Project Hyperion Design Competition

An Interstellar design challenge

CONTENTS

(...)

Humanity has overcome the great sustainability crisis in the 21st century and has transitioned into an era of sustainable abundance, both on Earth and in space.

Humanity has now reached the capacity to develop a generation ship without major sacrifices.

An interstellar starship flies by an icy planet in a nearby solar system. Going beyond the classical examination of the problem of interstellar propulsion and structural design, for a voyage lasting multiple centuries, ***what might be the ideal type of habitat architecture and society in order to ensure a successful trip?***

INTRODUCTION

A generation ship is **a hypothetical spacecraft designed for long-duration interstellar travel,** where the journey may take centuries or millennia to complete. The idea behind a generation ship is that the initial crew would live, reproduce, and die on the ship, with their descendants continuing the journey until reaching the destination.

This type of ship is often envisioned as a **self-sustaining ecosystem, featuring agriculture, habitation, and other necessary life-support systems to ensure survival across multiple generations.**

Project Hyperion works on a **preliminary study** that defines integrated concepts for a generation ship. The study aims to provide an assessment of the feasibility of crewed interstellar flight **using current and near-future technologies.** It also aims to guide future research and technology development plans as well as to inform the public about crewed interstellar travel.

TEAM COMPOSITION

The teams must be multi-disciplinary. Each team must have:

// At least one architectural designer
// At least one engineer
// At least one social scientist
(sociologist, anthropologist, etc.)

The above categories are broad and adaptable. Each team must provide a concise biography for its members along with a detailed description of their team structure. Eligibility will be determined by the Organizers following the review of this submission.

Note: Individual participation is not permitted. Each team must comprise **a minimum of two members** from distinct disciplines.

OBJECTIVE

The team shall design the **<u>habitat</u>** of the generation ship, including its **architecture and society** (See General Guidelines, Architecture Guideline, and Social Guidelinesno.1 for further details).

The habitat of the generation ship and its subsystems, are shown in Fig. 1 “The system to be designed”.

