements. Engineering characteristics were added to establish technical criteria that the product will accomplish, subsequently narrowing the scope of the project and applying restrictions to the ideation process. The project definition should now have enough clarity to begin formulating potential solutions to the problem statement and satisfy the customer needs.

1.3 Functional Decomposition

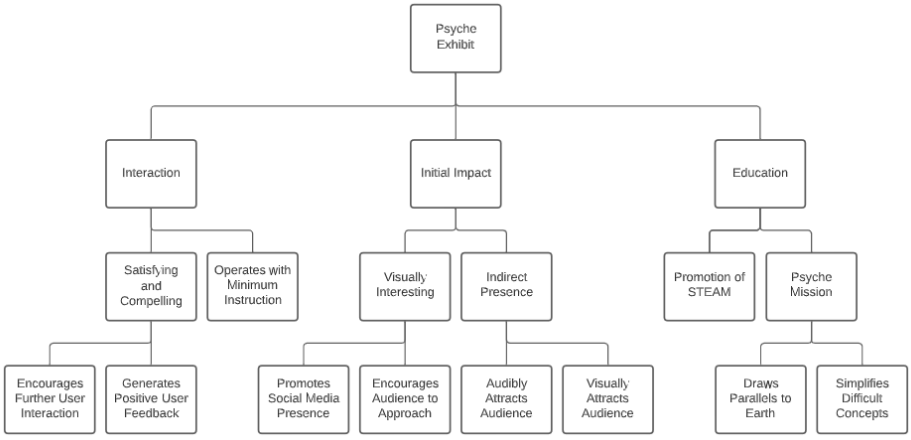

Figure 1: *Functional Decomposition*

1.3.1 Explanation of Results

This functional decomposition is a breakdown of all the functions and objectives this project aims to achieve. These functions were determined after communicating with our team's sponsor, Cassie Bowman, and analyzing what would be required to achieve this project's needs. It was determined that the exhibit must have some form of physical interaction to appeal to the largest number of audience members. The exhibit should also attract people that are not directly interacting with the exhibit. Most importantly, this exhibit should educate its audience about the Psyche mission and promote STEAM.

The functional decomposition was separated into three major functions: interaction, initial impact, and education. Interaction focuses on heuristics and giving the user a fun experience. Initial impact draws in audience members through visual or audio methods. Education simplifies and explains the Psyche mission to users at the 8th grade level and above while promoting STEAM.

1.3.2 Connection of Systems

All three primary features of the exhibit are inherently integrated. A visually appealing project will be appealing to more visitors, and therefore educational information will reach a larger audience. An interactive exhibit would attract more users because crowds attract crowds. Also, interactive exhibits can create memorable experiences. With our subject being an asteroid, a more memorable experience will make it easier for the information to be remembered. All three of these aspects are linked and improve each other.

The first effective system is initial impact. Unless the audience is attracted or wants to interact with the exhibit, the exhibit's other functions are useless. This means that the exhibit should attract audience members during use and while not in use. The design should also be catered to an audience of 8th grade and above; the educational concepts should be explained in an approachable and fun way.

The next system is interaction. The goal of interaction is to immerse the audience upon arriving at the exhibit. The exhibit should have physically interactive features that provide the user with encouraging feedback to entice them to continue exploring the exhibit. During this interaction, the exhibit should explain concepts about the Psyche mission.

Education is the result of the initial pull and interaction. The overall goal of this project is to educate audience members about the Psyche mission. This is done by simplifying difficult concepts of the Psyche mission and drawing parallels to ideas to be understood by the audience.

1.3.3 Actions and Outcomes

While the audience passes the exhibit, they should be compelled, audibly or visually, to draw their attention towards the exhibit. Upon having their initial attention and interaction, the audience should stay involved in the exhibit by means of satisfying interaction with the exhibit. The exhibit is made satisfying by having some sort of positive user feedback. The positive feedback for interactions should be paired with easily understood information about Psyche.

1.3.4 Functional Resolution

Overall, the project must educate the public about Psyche and the importance of the mission. This is achieved through the medium of a museum exhibit. This exhibit should be interactive, educational for a wide audience, and attract people to explore the exhibit.

Table 2: Function Matrix

Minor Function	Interaction	Initial Impact	Education
Satisfying and Compelling	X		
Operates w/ Minimum Instruction	X		
Visually Interesting	X	X	
Indirect Presence		X	
Promotion of STEAM	X		X
Simplifies Difficult Concepts			X

1.3.5 Function Relationships

The functional decomposition matrix separates the major function, “Psyche Exhibit”, into manageable minor functions. The function “Initial Impact” serves to attract the audience to interact with the exhibit. This interaction then ties into “Education”, which serves to promote STEAM and educate the audience about the Psyche mission. The information being conveyed should then have some sort of impact on the audience, attracting more audience members to the exhibit.

1.4 Target Summary

In summary, our project has three primary targets to satisfy. Interaction, initial impact, and education. The metrics for interaction include having an average interaction time of one minute, the exhibit must be interacted with in an intended manner, and finally, the exhibit must feature at least one form of haptic, audio, or visual response. Our metrics for initial impact focus on social media interactions, visually identifiable objects on the exhibit, and audible noises and vibrant colors to attract people. The metrics for our educational target include teaching participants a STEAM concept, recording the participants' age and understanding of the concepts we teach, and how much we relate Earth to Psyche in the information presented. Lastly, our final target is to make our museum exhibit replicable, including metrics regarding cost, size, and time to construct; other museums should be able to build our exhibit as well easily and affordably.

1.4.1 Interaction

Interaction functions include the features of the exhibit that will keep a user's attention by being both intuitive to use and rewarding.

The exhibit should encourage further user interaction to hold a user's attention for an extended period. The target for this exhibit is to have users spend an average of one minute at the

exhibit. Research conducted by at the Reuben Fleet Science Center concluded that museum guests spend an average of one minute at any given exhibit; we will use this as a baseline for a moderately successful exhibit (Sandifer, 1997). This target is measurable using a stopwatch. Users would be randomly sampled for time spent at a live demonstration of the exhibit.

To generate positive user feedback, the exhibit's interactable elements should produce at least one form of instant gratification. For the exhibit to be instantly gratifying, interactions should generate a haptic, audio, or visual response. These three options were selected to ensure the exhibit could be gratifying for most users. The exhibit should be gratifying to the middle school audience in addition to those older than the middle school audience. The target is to have a minimum of one gratifying haptic, audio, or visual response per interaction. To measure satisfaction from exhibit interaction, basic surveys on the net satisfaction of the interaction with exhibit features will be conducted.

The exhibit should operate with minimum outside instruction, which means the exhibit should contain features that can be interacted with instinctively. An important part of informal learning is allowing users to discover information without excessive assistance (Ray-Kaeser, 2018). The target is to have users interact with the exhibit in an intended manner within one minute; one minute is also the length of time that a user will be interacting with the exhibit. A

stopwatch will be used to measure the time it takes for a user to interact with the exhibit in the intended manner.

1.4.2 Initial Impact

Initial impact functions include promoting social media presence, encouraging the audience to approach, and attracting the audience audibly.

To promote social media presence, it was decided that we would initially promote our prototypes and concepts using Tik-Tok, where a large portion of users are in middle school. This will be done through short videos displaying some rapid prototypes to show a physical representation of the concepts. This is being measured using TikTok's analytical tools. Our target is to get a minimum of 150 interactions, such as likes, views, comments, hashtags, and duets. We will document our progress and analytics to validate our concepts.

