Project O.R.B.I.T.

Observe. Research. Brainstorm. Iterate. Teamwork.

Implementation Plan

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1. PROGRAM DESCRIPTION

Project ORBIT is a 6-week, workshop-based program where Chicago high school students come together to engineer solutions to problems that astronauts experience during acclimation to microgravity in space. Under the mentoring of Adler Planetarium Far Horizons team professionals, students will follow the Engineering design method to brainstorm, design, and iterate working prototypes that serve the needs of space-borne astronauts, such as a device that makes meal times easy and efficient by preventing food and utensils from floating away from the astronaut using them. Students will research and evaluate the needs of astronauts that can be addressed while identifying and staying within the project constraints. They will also learn about the scientific properties that need to be taken into consideration while designing for a microgravity environment. They will be exposed to real-world design tools, such as Computer Aided Design programs and 3D printers, and learn to utilize them to make their inventions come to life. Finally, the students will develop teamwork skills by collaboratively working in groups to achieve a common goal, and develop communication skills by showcasing their inventions to an audience at the program's conclusion.

Program Delivery Structure:

Duration	6 weeks
Format	Workshop Series
Meeting Frequency	1 workshop per week
Days of the Week	Saturday
Time	9am – 3pm

2. PROGRAM GOALS AND OBJECTIVES

2.1. Goal: Students understand what it means to be an engineer and how to take an idea from paper to product
- 2.1.1. Objective: Students identify issues facing astronauts in space, and identify needs by looking at the problem through an astronaut's point of view
- 2.1.2. Objective: Students are introduced to and employ the Engineering Design Method: Problem definition, Background research, Requirement specification, Brainstorm/Evaluation, Prototype development, Testing and Iteration, Results communication
- 2.1.3. Objective: Students establish project constraints and make creative design choices based on the constraints
- 2.1.4. Objective: Students plan and carry out tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved

2.2. Goal: Students have increased technical skills through utilizing different prototyping tools and design programs used in the scientific and engineering fields
- 2.2.1. Objective: Students utilize Computer Aided Design programs to create both 2D and 3D designs of their product and learn about real-world applications of CAD programs
- 2.2.2. Objective: Students utilize 3D printers to fabricate aspects of their product and learn about real-world applications of 3D printers

2.3. Goal: Students have developed professional skills through peer collaboration
- 2.3.1. Objective: Students engage effectively in a range of collaborative discussions with diverse partners by establishing team norms, building on others' ideas, and expressing their ideas clearly
- 2.3.2. Objective: Students establish a unifying goal for their team and delegate duties to all group members
- 2.3.3. Objective: Students establish deadlines for themselves and their team and work to maintain those deadlines

2.3.4. Objective: Students accurately and clearly present their finished product and findings to an audience

2.4. Goal: Students obtain new scientific knowledge and increase their research skills

2.4.1. Objective: Students find and document sources of information that explain the struggles astronauts face while in a microgravity environment and the current solutions to problems that the astronauts face

2.4.2. Objective: Students understand scientific principles, as explained by Adler professionals, such as Newton's Laws of Motion in a microgravity environment and the physics behind orbits

3. DEVELOPMENT AND IMPLEMENTATION TIMELINE

Task	Weeks															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Organize a preliminary meeting with Far Horizons team to: • Receive feedback about the goals/objectives, activities/lessons, and the program overall • Brainstorm additional lessons that could be incorporated • Generate a list of potential staff members and volunteers that would take part in different aspects of the program																
Update implementation plan and incorporate feedback																
Flesh out the workshop lesson plans and finalize the desired program components																
Create a publication to advertise the program to potential volunteers that are interested in helping with this type of program																
Reach out to NASA alumni in the Adler community for insight into the program and potential availability to volunteer or present a lesson																
Reach out to Adler community specialists to help with the generation of the scientific/engineering lessons																
Generate a list of potential prototype components that students may incorporate and go through the design process for these components																
Document the specific steps needed to aid in the design of potential prototypes and determine the difficulty and the path that would need to be taken for a high school student to complete that prototype (plan how to guide a student through the process)																
Reserve the Far Horizons Lab and design/fabrication resources for the 6 workshop dates and the showcase																
Generate lesson content (PowerPoints, worksheets, science demos, etc…)																
Test any group activities to see how they should be run and what materials to use																
Create pre-assessment and post-assessment surveys for the students and staff																
Document the materials needed for all lessons and activities as well as training instructions for facilitating all lessons and activities (include troubleshooting tips)																
Procure the materials needed for the lessons (all materials needed for activities, product fabrication materials, etc…)																