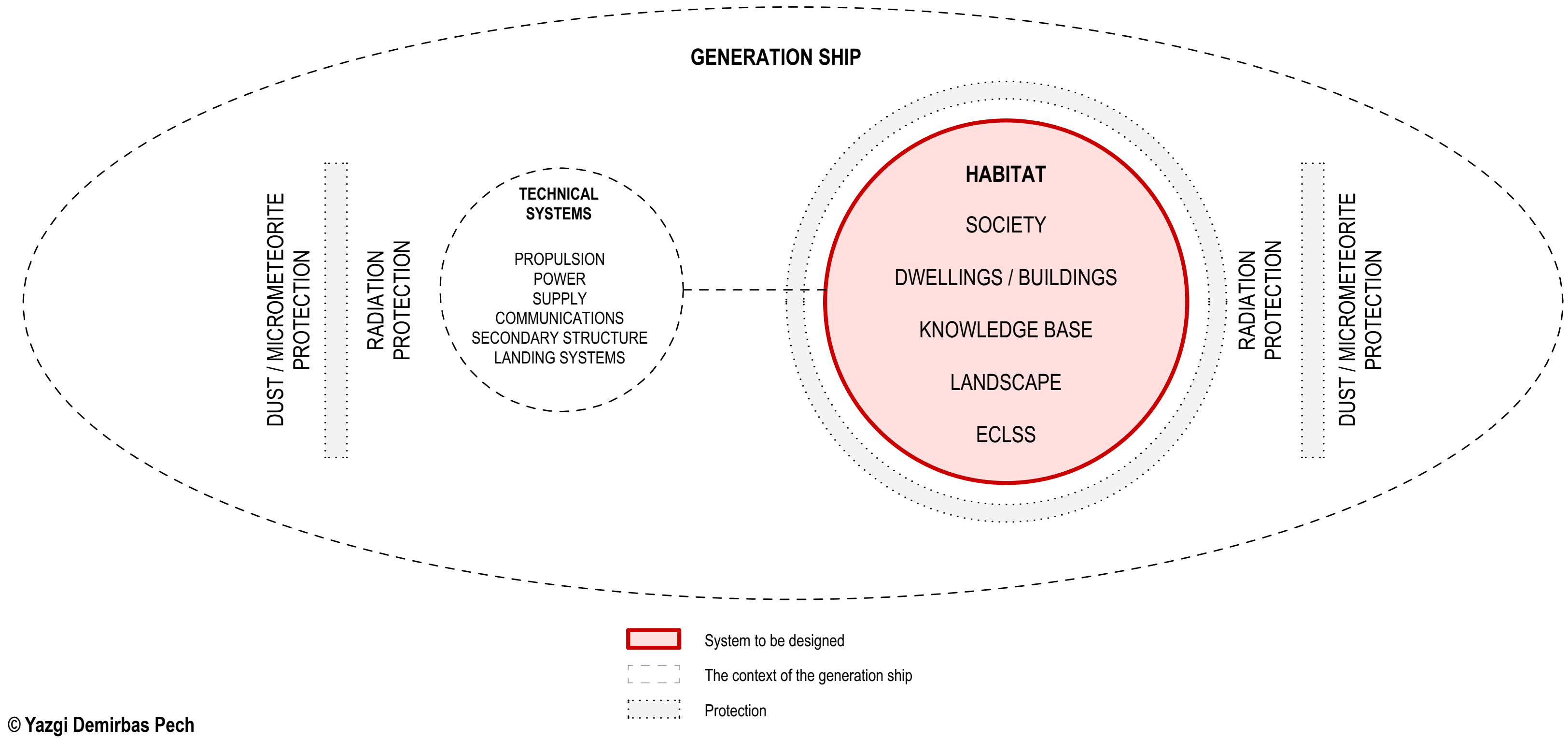


Fig. 1 : The System to be designed

ASSUMPTIONS

1 // Duration

The mission is designed to span 250 years, from launch to arrival at the target star system, with spacecraft achieving velocities of a few %c to reach the nearest stars.

2 // Destination

The generation ship's target is a rocky planet equipped with an initial artificial ecosystem, established by a precursor probe or through panspermia methods. The environment requires no significant genetic or biological adaptations for human survival.

3 // Radiation Protection

Comprehensive radiation shielding will protect inhabitants from galactic cosmic rays and other space radiation hazards. Bulk mass shielding is assumed unless otherwise specified by the team.

(Refer to the ECLSS Guideline for further details).

4 // Impact Protection

The habitat will be fortified to safeguard against micrometeoroids and interstellar dust impacts.

(Refer to the ECLSS Guideline for further details).

REQUIREMENTS

1 // Settlement

The habitat shall maintain the on-board society in a state such that the latter is able to settle the target destination at the end of trip. This includes maintaining biocultural aspects such as population size and availability of competences required for settlement.

2 // Habitat Size

The habitat shall be designed for 1,000 ± 500 people, ensuring habitability and stable living conditions for the mission duration.

3 // Gravity

The habitat will provide Earth-equivalent gravity through artificial means, such as rotation. Some areas within the habitat will accommodate reduced gravity conditions for specific purposes.

4 // Life Support System

The habitat shall provide the society with the basic physiological necessities, including water, food, waste processing and atmospheric conditions similar to those on Earth, ensuring breathable air and stable environmental pressure.

(Refer to the ECLSS Guideline for further details).

5 // Essential Resources

The habitat and/or society shall provide access to fundamental necessities, including clothing, shelter, and basic goods, for the entire journey duration. ***(Refer to the Knowledge Transfer Guideline for comprehensive details)***.

6 // Retain Key Knowledge

The habitat and/or society shall maintain as a minimum key knowledge, including competences, which are required for contributing to its fundamental necessities, life-support system, and settling the target destination.*

Additionally, knowledge related to the society's biocultural health shall be maintained.
(Refer to the Knowledge Transfer Guideline for comprehensive details).

**** Defined means of knowledge transfer shall ensure continuity of expertise and education. The society will address potential knowledge loss compared to Earth, a challenge exacerbated by the reduced population size. It is up to the teams to decide how knowledge is maintained, for example, embodied in software, robotics, libraries, or humans.*** >>>

7 // Internal architecture

The architectural design should incorporate flexibility, allowing modifications such as reconstructing dwellings to adapt to evolving needs.