To encourage the audience to approach the exhibit, it was decided that the exhibit should have a minimum of two identifiable interactable features. This can be indicated using visual or audio cues. This would be measured using a participant survey and asking what features they noticed when first approaching the exhibit.

To audibly attract the audience, it was decided that the exhibit must have sounds that are appropriate for a museum at low levels that are not distracting. This will be measured using a sound meter and having a maximum decibel as a constraint. To visually attract the audience, it was decided that the exhibit should have colors that are naturally appealing to the eye. Orange and red tend to stand out and are therefore used on many warning signs or safety equipment (Vision Boutique, 2022), but our entire exhibit should have colors related to space so that it's catchy to the eye but also accurate to what planets and space look like.

1.4.3 Education

Education functions include the subfunctions of the promotion of STEAM, promotion of the Psyche Mission, drawing parallels between Psyche and Earth, and ensuring that concepts are easy to understand.

For the promotion of STEAM function, the exhibit should promote and encourage STEAM. The target is to have at least one piece of content that promotes STEAM. The measurement method is to use a survey that asks participants if they learned at least one STEAM related concept.

To simplify concepts, the exhibit will have educational information with few technical words and definitions that make the information easier to digest for ages below 14. The target is to not have to clarify any information displayed. This will be measured by giving visitors a short quiz about their age and asking questions about what they learned. The answers between the young and adult populations would be compared to evaluate each population's level of understanding.

By drawing parallels between Earth and Psyche, users can relate information about the Psyche mission to their existing knowledge. Pieces of the exhibit should relate Earth and the Psyche asteroid together with at least 50% of the information relating to the two. The method of measurement is through documenting the information given in the exhibit and analyzing what percentage of the informational points relate Earth and Psyche together. The minimum will be 50% but can go up to 100% of the information drawing parallels.

Explaining the Psyche Mission is a metric for the education function. The mission overview is explained to the listener and is measured by documenting the mission overview information and analyzing if the content is the same of the overview on Psyche's website.

1.4.4 Critical Targets

It was determined that the size of the exhibit, promotion of STEAM, promoting the Psyche Mission, and the cost to replicate will be critical targets. Informing the users about the Psyche mission and STEAM is important because these two functions directly impact our mission statement. The size and cost of the exhibit is critical because if the exhibit is too large or expensive, then it will be harder to fit into different science centers and museums, which will decrease the museum's and science center's desire to replicate the exhibit.

1.4.5 Summary

In summary, our project has three primary targets to satisfy. Interaction, initial impact, and education. The metrics for interaction include having an average interaction time of one minute, the exhibit must be interacted with in the intended manner, and finally the exhibit must feature at least one form of haptic, audio, or visual response. Our metrics for initial impact focus on social media interactions, visually identifiable objects on the exhibit, and audible noises and vibrant colors to attract people. The metrics for our educational target include teaching participants a STEAM concept, recording the participants' age and understanding of the concepts we teach, and how much we relate Earth to Psyche in the information presented. Lastly, our final target is to make our museum exhibit replicable, including metrics regarding cost, size, and time to construct; other museums should be able to build our exhibit as well easily and affordably.

Table 3: Primary functions

Function	Target	Metric	Method of Measurement	Method of Validation	Tolerance
Operates with Minimum Instruction	1	Time (minute)	Stopwatch	The crowd sampled time taken to operate as intended	-100% to +10%
Encourages Further User Interaction	1	Time (minute)	Stopwatch	Random sampling of crowd interacting with exhibit	-50% to +any %
Generates Positive User Feedback	1	Haptic response per interaction.	Survey	Ask users how they felt about each interaction	-0% to +any %
Promotes Social Media Presence	150	Interactions (Likes, Shares, Replies, Views, hashtags)	Tik-Tok analytics	If we see interest in Tik-Tok increase or decrease	-10% to +any %
Encourages Audience to Approach	2	Identifiable interactable features.	Survey	Ask users what features they first noticed	-50% to +any %
Audibly Attracts:	65	dB	Sound meter	Standing near the exhibit with the meter and recording results	-25% to +10%
Visually Attracts Audience	70	Percent	Survey	Asking participants if they found the exhibit visually appealing	-10% to +any %
Promotion of STEAM	1	Promotional piece of the exhibit that directly talks about and	Survey	Asking participants if they learned one	-0% to +any %

		encourages STEAM.		STEAM related concept.	
Draws parallels to Earth	50	Percent	Documenting the information told in the exhibit.	Listing all informational points and analyzing percentage that relates to Earth.	-10% to +any %
Psyche Mission	95	Percent	Documenting of mission overview part of the exhibit design.	Analyzing if the mission overview is the same as the one told on Psyche's website.	-10% to +any %
Simplifies Difficult Concepts	50	Percent	Quiz	Measure if middle schoolers have a similar comprehension score to adults	-10% to +any %
Cost to Develop	1000	Dollars	Excel (BoM)	Keep an up-to-date Excel sheet	-any % to +10%
Cost to Replicate	1000	Dollars	Excel (BoM)	Keep an up-to-date Excel sheet	-any % to +10%
Durability – Life Cycle	6	Months	Life Cycle Test – determine what each part experiences during 1 cycle	Life Cycle Test, Individual part life cycle test vs expected	±2
Time to Assemble for a nonskilled worker	3	Hours	Timer	Have a nonskilled person assemble	-any % to +50%

Size of the Exhibit	3400	Square feet	Measuring tape	Measuring the assembled product and the CAD assembly	-any % to +10%

1.5 Concept Generation

For our project, ideas and concepts were generated using a variety of methods; the main one being brainstorming. A concept list was created with the purpose of creating over 100 ideas, then all team members added ideas as a deeper understanding of customer needs was developed. The other methods we used were crap shoot, anti-problem, and forced analogy.

Eight ideas in total, three high-fidelity, and five medium-fidelity concepts were chosen from the list of ideas in Appendix E. These are ideas that the team considers to be viable solutions that meet the customer's needs and are capable of achieving the goals and metrics outlined in the preceding section. The eight concepts that were selected will go through a rigorous selection process using a set of charts that assign crucial factors to various engineering design aspects.

High Fidelity Concepts

Concept 1: IR Pointer Game (26) + Satellite Controls (212)

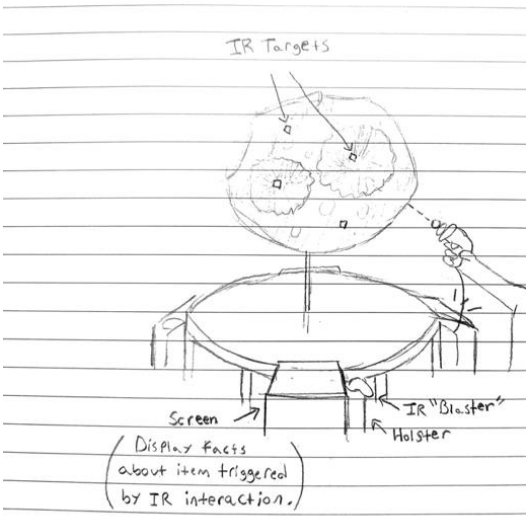

Figure 2 *Concept 1*

Figure 2 shows the first high-fidelity concept depicting a large Psyche model surrounded by screens and Psyche orbiter-shaped IR pointers. The Psyche model would have IR detectors that detect when the IR pointer is aimed at it. This allows users to analyze the surface of Psyche and answer on-screen questions. The screens would then display information about the point of interest at the IR sensor. Additionally, a mock satellite could be controlled to orbit the Psyche model and a live feed of the Psyche surface would be displayed on a screen.