Tasks	Weeks															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Procure all classroom materials (student rosters and emergency contacts, first aid kits, snacks for the students, cleaning supplies, Adler "swag" for the students, etc…)																
Organize and pack all materials so they are ready for each workshop																
Finalize instructor and specialist staff for program as well as volunteers (Adler and NASA)																
Train instructor and volunteer staff on program specific material																
Send out waiver forms to parents/guardians and gather any emergency and medical information about all students participating in the program																
Pre-order lunch for the workshop days and schedule transportation for the students if needed																
Send out pre-program emails to all students and parents/guardians explaining the dates and agenda for the program, the workshop schedules, contact information, and information about the showcase at the end of the program																
Run IT checks on the tech being used during the program and check the functionality of the makerspace tools																
Prepare thank you gifts for volunteers																

4. DESCRIPTION OF PROGRAM STRUCTURE AND ACTIVITIES

Workshop 1	
9:00 am – 10:15 am	1. Workshop Introduction and Expectations 2. Student introductions and team building/bonding exercises 3. Introduction to an astronaut's life in space a. Present lesson on conditions in a space shuttle or at the ISS, how humans are affected by a microgravity environment, and how astronauts go about completing everyday tasks in space
10:15am – 10:30am B R E A K	
10:30 am – 12:00 pm	1. Begin research process a. Review good research practices and helpful sites to reference b. Have the students focus on researching daily struggles or inconveniences that astronauts encounter every day c. Research current solutions to these issues and determine where they can be improved 2. Research Progress Check-in and Group Share
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Continue researching and have the students begin to narrow in on a specific area of interest to them 2. Project brainstorming a. Group sticky note activity: students have 3 minutes to write as many big picture ideas down on sticky notes as they can b. Review the sticky notes and have the students divide them into categories of similarity c. Review the categories and see which categories have caught the students' eyes 3. Establishment of project constraints
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. Tour of facility and demonstration of resources available to the students 2. Refined Project brainstorming

	a. With the established restraints and knowledge of the resources available, have the students begin to brainstorm refined and plausible project ideas

Workshop 2	
9:00 am – 10:15 am	1. Quick team bonding activity and recap of Workshop 1 2. Establishment of final prototyping ideas and project teams 3. Team communication activities a. Mirrored sculpture activity
10:15am – 10:30am B R E A K	
10:30 am – 12:00 pm	1. Introduction of Engineering Design Method a. Explain that we have already defined the problem and done some background research (more can always be done), and we are now on to the prototyping phase 2. Group work a. Ensure all team members are aligned on the goal of the project and that tasks are delegated evenly
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Group work continues
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. SCIENTIFIC CONCEPT LESSON: Newton's Laws of Motion in a microgravity environment a. Perform cool demos and activities that showcase Newton's laws, and explain how these demos would be different with gravity out of the equation 2. Wrap up group work

Workshop 3	
9:00 am – 10:15 am	1. Quick team bonding activity and recap of Workshop 2 2. Rapid Prototyping session a. Students will use everyday materials (cardboard, string, tape, etc…) to make a rough prototype of their solution
10:15am – 10:30am B R E A K	
10:30 am – 12:00 pm	1. Continue Rapid Prototyping session
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Brief presentation of rough prototypes 2. Introduction to CAD (specific CAD program TBD) a. An instructor will give a tutorial of how to navigate within the CAD program, and will go step by step with the students to construct a simple model as practice
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. Continue CAD lesson a. Students can continue to become familiar with CAD and customize their simple models to send to the 3D printer 2. 3D printer tutorial a. An instructor will teach the students how to take a CAD drawing, convert it into an .stl file, and correctly send it to the 3D printers

Workshop 4	
9:00 am – 10:15 am	1. Quick team building activity and recap of Workshop 3 2. SCIENTIFIC CONCEPT LESSON: Physics behind orbits a. Review the motion equations and prove that astronauts are not actually floating while in orbit around the Earth, but falling!
10:15am – 10:30am B R E A K	

10:30 am – 12:00 pm	1. Group Design a. Students work in their groups to design their projects in CAD or fabricate parts using other methods of their choice b. Send designs to the 3D printer/ other makerspace tools c. Take into consideration the beauty of the product as well as the efficiency/ convenience of use
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Introduce the process of testing the products a. Go over what techniques should be used to test, such as finding accurate test subjects, making controlled tests with standardized variables, etc… 2. Students should determine their testing processes and continue designing/building or begin the path to testing
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. Continue Group Design and Testing 2. Send last minute designs to the printers so they can be ready for next session