(Refer to the Architectural Guideline for further details).

8 // The Society's Structure

The society onboard shall be positioned along key cultural invariants, including:

// Language
// Morality, ethics and justice
// Social organisation & power relations
// Subsistence mode
// Settlement pattern
// Family structure
// Economic-political structure
// Enculturation
// Kinship and descent
// Food Preferences
// Art and aesthetics
// Religion and mythos

(Refer to the Social Guideline for comprehensive details).

9 // Technologies

All onboard technologies shall meet a minimum Technology Readiness Level (TRL) of 2.

(Refer to the TRL Guideline for further details).

10 // Mass Optimization

The habitat's overall mass shall be minimized without compromising safety, functionality, or reliability.

11 // Reliability and Redundancy

The habitat's systems shall maintain reliability over the mission, ensuring uninterrupted operation for 250 years, for example, via robust design and redundancy.

REGISTRATION PERIOD

Competition announcement : 1st of November 2024

Submissions until: 15th of January 2025

Phase 1 Deadline : 2nd of February 2025

Phase 2 Deadline : 4th of May 2025

Winners Announcement : 2nd of June 2025

Q & A CONTACT ADRESS

info@i4is.org

PARTICIPATION FEE

· $ 20 participation fee for registration

CASH AWARD

· 1st: $ 5000
· 2nd: $ 3000
· 3rd: $ 2000
· 10 honorary mentions

DELIVERABLES FOR PHASE 1

A3 Project Booklet
Maximum 30 pages

It shall contain :

// Sketches, 3D renderings of the habitat interior and exterior
// Plans, sections, 3D diagrams that best describe the project (Scale is to be decided by the team)
// Technical diagrams describing the different components, subsystems, societal structure, etc.
// Requirements satisfaction matrix
// First order mass budget
// A summary of the project (1000 words max). Key design decisions shall be explained, including which alternatives and trade-offs have been considered.

* Participants are encouraged to release their submissions after the competition under a Creative Commons license CC BY-NC-SA or CC BY-NC (https://creativecommons.org/share-your-work/cclicenses/), i.e. only non-commercial usage and credit has to be given to creator.
** Participants are encouraged and will be supported in submitting their work to a journal for publication.

DELIVERABLES FOR PHASE 2

A3 Project Booklet (Revised), Maximum 40 pages

A0 Poster: Vertical Orientation, max 200 mb, containing:

// 3D renderings of the habitat interior and exterior

// Plans, sections, 3D diagrams, that best describes the architectural and technical aspects of the project
(Scale is to be decided by the team)

// Architectural detail drawing on the scale of 1/20 from a part of the project that best describes the design and material choices

// Technical diagrams describing the different components, subsystems, societal structure, etc.

// Power budget

EVALUATION CRITERIA

A // Architectural Evaluation Criteria

// Logical integration of form, function, and aesthetics (Architectural Quality): Competitors must elucidate how the chosen volumes' forms functionally or aesthetically align with their core concepts.

// Flexibility and modularity: Given the ship-city's multi-generational use, the modularity of designed spaces holds significance. Competitors must elaborate on the reasons and methods for incorporating flexibility and modularity into their designs.

// Innovation & Technology: These factors are pivotal, and their influence on architectural design must be clearly defined.

// Habitability: The generation ship must provide an environment that is both physically (as outlined in the ECLSS criteria) and psychologically suitable for the generations that will inhabit it.

// Graphic quality: Deliverables should be presented in clear and comprehensible architectural graphic design.

B // Technical Evaluation Criteria

// Technical Feasibility : Competitors must explain how the design is viable, considering factors such as society-habitat interdependencies, technological maturity, and reliability.

// Sustainability: The long-term sustainability of the society, habitat, and its technologies must be clearly articulated.

// Completeness: Competitors must demonstrate that all required design perspectives (habitat and society) are covered and that their interdependencies are effectively described.

// Correctness: The design's functionality must be proven, including its ability to meet requirements, adhere to assumptions, and remain sound from an engineering perspective.