The use of screens allows information about Psyche to be added or removed as new information about the asteroid is discovered. This adds to the longevity of the exhibit and allows it to remain relevant. The gamified use of IR sensors and facts on the screens should reward the

users for their “hit” on the IR sensor through sounds, visuals, or haptics. Additionally, the satellite controls allow kids to pretend to be a satellite operator and have a memorable moment at the exhibit as they explore the terrain of Psyche.

This exhibit overall should attract users using the model, lights and sounds. The users would then interact with the model using the IR pointers and mock satellite and receive positive feedback. Finally, the facts, questions, and physical appearance would educate users about the Psyche asteroid and mission.

Concept 2: Pinball (17)

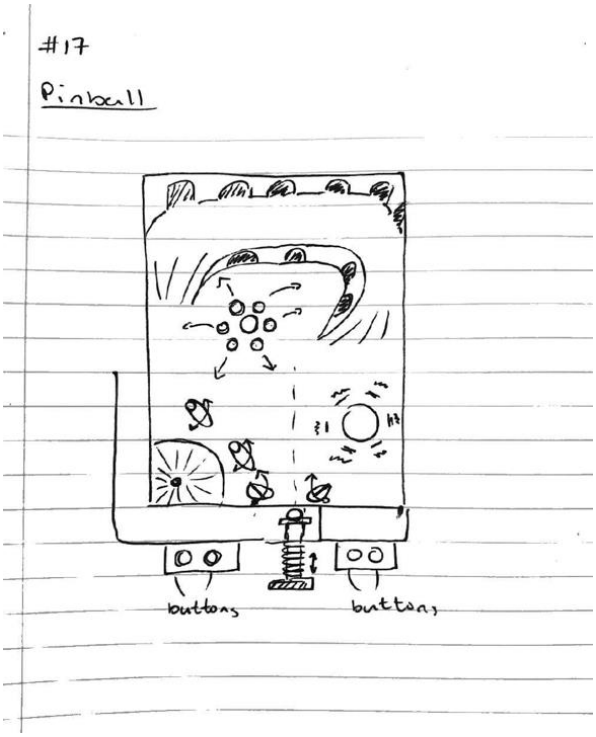

Figure 3. *Concept 2*

Figure 3 represents another high-fidelity concept. A pinball representing a satellite is launched into the playfield through the shooter lane. Paddles propel the ball through the playfield, the main goal is to score the ball into a narrow ramp that leads to Psyche. The ramp loops around Psyche to represent the satellite entering Psyche's orbit. Alternatively, the ramp could lead into a basin that acts like a funnel around Psyche, also to appear like the ball (satellite)

is orbiting Psyche. Players avoid letting the ball pass the paddles into the trough. The primary educational goal of the pinball machine is to communicate the primary goal of the Psyche Mission: to launch a satellite into Psyche's orbit. The pinball screen may also be used to display psyche facts when not in use.

Concept 3: Disco ball + DDR Pad (101)

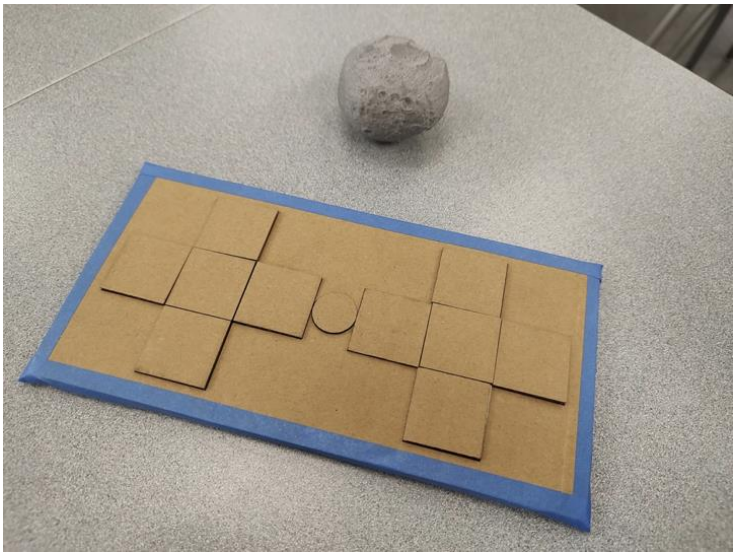

Figure 4. *Concept 3*

Figure 4 shows our last high-fidelity concept consisting of two DDR pads side by side with a circle in the middle, resembling the shape of the Psyche orbiter. DDR pads are inputs for a game, testing the user's knowledge about asteroids and Psyche. Hung above the head is the Psyche disco ball, it is made reflective to represent the metals it is made of. The game, as an

alternative to being rhythm-based, requires users to match inputs displayed (like Simon says) in order to direct a satellite into Psyche's orbit. This design is meant to immerse the user in the experience of being a satellite operator. It simulates the trials and tribulations of studying Psyche, instead translating those challenges into more fun and engaging activity. Framing the science behind the Psyche mission as "fun" will promote further interest in the subject.

Medium Fidelity Concepts

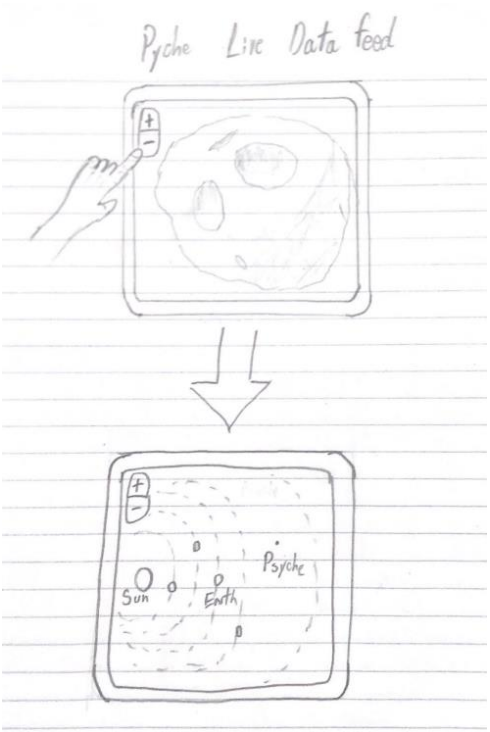

Figure 5. *Concept 4*

Concept 4: Psyche live data feed (83)

This idea is based on the live data provided on the Psyche website. The Psyche website shows a simulated Psyche asteroid in space, featuring an accurate live position relative to the other planets in the solar system. The size and surface of Psyche can also be observed on this application. The integration of this idea would be through a touchscreen that allows the user to zoom in and out to see the surface of Psyche, its position in the solar system, and relative size.