Workshop 5	
9:00 am – 10:15 am	1. Quick team building activity and recap of Workshop 4 2. Check-in a. Teams explain the work they have done so far and share successes and challenges with the group b. Teams can share ideas, provide advice and tips, and give brief constructive criticism c. Teens can ask specifically for help from certain Adler professionals
10:15am – 10:30am B R E A K	
10:30 am – 12:00 pm	1. Continue Group Work
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Continue Group Work
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. Final Check-in a. Go over what is needed for each team to be successfully finished with their projects on the last day 2. Introduce the Showcase and student expectations

Workshop 6	
9:00 am – 10:15 am	1. Quick team building activity and recap of Workshop 5 2. Teams review the last steps needed for completing the presentation and the product 3. Quickly finish any last-minute designs for 3D printed pieces so that they can be finished printing before the end of the day
10:15am – 10:30am B R E A K	
10:30 am – 12:00 pm	1. Group work a. Attempt to completely finish the product during this time
12:00pm – 12:45pm L U N C H	
12:30pm – 2:00pm	1. Group work a. Attempt to fully finish the presentation during this time, and practice lines
2:00pm – 2:15pm B R E A K	
2:15pm – 3:00pm	1. Rehearsal presentations a. Students practice presenting their products to their peers 2. Prepare for the Showcase a. Set up tables and chairs b. Change into professional clothes
	SHOWCASE Students present their products and PowerPoints to friends and family with a Q and A session for each team

5. RESOURCE REQUIREMENT

Resource	Additional Cost
Facilities	
Far Horizons Lab Facility	
Human Resources	
Full time instructor (1)	
Volunteer instructors to help guide students through designing in CAD and using the maker tools (2+)	
Volunteers to provide in-depth physics knowledge to assist in the creation of scientific/engineering lessons and/or presentation of physics topics to students in the program (1+)	
Materials (Consumable)	
Prototyping Activity Supplies (ex: cardboard, string, duct tape, pipe cleaners, popsicle sticks)	$75
Fabrication Materials (ex: 3D print filament, Baltic Birch wood, hardware)	$200
Science Demonstrations/Activities supplies	$30
Classroom Supplies (ex: pencils, markers, sticky notes, art supplies, cleaning supplies)	$100
Student snacks	$50
Student/volunteer Lunch, Jimmy John's Box Lunches	$140/ workshop
Materials (non-consumable/ instrumentation)	
Maker Gear M2 3D printers (3+) **assuming no prior procurement	$1,999 / printer
Boss Laser CO2 Engraver and Cutter (1) **assuming no prior procurement	$6,997
Dell Laptops (12+) **assuming no prior procurement	$370/laptop
Traditional tools (ex: hammers, screwdrivers, pliers, exacto knives, super glue)	$200
Optional Resources Provided through Relationship with TinkRworks LLC	
Makerspace Toolset Purchase Consultation	Quote available upon request
Professional Development for instructors teaching the Engineering Design Method through the creation of projects in a makerspace setting	
Future Design thinking programs for students who want to continue to work on similar projects after this program (ex: Arduino, robotics, drones, rocketry)	

6. PROGRAM ASSESSMENT PLAN

1. Student Surveys
   a. **Pre-program survey**: Assess interest in the STEM fields, exposure/experience with Engineering Design Method, experience with prototyping and designing products, problem solving skills, peer-interaction preferences, and student expectations for the program
   b. **Post-program survey**: Assess changes in interest in the STEM fields due to the program, student proclaimed proficiency level of making/design skills, comfortability with toolsets, and understanding of scientific concepts due to the program, and an increase in teamwork skills due to the team build and communication exercises
   c. **Student reflection**: Students record their sentiments about their program experience, how they benefitted from it, what could have been improved, whether they experienced an increase in teamwork skills, what they could have done better as a teammate, whether or not they wish to pursue their product further, and whether or not they would like to participate in another Adler program and what their preferred theme would be
2. Presentation Checkpoints
   a. Check that the group fully understands all of the steps involved with the Engineering Design method by evaluating whether the group was able to successfully communicate how their team fulfilled all of the necessary method steps and how they identified the problem that their product solves
3. Instructor Post Surveys
   a. Asses the instructor sentiments about the success of the program, what aspects were successful, what aspects could be improved, how they benefitted from the program, and what to add to the program in the future