Project Documentation: AstroNest - The Habitat Layout Creator

Project for NASA Space Apps Challenge 2025 Challenge: Your Home in Space: The Habitat Layout Creator

1. Project Overview

AstroNest is an interactive, web-based visual tool designed to tackle the complexities of designing sustainable and efficient space habitats. It provides a gamified, data-driven platform for users of all levels—from students to aerospace engineers and astronauts—to design and explore habitat layouts for various orbital and planetary environments. By integrating real-time NASA data, the tool ensures that designs are not just creative but also scientifically grounded and mission-ready.

Project Name	**AstroNest**
Challenge Addressed	**Your Home in Space: The Habitat Layout Creator**
Core Concept	**A visual, drag-and-drop tool for designing and simulating space habitats.**
Primary Goal	**To make space habitat design accessible, educational, and collaborative, fostering a universal community of space exploration enthusiasts and experts.**
Target Audience	**Enthusiastic Learners, Aerospace Engineers, Mission Planners, and active Astronauts.**

2. The Challenge: A Home in Space

The "Your Home in Space" challenge calls for a visual tool to design space habitats, considering critical life-support functions, materials, geometries, and layouts. The core problem is creating habitats that are not only structurally sound but also optimized for crew health, mission success, and the unique environmental conditions of a target location (e.g., Mars, a moon, or in orbit).

Key Problems Addressed:

- **Environmental Adaptation: Habitats must be tailored to specific environmental factors like gravity, atmosphere, temperature, and radiation.**
- **Functional Integration: A layout must seamlessly integrate numerous critical systems: life support, waste management, power, medical facilities, exercise equipment, and more.**

- **Knowledge Gap: The complexities of habitat design are often limited to experts. There is a need for a tool that can educate and inspire a wider audience.**
- **Lack of Collaboration: A need for a centralized platform where diverse groups can contribute ideas and feedback to a common goal.**

3. Our Solution: AstroNest

Astronist is a lightweight, browser-based application that offers a comprehensive solution through two primary modes: Learn Mode and Build Mode.

3.1 Key Features

Feature	Description
Learn Mode	**• Interactive Education: Users can explore foundational concepts of space habitats.** **• Habitat Types: Differentiates between Orbital Habitats and Planetary Surface Habitats.** **• Geometries & Layouts: Provides interactive learning modules on various habitat shapes, geometries, and common layouts.**
Build Mode	**• Data-Driven Design: Users select a real planet or create a custom environment. The tool fetches and displays relevant environmental data directly from NASA APIs.** **• Intelligent Recommendations: Based on the environmental data, the app suggests scientifically valid habitat designs and geometries.** **• Drag-and-Drop Interface: An intuitive, gamified workspace where users can place modules and design their habitat layout.** **• Real-Time Fit Check: The system validates module placement and connections instantly, making the design process interactive and error-free.**
Universal Feedback System	**• Collaborative Hub: A feedback button is present on every page, allowing users from all backgrounds (learners, engineers, astronauts) to submit ideas and observations.** **• Future AI Integration: The collected feedback will be analyzed by AI/ML algorithms to generate innovative design solutions and improvements.**

4. Technical Architecture & Data

Component	Technology / Source
Frontend	HTML5, CSS3, JavaScript
Core Logic	Plain JavaScript for application flow, drag-and-drop functionality, and real-time validation.
Deployment	Static web hosting (e.g., GitHub Pages), ensuring global accessibility with no complex backend requirements.
NASA Data Integration	The application fetches real-time planetary data (e.g., gravity, temperature, atmospheric conditions) from official NASA data sources and APIs to inform design constraints and recommendations.

5. Alignment with Judging Criteria

Our project was designed from the ground up to excel across all five key judging criteria.

Criteria	How AstroNest Aligns
Influence (20%)	• Broad Reach: Engages a wide audience, from young learners to seasoned professionals. • Solves a Big Problem: Addresses the fundamental challenge of sustaining human life beyond Earth. • Inspires a Community: Creates a "universal community" for collaborative design and innovation in space exploration.
Creativity (20%)	• Gamified Learning: Merges education with an engaging, game-like experience. • AI-Powered Future: The plan to integrate AI for analyzing crowd-sourced feedback is a novel approach to iterative design. • Multi-Mission Scope: The tool's framework extends to multi-hop mission planning and emergency scenarios, a unique long-term vision.
Validity (20%)	• NASA Data-Driven: All design recommendations and environmental constraints are based on real, scientifically valid data from NASA.

	• Real-World Application: The tool simulates real-world design challenges, producing practical and feasible habitat layouts.
Relevance (20%)	• Direct Solution: Directly answers every component of the challenge brief by providing a visual tool to define shape, volume, and layouts. • User-Friendly & Complete: The solution is a fully functional web application that is intuitive, accessible, and provides a complete design loop from learning to building.
Presentation (20%)	• Clear Narrative: Our presentation tells a compelling story of the challenge, our innovative solution, and its future impact. • Live Demo: We demonstrate a working, interactive prototype that brings the concept to life. • Exceptional UX: The application features a clean, intuitive, and visually appealing user interface.

6. Future Development Plan

Astronist is a scalable platform with a clear roadmap for future enhancements.

- **Phase 1: AI & ML Integration**
  - **Deploy an AI model to analyze user feedback from the feedback system.**
  - **Use insights to auto-generate innovative and optimized habitat layouts.**
  - **Create an "AI learning prompt" to guide users toward more effective designs.**
- **Phase 2: Advanced Simulation & Planning**
  - **Multi-Hop Mission Design: Introduce functionality to design and link a network of habitats across different planets and orbits.**
  - **Emergency Scenario Simulation: Model responses to emergencies (e.g., solar flares, system failures) and use the tool as a decision-making hub for relocations.**
  - **Resource Management: Add trade-study exports for mass, power, and volume calculations.**
- **Phase 3: Community & Collaboration**
  - **Introduce user accounts and collaborative "sandboxes" where teams can co-design habitats in real-time.**

- **Develop a "share and rate" system for community-created designs.**

This roadmap transforms Astronist from a design tool into a comprehensive, collaborative, and intelligent ecosystem for planning humanity's future in space.