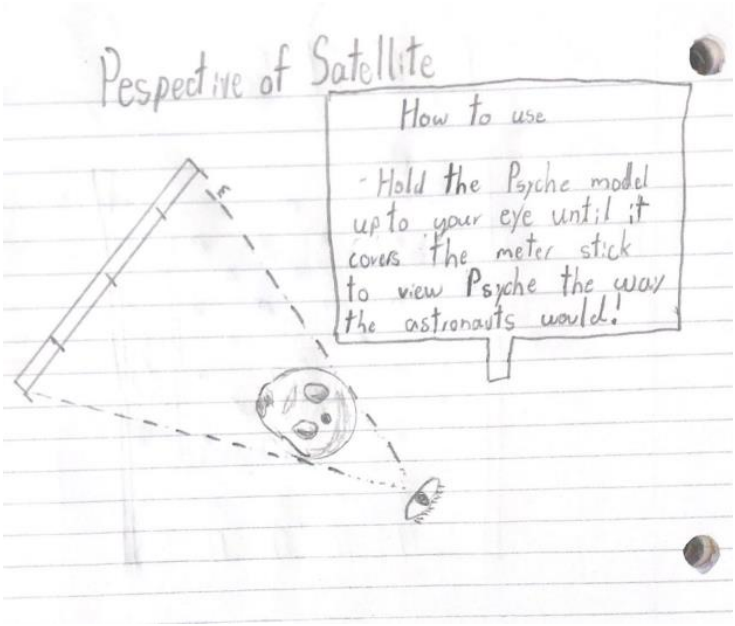

Figure 6. *Concept 5*

Concept 5: Perspective of satellite to psyche size comparison demonstration (103)

A scale is visible with a small replica of Psyche. The users are challenged to change their perspective and orientation so that the model of the psyche appears to line up with the scale. The purpose of this demonstration is to educate on the size of the psyche relative to something more common. The illusion is meant to be interesting to the users.

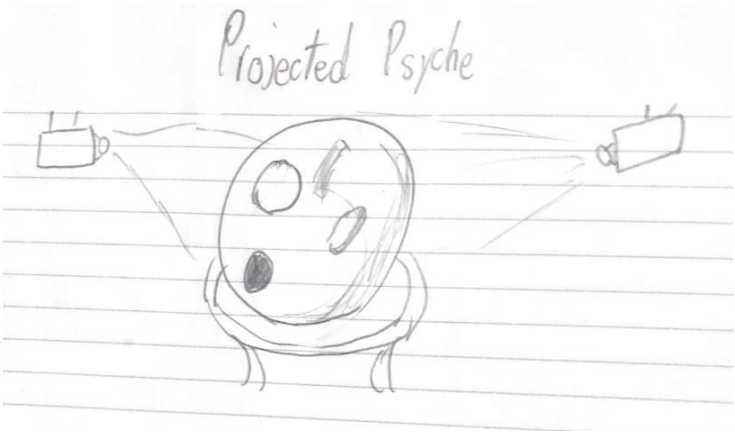

Figure 7. *Concept 6*

Concept 6: Projected Psyche (56)

Figure 7 shows a projector on the ceiling projects Psyche and the solar system. Can interact with it using buttons on the floor to zoom in and see Psyche up close. Alternatively, an image of Psyche can be projected onto an unpainted sphere or model of Psyche to appear to give it texture and color, and projection can be modified to show ores, topography, etc. The objective of this model is to drive interest in Psyche itself. The idea emphasizes the interesting properties of Psyche that justify its research and exploration, such as its metals and formation.

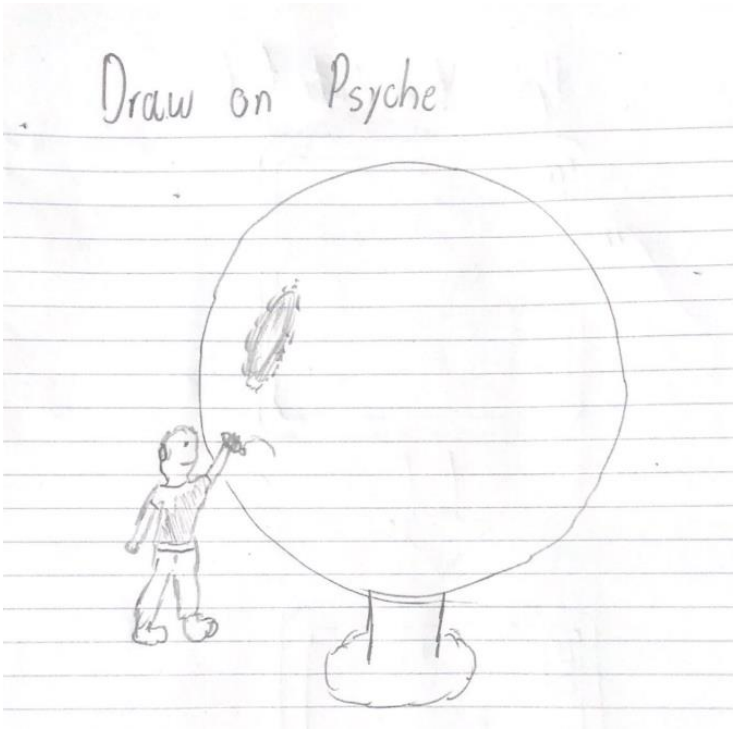

Figure 8. *Concept 7*

Concept 7: Draw on Psyche's surface~~.~~ (89)

A model of Psyche with an outer coat of that can be drawn on by users. Coat could be whiteboard or chalkboard. The coloring implements may be matte or reflective to represent to ores and metals that psyche is composed of. This exhibit encourages users to grow interested in finding out what psyche truly looks like by allowing them to interpret it.

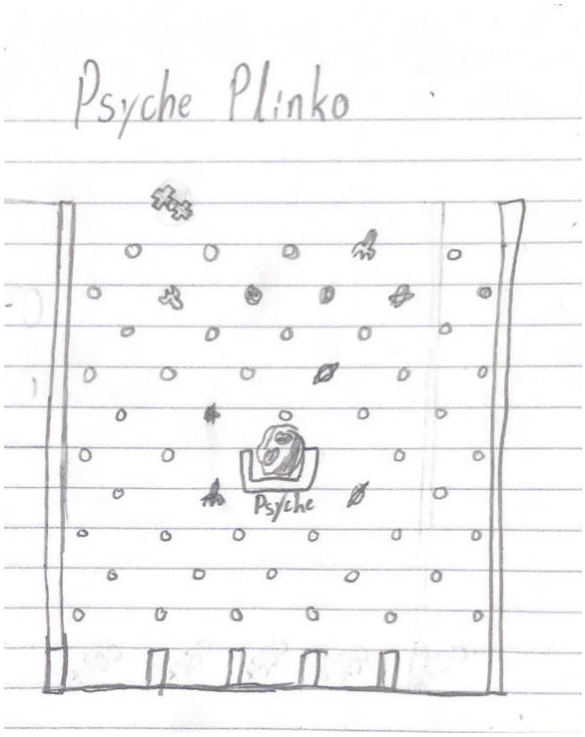

Figure 9. *Concept 8*

Concept 8: Psyche Plinko~~.~~ (50)

A decorated model of the solar system that encourages you to drop a ball (representing a satellite) down into a case of pegs. These pegs will deflect the ball in difficult to predict directions inside the case. Some of the pegs may be asteroids, other planets, or random space debris. The goal is to get the ball in an elevated small hole in the center representing Psyche,

with a basic to catch the ball. The goal of the game is a direct parallel of the Psyche mission: to launch a satellite into Psyche's orbit.