// Consistency: Contradictions within the design, particularly across disciplines, must be avoided. Example: Population size stated as 1,000 in one section but 600 in another.

// Level of Detail: Competitors must ensure the design reflects a thorough and detailed approach.

// Traceability: Key design characteristics must be clearly traced back to initial requirements and assumptions, with explanations and justifications provided for major decisions and hypotheses.

// Scientific Basis: Designs must be grounded in current scientific knowledge, with appropriate referencing. For concepts extending beyond the state-of-the-art, key hypotheses and assumptions must be explicitly outlined.

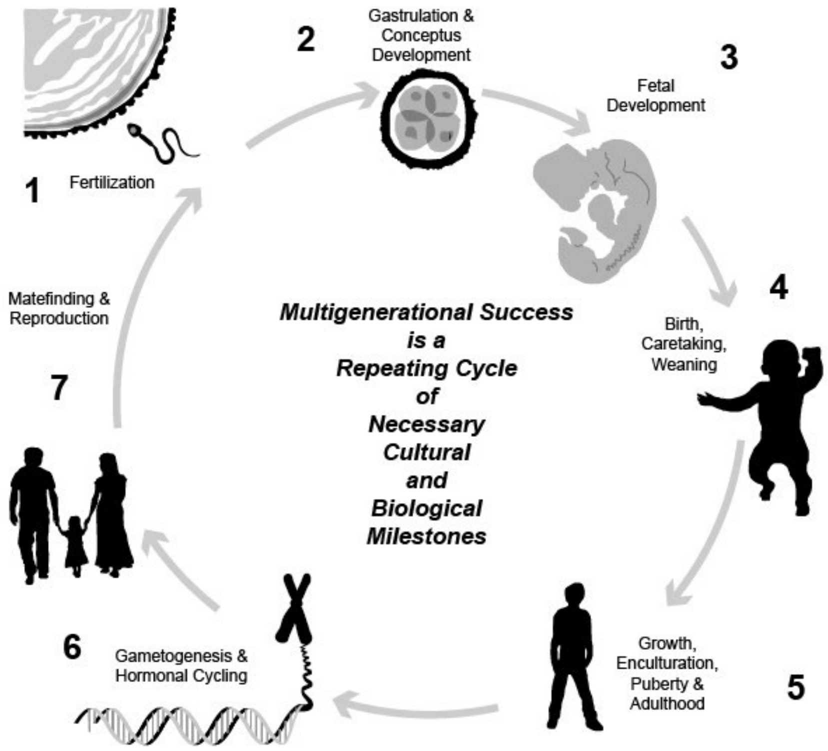
C // Social Evaluation Criteria

The design of the society must address the fact that interstellar voyages would be multigenerational. Both biology and culture must be accounted for on such a timescale. Design criteria include:

// Realistic multigenerational design considering the departure, travel and arrival population

// Capacity for the biocultural system to adapt to change over time

// Commentary on some expected changes to biology and culture over multiple generations



Significant Influences of:

	Biology	Culture
1	sperm & egg viability	-
2	developmental scheduling & oogenesis	-
3	systems development	-
4	early maturation	learning interactions, social & natural history intelligence
5	later maturation & hormonal scheduling	expanding space & time awareness, linguistic & technical intelligence
6	spermatogenesis	-
7	reproductive biology	matefinding & establishment of stable lifestyle

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Fig. 2 : The challenges in maintaining biocultural health over multiple generations

ORGANISATION TEAM

Andreas Hein
Aerospace engineer

Yazgı Demirbaş Pech
Architect, Illustrator

Dan Fries
Aerospace engineer

Michel Lamontagne
Illustrator, Designer

Cameron Smith
Anthropologist

Maciej Rebisz
Concept Artist

Steeve Summerford
Landscape Architect

ADDITIONAL MATERIAL LIST

A // Architectural Guidelines

B // ECLSS Guidelines

C // Social Guidelines

D // Technology Readiness Level Assessment Guidelines

E // Knowledge Transfer Guidelines

F // General Guidelines

H // Habitat Guidelines

** All guidelines will be made available to registered teams upon the successful completion of their registration and payment process.*

Good luck, Ad Astra!