Methods Used for Ideation

Since the objective of this project is open-ended, ideation methods such as biomimicry were not applicable. Methods such as crap shoot and anti-problem were applied in some methods, but these were used in conjunction with our main methods of concept generation. The first main method of ideation was individual brainstorming, and this was used to generate most of the concepts. Each group member researched their topics of interest and generated as many ideas as possible. This allowed the concept generation process to create unique approaches and remain unbiased toward a specific topic.

The next method was group brainstorming to discuss each idea and their origin to create new concepts. Overall, the main categories of concepts were interactive simulations of physical phenomena, gamified methods of conveying interesting information, modifying existing entertainment to contain Psyche themes, and hands-on activities to create souvenirs or artwork. These methods generated over one hundred ideas to be potential solutions. Individual concepts may not be the best solution, but some concepts could be combined to create stronger solutions.

1.6 Concept Selection

Binary Pairwise

In a binary pairwise comparison, two customer needs are examined and compared against each other to determine which is more important. When the row need is more important than the column need, a "1" was given, otherwise a “0” was given. This resulted in a weight of the customer needs as given in Table 4. These weights will be used in the next comparison done in the House of Quality chart.

Table 4: Binary Pairwise

Weight	Customer Need
3	The product has the ability to have a user interact with it.
4	The product has the ability to stimulate the users' senses.
5	The product has the ability to hide components that are not meant for the user to touch.
0	The product is a similar size to other exhibits.
1	The product has the ability to run without a wall outlet if one is not available.
4	The product can be troubleshot easily and requires no custom tools to repair.
4	The product should use little to no custom parts outside of parts that are 3D printable.

House of Quality

The house of quality (HOQ), in Table 5, is a product planning matrix that is built to show customer requirements and how the customer needs relate directly to the targets and metrics of

the project. It uses a biased ranking system to exaggerate which targets are most important based on the needs provided by the project sponsor. In the far-left column of the HOQ, our customer needs were entered. From the binary pairwise table results, an important weight factor was determined. The engineering traits from our functional decomposition that were deemed to have the greatest impact on our project are the ability to stimulate the user's sense, to hide components not meant for the user to touch, to be easily troubleshot and require no custom tools to repair, and to use little to no custom parts outside of 3D printable parts. Going row by row, we asked whether the engineering criteria would help to satisfy the customer's need to determine the ranking. With 0 denoting no contribution and 9 denoting the maximum amount of contribution, values of 0, 1, 3, or 9 were assigned.

Table 5: House of Quality

		Engineering Characteristics																
Improvement Direction		-	-	↑	↓	↑	↓	↑	↑	↑	↑	-	-	↓	↑	↓	-	
Units		Minute	Minute	Haptic Response	Interactions	Identifiable Features	dB	%	Promotional Piece	%	%	%	$	$	Months	Hours	square-feet	
Customer Requirements	Weight Importance	Operates with Minimum Instruction	Encourages Further User Interaction	Generates Positive User Feedback	Promotes Social Media Presence	Encourages Audience to Approach	Audibly Attracts Audience	Visually Attracts Audience	Promotion of STEAM	Draws parallels to Earth	Psyche Mission	Simplifies Difficult Concepts	Cost to Develop	Cost to Replicate	Durability - Life Cycle	Time to Assemble for a Nonskilled Worker	Size of the Exhibit	check
1. The product has the ability to have a user interact with it.	3	9	9	9	3	3	3	3	3	1	3	3			9			
2. The product has the ability to stimulate the users senses.	4		9	9	1	9	9	9			1	3			1			
3. The product has the ability to hide components that are not meant for the user to touch.	5	3		1	1	1		3					1	1	1	3	3	
4. The product is a similar size to other exhibits.	0																9	
5. The product has the ability to run without a wall outlet if one is not available.	1		1	1			1	1					3	3	3	3	1	
6. The product can be troubleshot easily and require no custom tools to repair.	4	1							3		3		3	3	9	9	1	
7. The product should use little to no custom parts outside of parts that are 3D printable.	4								3	3	3		9	9	1	9	1	
Raw Score	765	46	64	69	18	50	46	61	33	15	37	21	56	56	79	90	24	
Relative Weight %	100	6.01	8.37	9.02	2.35	6.54	6.01	7.97	4.31	1.96	4.84	2.75	7.32	7.32	10.33	11.76	3.14	100
Rank Order		8	4	3	13	7	8	5	10	14	9	12	6	6	2	1	11	

Pugh Charts

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Pugh charts were used to compare each concept to an existing state of the art similar to our system. If the concept being compared is better than the datum concept then it is marked by a plus sign, "+", if it is inferior to the datum then it receives a minus sign, "-," and if the concept is equally comparable to the datum concept it will be marked by an "S". The pluses and minuses in each column of the Pugh chart were then added together. The Pugh chart is restarted when the worst idea has been eliminated and the datum concept has been changed to the middle concept.

Table 6: Pugh Chart 1

Selection Criteria	Above and Beyond: The Ultimate Interactive Flight Exhibition	Concepts							
		Concept 1: IR Pointer Game + Satellite Controls	Concept 2: Pinball	Concept 3: Discoball + DDR Pad	Concept 4: Psyche Live Data Feed	Concept 5: Size Comparison Sattelite vs. Psyche	Concept 6: Projected Psyche	Concept 7: Draw on Psyche's Surface	Concept 8: Psyche Plinko
Time to Assemble for a Nonskilled Worker	DATUM	+	+	+	+	+	+	+	+
Duribility - Life Cycle		-	-	-	-	-	-	-	-
Generates Positive User Feedback		S	S	S	S	-	S	-	S
Encourages Further User Interaction		+	S	S	-	-	-	+	S
Visually Attracts Audience		S	S	S	-	S	+	-	-
Cost to Develop		+	+	+	+	+	+	+	+
Cost to Replicate		+	+	+	S	+	S	S	+
Encourages Audience to Approach		S	S	S	-	-	-	-	-
Number of pluses		4	3	3	2	3	3	3	3
Number of minuses		1	1	1	4	4	3	4	3

The first Pugh Chart is shown in Table 6. The chosen datum to start with was "Above and Beyond: The Ultimate Interactive Flight Exhibition" (2015) because it is an interactive museum exhibit with a focus on educating visitors about space. The exhibition had several interactive components such as motion-sensing screens, video games, and flight simulators.

The selection criteria that all our concepts got pluses on was the cost to develop and time to assemble for a nonskilled worker since the datum exhibit has very expensive technology and complicated engineering that wouldn't be able to be replicated by regular museum staff while our concepts account for non-engineering workers and a less costly design. Because the datum concept is a 5,000 square foot traveling aerospace exhibition sponsored by Boeing, one of the largest aerospace companies, and had the budget to include more durable elements so it could travel, all our concepts received a minus in durability - life cycle since our customer needs were for the exhibit to be replicable and less expensive. From this chart, Concepts 4 and 5 were denoted as the worst with 4 minuses and few pluses therefore they were removed, and the chart was restarted by choosing the middle road concept Draw on Psyche's Surface.

Table 7: Pugh Chart 2

Selection Criteria	7	Concepts				
		1	2	3	6	8
Time to Assemble for a Nonskilled Worker		+	-	+	+	+
Duribility - Life Cycle		-	S	-	-	-
Generates Positive User Feedback		+	+	S	S	S
Encourages Further User Interaction		+	+	+	-	S
Visually Attracts Audience		+	S	+	+	-
Cost to Develop		S	+	-	+	+
Cost to Replicate		S	+	S	S	+
Encourages Audience to Approach		+	S	+	-	-
Number of pluses		5	4	4	3	3
Number of minuses		1	1	2	3	3

The second chart is shown in Table 7 and the datum selected is concept 7. Since Concepts 6 and 8 had the same number of pluses and minuses, but higher minuses compared to the rest of the concepts, they were chosen as the worst concepts. Compared to the datum,

Concepts 1 and 2 are the best concepts with only one minus each and pluses in our most important criteria such as encourages further user interaction.

Table 8: Pugh Chart 3

Selection Criteria	8	Concepts		
		1	2	3
Time to Assemble for a Nonskilled Worker		+	S	+
Duribility - Life Cycle		-	S	-
Generates Positive User Feedback		+	+	+
Encourages Further User Interaction		+	+	+
Visually Attracts Audience		+	S	+
Cost to Develop		S	S	-
Cost to Replicate		S	S	-
Encourages Audience to Approach		+	-	+
Number of pluses		5	2	5
Number of minuses		1	1	3

The last Pugh chart can be observed in Table 8 with Concept 8 being the chosen datum. Concept 8 has the interactive component of the user utilizing a ball and educational components about space and Psyche. Concept 2 was very similar to the datum concept since it also involved a ball which is why it received mostly S and a few pluses and minuses. Concepts 1 and 3 got pluses in visually attracts audience because they both have a larger component in their exhibits like the disco ball Psyche in concept 3 and a large replica of Psyche in Concept 1. This final Pugh chart shows that Concepts 1 and 3 are the strongest concepts after comparing them to other concepts and an already existing interactive space exhibit.

Analytical Hierarchy Process (AHP)

The analytical hierarchy process (AHP) is a chart explaining the most ideal concept. The process begins with a criteria comparison matrix (CCM). The CCM, in Table 9, lists a set of important criteria for the concepts to satisfy and compares them numerically with a ranking system of values of odd numbers from one to nine. A value of one implies that the two criteria compared are of equal importance, while higher numbers imply a greater magnitude of importance. A value less than one implies a magnitude of less importance.

Table 9: Criteria Comparison Matrix {C}

	Time to Assemble for a Nonskilled Worker	Duribility - Life Cylce	Generates Positive User Feedback	Encourages Further User Interaction	Visually Attracts Audience	Cost to Develop	Cost to Replicate	Encourages Audience to Approach
Time to Assemble for a Nonskilled Worker	1.00	0.20	3.00	1.00	5.00	3.00	1.00	7.00
Duribility - Life Cylce	5.00	1.00	0.14	0.20	1.00	3.00	3.00	0.33
Generates Positive User Feedback	0.33	7.00	1.00	1.00	3.33	0.33	0.33	3.33
Encourages Further User Interaction	1.00	5.00	1.00	1.00	1.00	3.00	5.00	0.33
Visually Attracts Audience	0.20	1.00	0.30	1.00	1.00	3.00	1.00	1.00
Cost to Develop	0.33	0.33	3.00	0.33	0.33	1.00	3.33	3.33
Cost to Replicate	1.00	0.33	3.00	0.20	1.00	0.30	1.00	1.00
Encourages Audience to Approach	0.14	3.00	0.30	3.00	1.00	0.30	1.00	1.00
Sum	9.01	17.87	11.74	7.73	13.67	13.93	15.67	17.33

The criteria selected for the series of AHPs were based on those selected in the targets and metrics assignment. For satisfactory selection, a concept should be strong in most of these criteria.

After the CCM is created, values are normalized with respect to their sum to create a normalized criteria comparison matrix (NCCM), in Table 10. From here, parameters that describe the importance of each criterion are created by averaging their row and termed criteria weights {W}.

Table 10: Normalized Criteria Comparison Matrix

	Time to Assemble for a Nonskilled Worker	Duribility - Life Cylce	Generates Positive User Feedback	Encourages Further User Interaction	Visually Attracts Audience	Cost to Develop	Cost to Replicate	Encourages Audience to Approach	**Criteria Weights {W}**
Time to Assemble for a Nonskilled Worker	0.11	0.01	0.26	0.13	0.37	0.22	0.06	0.40	**0.19**
Duribility - Life Cylce	0.55	0.06	0.01	0.03	0.07	0.22	0.19	0.02	**0.14**
Generates Positive User Feedback	0.04	0.39	0.09	0.13	0.24	0.02	0.02	0.19	**0.14**
Encourages Further User Interaction	0.11	0.28	0.09	0.13	0.07	0.22	0.32	0.02	**0.15**
Visually Attracts Audience	0.02	0.06	0.03	0.13	0.07	0.22	0.06	0.06	**0.08**
Cost to Develop	0.04	0.02	0.26	0.04	0.02	0.07	0.21	0.19	**0.11**
Cost to Replicate	0.11	0.02	0.26	0.03	0.07	0.02	0.06	0.06	**0.08**
Encourages Audience to Approach	0.02	0.17	0.03	0.39	0.07	0.02	0.06	0.06	**0.10**
Sum	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	**1.00**

To verify the consistency of the rankings assigned for the criteria comparisons found in the CCM, a consistency check was performed, in Table 11. First, a weighted sum vector {Ws} was created by multiplying the CCM values with the criteria weights {W}. A consistency vector (Cons) was then created by dividing the {Ws} and {W}.

Table 11: Consistency Check

{Ws}=[C]{W} Weighted Sum Vector	{W} Criteria Weights	Cons={Ws}./{W} Consistency Vector
1.75	0.19	9.01
2.56	0.14	17.87
1.65	0.14	11.74
1.19	0.15	7.73
1.10	0.08	13.67
1.49	0.11	13.93
1.23	0.08	15.67
1.76	0.10	17.33

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This process verified that there was no bias in the previous decisions and weights in the matrices. It additionally gives valuable data, specifically the criteria weights, for eventually choosing our final design selection. The analytical hierarchy process concluded with all our design traits evaluated fairly.

Table 12: Final Rating Matrix

Final Rating Matrix			
Criteria	IR Pointer + Satellite Controls	Pinball	Disco ball + DDR pad
Time to Assemble	**0.43**	**0.37**	**0.21**
Durability - Life Cycle	**0.60**	**0.12**	**0.28**
Generates Positive User Feedback	**0.69**	**0.10**	**0.21**
Encourages Further User Interaction	**0.44**	**0.32**	**0.24**
Visually Attracts Audience	**0.44**	**0.32**	**0.24**
Cost to Develop	**0.32**	**0.24**	**0.44**
Cost to Replicate	**0.24**	**0.32**	**0.44**
Encourages Audience to Approach	**0.60**	**0.28**	**0.12**
sum	**3.75**	**2.08**	**2.17**
Average	**0.47**	**0.26**	**0.27**
check	**1.00**		

Table 13: Normalized Final Rating Matrix

Normalized Final Selection Matrix			
Criteria	IR Pointer + Satellite Controls	Pinball	Disco ball + DDR pad
Time to Assemble	**0.11**	**0.18**	**0.10**
Durability - Life Cycle	**0.16**	**0.06**	**0.13**
Generates Positive User Feedback	**0.18**	**0.05**	**0.10**
Encourages Further User Interaction	**0.12**	**0.16**	**0.11**
Visually Attracts Audience	**0.12**	**0.16**	**0.11**
Cost to Develop	**0.09**	**0.11**	**0.20**
Cost to Replicate	**0.06**	**0.16**	**0.20**
Encourages Audience to Approach	**0.16**	**0.14**	**0.06**
sum	**1.00**	**1.00**	**1.00**

The values from Table 12 were then multiplied by the engineering characteristics weight factors obtained in Table 10. The results are shown in Table 14 below. This table shows the design concept that best meets the customer requirements.

Table 14: Alternative Value

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Alternative	Value
IR Pointer + Satellite Controls	0.47
Pinball	0.26
Disco ball + DDR pad	0.27

Final Selection

The design chosen by the team is the IR Pointer + Satellite Controls (Concept 1) shown in Figure 2 above, which was determined by an examination of the three high-fidelity concepts and five medium-fidelity designs. The design consistently placed first on all concept selection charts and satisfies most client criteria. All team members agreed that this design best integrates all of our individual skills while satisfying requirements and customer needs because it merges two of our concept ideas, therefore, meeting customer needs at a higher level.

1.8 Spring Project Plan

Chapter Two: EML 4552C

2.1 Spring Plan

Project Plan.

Build Plan.

Appendices

Appendix A: Code of Conduct

Appendix B: Customer Needs

Submitted Questions and Respective Answers

1. What did you like about previous projects?
    a. Buttons, moving things, lights, sounds
2. What did you dislike about previous projects?
    a. Do not touch when expected to touch
3. Should we account for exhibit being outdoors? Weather resistant?
    a. Expect that it will not be used outside
4. Is there a weight limit?
    a. None in mind, but check out museums and space are a premium
5. Is there a size limit?
    a. Around the same size as other exhibits
6. Will we have access to a power supply?
    a. Power could be a problem. But if critical, it is ok. Consider batteries (look at using rechargeable batteries)
7. Will maintenance be done, or will the exhibit be left unattended for a long time?
    a. Expect that if anything looks broken or is not functioning as it should, then someone will fix it. Also, in the case that something does break, it should be able to be fixed by someone with minimal skills or have easy to replace parts
8. How much should we expect this to cost?
    a. It depends, but you might want to submit two separate projects for me and for the festival. A simpler version for me and a more advanced version for the festival

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Appendix C: Target Catalog

Summary

In summary, our project has three primary targets to satisfy. Interaction, initial impact, and education. The metrics for interaction include having an average interaction time of one minute, the exhibit must be interacted with in the intended manner, and finally the exhibit must feature at least one form of haptic, audio, or visual response. Our metrics for initial impact focus on social media interactions, visually identifiable objects on the exhibit, and audible noises and vibrant colors to attract people. The metrics for our educational target include teaching participants a STEAM concept, recording the participants' age and understanding of the concepts we teach, and how much we relate Earth to Psyche in the information presented. Lastly, our final target is to make our museum exhibit replicable, including metrics regarding cost, size, and time to construct; other museums should be able to build our exhibit as well easily and affordably.

Table 1: Primary functions

Function	Target	Metric	Method of Measurement	Method of Validation	Tolerance
Operates with Minimum Instruction	1	Time (minute)	Stopwatch	The crowd sampled time taken to operate as intended	-100% to +10%
Encourages Further User Interaction	1	Time (minute)	Stopwatch	Random sampling of crowd	-50% to +any %

				interacting with exhibit	
Generates Positive User Feedback	1	Haptic response per interaction.	Survey	Ask users how they felt about each interaction	-0% to +any %
Promotes Social Media Presence	150	Interactions (Likes, Shares, Replies, Views, hashtags)	Tik-Tok analytics	If we see interest in Tik-Tok increase or decrease	-10% to +any %
Encourages Audience to Approach	2	Identifiable interactable features.	Survey	Ask users what features they first noticed	-50% to +any %
Audibly Attracts:	65	dB	Sound meter	Standing near the exhibit with the meter and recording results	-25% to +10%
Visually Attracts Audience	70	Percent	Survey	Asking participants if they found the exhibit visually appealing	-10% to +any %
Promotion of STEAM	1	Promotional piece of the exhibit that directly talks about and encourages STEAM.	Survey	Asking participants if they learned one STEAM related concept.	-0% to +any %
Draws parallels to Earth	50	Percent	Documenting the information told in the exhibit.	Listing all informational points and analyzing	-10% to +any %

				percentage that relates to Earth.	
Psyche Mission	95	Percent	Documenting of mission overview part of the exhibit design.	Analyzing if the mission overview is the same as the one told on Psyche's website.	-10% to +any %
Simplifies Difficult Concepts	50	Percent	Quiz	Measure if middle schoolers have a similar comprehension score to adults	-10% to +any %
Cost to Develop	1000	Dollars	Excel (BoM)	Keep an up-to-date Excel sheet	-any % to +10%
Cost to Replicate	1000	Dollars	Excel (BoM)	Keep an up-to-date Excel sheet	-any % to +10%
Durability – Life Cycle	6	Months	Life Cycle Test – determine what each part experiences during 1 cycle	Life Cycle Test, Individual part life cycle test vs expected	±2
Time to Assemble for a nonskilled worker	3	Hours	Timer	Have a nonskilled person assemble	-any % to +50%
Size of the Exhibit	3400	Square feet	Measuring tape	Measuring the assembled product and the CAD assembly	-any % to +10%

Appendix D: List of 100 Ideas

1. Demo of asteroid collision using puppet strings with magnets.
2. Create a globe like the one at the EOAS building with interactive animations.
3. Create a scale model of Psyche Spacecraft & Asteroid.
4. Have someone in a psyche costume to promote information.
5. Project the solar system onto the floor and get little racer planets that follow a "track" that is their gravity. They affect the "gravity" of the other racer planets.
6. Big interactive "playground" area with lots of things to do.
7. A giant metal mobile, with real-time rotation of Psyche using motors. Cool and high scale models of the respective planets rotating around each other.
8. Bowling with Psyche. Bowling pins retract using motors/hydraulics and automatically reset themselves. Pins themed around Psyche.
9. Pinata where the core is Psyche.
10. Kinetic sand covered "metal" to represent Psyche and its deterioration.
11. Like the Star Wars smuggler ride (Have people go through the Psyche mission and they have to "complete" tasks like pressing buttons in a certain order to simulate the process before making the spacecraft and "guiding" the spacecraft along the correct trajectory to land on Psyche).
12. Picture spot with asteroid.
13. Penny crusher that would have Psyche as the penny.
14. Pop up tent constellations.
15. Pinball where Psyche is the ball to demonstrate the formation of Psyche. (May be virtual pinball, with a screen, and we just render the assets in the game with emulated analog controls).
16. A funny-looking secretary robot guides visitors through exhibits. The robot may have apposable arms and LED face, with no legs. They are on a fixed track.
17. Multiple exhibits with a robot guide that is manually activated. A mascot is a tried-and-true method of appealing to kids.
18. Psyche puppets show. Small stage, popsicle stick props.
19. A table that has 3d recreations of Psyche and other planets appearing to rotate around each other freely with nothing guiding them. Ideally, the planets would roll, rather than be dragged.
20. Booth that simulates being a scientist with a cool telescope (a digital screen on the other side of the lens) looking at Psyche to identify what materials it is made of.
21. Visitors operate something made to look like a satellite control terminal that is viewing Psyche, analyzing its materials. Maybe add a cool interface/HUD to make it seem very scientific and advanced.
22. A series of small physics demonstrations meant to be done in order, each demonstrating the lifeline of Psyche. For example, the first part is Psyche breaking

off a planet, next is Psyche being stripped to its core, and lastly is a bunch of minerals mended to a table.
23. Touching the crater of a Psyche model plays a tone and lights up.
24. The solar system modeled, but touching each planet makes it play a tone corresponding to its size.
25. Bop-it, but with the craters of Psyche.
26. An IR scanner you can hold up to a model of Psyche and hitting sensors triggers an on-screen display to tell you about the part of Psyche you pointed at.
27. A basic table you can swipe through to see the timeline of Psyche next to a large model of it.
28. Snapchat AR projection of Psyche.
29. Whack-a-mole asteroid to hit Psyche as it pops up with less and less "rock" on it to show the collisions removing the outer layer and at the end have like a coocoo clock with the full metal Psyche pop out.
30. Hopscotch with the constellations – projection on the floor where you can see the expected trajectory (show the actual when not being used) of the Psyche spacecraft and it appears in increments so they can jump from each one until they reach the Psyche asteroid.
31. T-ball Psyche collision – hit a ball that looks like space trash and try to hit Psyche (as a projection like those indoor golf screens) and if you hit it then big explosion.
32. Showing the seasons next to earth – use a 3d model of Psyche and earth with different colored lights to simulate the typical colors for each while they happen relative to each other.
33. Show the physics behind how they think the metals gathered to the middle of Psyche before the rock was hit off – a demonstration using a centrifuge like device to show the separation of different density materials.
34. Volume comparison using a common item like rice or sand.
35. "Inside" Psyche – walk through Psyche and see fun facts on the walls to show what is believed to be in Psyche and it leads up to a slide that can act as an old volcano (there's a theory that there used to be metal spewing volcanoes that contributed to the interesting surface).
36. Psyche orbiter – have a model of the orbiter and explain what is on it and why it is on there (have smaller versions of the stuff being used so they can play with what it does).
37. Communication in space – what was done before and what is being done differently in this mission and why. Have different forms of distanced communication that they can play with (tubes with cones at the end, 2 cans with a string, "walkie talkies").
38. A space that looks like the artist rendition of the surface of Psyche with the orbiter in the air above like it is in orbit.

39. Where's Psyche – like a big where's Waldo but Waldo is Psyche and you must find it by using buttons to move where a telescope is "looking" and what the telescope "sees" is shown on a display.
40. Plinko – have them do something to get a Psyche coin above a big Plinko board and drop it – different lights and sounds to indicate where they land and it could be something like a chance of what could happen during the mission (delay in launch, successful launch -> hit space trash, go off course, reach Psyche successfully). Basically, multiple stages that they go through trying to make a successful mission to orbit Psyche.
41. Plinko – have Psyche be the ball that loses volume as it falls.
42. Asteroid blasters – they get to try to shoot obstacles flying at Psyche before it is left as a metal core.
43. A pretend version of what they believe Psyche used to be – a planet – and every time someone presses a button, space trash collides with it and over time The surface corrodes and leaves the core.
44. Launcher to catapult the orbiter at Psyche.
45. Spherical plastic/rock/wood puzzle with metal core.
46. RC Spaceship flying around asteroid belt game.
47. Demonstration of Earth's and Psyche's magnetic fields using iron filings. Psyche has a much stronger magnetic field. Scale comparison is possible too.
48. Interactive video showing perspective of view of orbiter leaving earth and reaching Psyche, with info along the way.
49. Drawing game. Kids draw on a tablet/screen. Could draw a model of the layers of the earth, followed by an animation showing that Psyche is like the core of our earth.
50. Psyche game where you launch a satellite at the moving asteroid, and it intercepts if made it.
51. Spumoni but Psyche missions.
52. Moving sand that depicts the topography of Psyche and can show peaks and valleys through a projector.
53. Projector with Psyche being depicted over you to depict what being on Psyche would look like.
54. Projection over you to depict what the launcher sees at each orbit.
55. Look through a telescope and the story of Psyche is told and ways to interact with the asteroid are given.
56. Sit inside a rocket going to Psyche.
57. Build a realistic satellite to play on.
58. Racing game that challenges multiple people to fly to Psyche the fastest.
59. Psyche VR roller coaster ride.
60. Play Doh - build your own Asteroid.
61. Disorganized color blocks that once they get the same color displays facts. Each color represents a different fact.
62. Tic Tac Toe game that displays facts once someone wins.

63. Create a socket wall where they can throw balls and if they make it produce a sound and display a fun fact about Psyche.
64. Have some type of floating prototype of how Psyche moves that can be touched and the magnets will put it back in place.
65. 4D experience of Psyche's seasons while projecting them on a screen
66. VR video game about Psyche.
67. VR headset with a video about Psyche.
68. Simulate an explosion with lights and smoke to show how the asteroid was created and then have them put the pieces together.
69. Create different puzzles with pictures of Psyche that, once completed, explain what the picture represents.
70. Make a video game that tells quick facts about Psyche before playing the game.
71. Replicate Psyche's surface and have buttons on it that display information about it.
72. Create piano tiles that make sounds and project certain facts about the asteroid.
73. Musical "playground" that is the Psyche launcher (have screens and buttons to make noises and display facts, even a floor simulating what you see on the surface of Psyche at each orbit).
74. Act out the myth of Psyche or create an interesting/educational story that can be acted out like in a theater.
75. Simulate landing with smoke canisters and a cheap prototype of a rover.
76. Small robot projecting information about Psyche.
77. Psyche billiards (hitting balls against balls).
78. Pinball machine that lets the user pull back the ball launcher to "break" a cluster balls to represent the creation of Psyche.
79. Where is Psyche now? Pulls live data and renders.
80. Have a reflective model of the Psyche asteroid and a light. The user can control the light and spin of the model and it would show how Psyche might look and why we think it's metal. We could also include a "satellite" that has a camera to show what the satellite would see.
81. A solar system model that lets the user adjust the speed of the Earth and asteroid. We could have sounds and lights to show when the correct ones are chosen. This would show the orbit and distance.
82. Interactive floor (like a dance pad) that lets users play a game.
83. Kinect sensor to dodge asteroids on a screen.
84. Thermal paint Psyche.
85. Psyche chalk draw, wash with water after.
86. Psyche black with shiny bits like what we see with telescope.
87. Asteroid creation simulator. Kids could play around with a simplified simulator featuring collisions, volcanoes, and time effects.
88. Psyche balls for throwing and playing with. Earth and other planets as well
89. Lego Psyche and Earth builds with scale comparison.

90. Rebuild Psyche. Given Psyche and shell parts (that look like rocks) and you can put Psyche back together.
91. Make your own bouncy balls that look like Psyche.
92. Psyche dart board with spaceship/orbiter darts.
93. Build the orbiter. Large pieces with few parts to build a life-sized orbiter.
94. Infographics show all the interesting asteroids in our solar system and their sizes, locations, etc.
95. Earth and Psyche models side by side on display. Proper size comparison and rotational axis.
96. Psyche comparison game. Spot the difference.
97. Display the Psyche propulsion system with lights and show the energy it radiates.
98. Disco ball – Make a reflective model of Psyche that is hung above users
99. Use a scale model of Psyche to show how Psyche would look like from the satellite.
100. DDR pad controller used in a sort of Simon-says type of quick time game that has player match inputs as if controlling the satellite launching towards psyche.

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