Project name: *AEROO: Autonomous Kuiper Belt Colony*

Ship name: “Genesis”
Team: *“Genesis”*
Participants:

1. Nurgazinov Nurali Askhatuly,
2. Umudov Makhmud Togrulogly,
3. Batyrbek Aibarys,
4. Mirzhanov Aldiyar Serikzhanovich,
5. Erik Rasul Sayatuly.

Filing date: October 29, 2025

Annotation

The goal of the project is to model a scientifically based colony capable of developing culturally, technically, and biologically without the support of outsiders.
civilizations.

The main idea: designing an autonomous space colony in the form of a rotating spherical ship, ensuring the long-term existence of human civilization beyond Earth by using local resources and closed life support systems.

Key technologies:

Hall effect motor

Use and creation of nuclear fuel

Using solar panels to generate energy as fuel

Using titanium and carbon to build a ship's hull

Use of bioregenerative modules

Using a heat removal system from energy systems into the soil 2 layers

Unique features of “Genesis”:

Simulates the shape of planet Earth

The ability to land on celestial bodies by landing using the design,
in shape resembling a rectangle.

The AERIS artificial intelligence controls the colony's energy, climate, and security systems.

Robotic drones service and repair external structures.

Quantum sensors monitor radiation levels and detect threats micrometeorites.

A fusion reactor provides a stable supply of energy with minimal losses.

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1. Introduction

The project is based on the principles of astroengineering and systems modeling of closed ecosystems. A rotating spherical structure provides artificial gravity of up to 0.8 g, which reduces the negative physiological effects of prolonged exposure to weightlessness. Placing the colony near Jupiter's orbit allows for the use of cryogenic resources from its icy satellites (water, methane, ammonia) for

obtaining water, oxygen and rocket fuel through electrolysis and

catalytic processes. The integration of bioregenerative modules closes the carbon and nitrogen cycle, ensuring ecosystem sustainability. Thus, the project
demonstrates the real possibility of the autonomous existence of a large human community outside of Earth.

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2. Concept and purpose of the colony

The project is an autonomous, rotating, spherical space colony functioning as a closed ecosystem. The structure's rotation provides artificial gravity, necessary to support human physiological processes. Internal bioregenerative and engineering systems ensure the production and processing of air, water, food, and energy.

minimizing external dependence.

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3. Technical design

- The station is shaped like a sphere with a diameter of 10 kilometers. The ship has four thrusters at its bottom that can change direction, and a landing frame consisting of four landing legs connected to each other. The station's orbit is slightly elliptical, with an eccentricity of less than 0.2, ensuring stable rotation within the Kuiper belt.

- To develop spacecraft for missions to the Kuiper Belt,
  Specific materials that can withstand the conditions of outer space are critical. This includes very low temperatures, high radiation, and distances from Earth. Key materials and their applications. Metals and alloys: For load-bearing elements, frames, housings, and fuel tanks,

  Aluminum alloys are used, offering an ideal compromise between strength and light weight, and titanium alloys, which are critical for highly loaded mechanical structures in terms of specific strength and corrosion resistance. To create lighter and stronger structures, composites such as carbon fiber are used for skins, antennas, panel structures, and other elements. This allows for outstanding mechanical properties with minimal weight. Special materials provide protection against radiant water, ionizing radiation, and deep space. Polymer composites with heavy fillers, such as polyimide filled with bismuth silicate (BiÿÿSiOÿÿ), offer promising protection, providing more effective protection over a wide temperature range. The main challenges are the limited and high cost of terrestrial resources. Asteroid and lunar mining are considered promising. The need to develop multifunctional structural materials that would store radiation, provide load-bearing properties, and provide shielding properties is growing.

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- https://genesis-veb7.onrender.com link to the ship model

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4. Population and structure of society

- Population: from 100,000 to 300,000 people
- Form of government: democracy
- Distribution by sectors
- Education, work, culture, leisure
- Psychological resilience in isolation

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5. Life support systems

- Analysis of technologies for an autonomous space station in the Kuiper belt indicates the need to create fully closed life support systems. Zeolite-based regenerators, which provide carbon dioxide (COÿ) adsorption followed by vacuum regeneration, are suitable for critical air regeneration, as confirmed by operating experience on the ISS. The integration of bioreactors with green algae (chlorella, spirulina) appears attractive in this regard, since they assimilate COÿ during photosynthesis and produce oxygen, simultaneously serving as a source of protein. To counteract the negative physiological effects of weightlessness, a centrifugal artificial gravity system will be required. The optimal solution should be recognized as a design with a large rotation radius (tens of meters) to reduce Coriolis acceleration and side effects.
  Consumable systems with nuclear reactors, developed for lunar missions, will solve the problem of power supply for such systems. Therefore, the designed architecture of the station should be based on a hybrid life support system.

- The second layer of the ship will house farms for animals such as sheep,
  Cows and chickens. Agricultural crops will also be located there. A list of the products grown will be provided below.

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6. Energy and modules

- A reliable power system in an autonomous space station is the foundation of foundations. As with any system, the fundamental principle is one of three types of energy. For example, solar panels, the efficiency of which reaches 30% on modern gallium arsenide panels. In the Kuiper Belt, among the only

  realistic variants of nuclear fission reactors for stationary use. Documented examples such as the Topaz and Buk were demonstrated,

The power of which is 3-10 kW. Directly, respectively, the powerful negative and nuclear solar radiation, power = 3-10 kW. Cassin probes of nuclear isotopes and nuclear cycles, the operation of RTGs for flawless. The combination of the described mechanisms of a capable controlled system will not eliminate energy sources. Continuous autonomy, as described, is assumed for the operation of all other systems switching lithium-ion systems. Within the framework of bioreactors with regeneration of life support systems, synchronization, systems and networks.

- For stations located in deep space, a combined system is best suited, in which nuclear reactors are used as the main energy source, and solar panels and RTGs are used as backup source.

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7. Biodiversity

- Food products that will be grown on the ship include:

- Potatoes (grows as tubers, is the most saturating product, requires little water)
- Bamboo (building material)
- Tomatoes (a bush that produces a lot of fruit while taking up little space, resistant to lack of moisture)
- Everbearing strawberry (a bush that produces many fruits)
- Banana (grows in groups, resistant to lack of water)
- Soy (meat alternative)
- Wheat (adaptability to different conditions, resistant to temperature changes, basis for many products)
- Spinach (adaptability, fast growth and self-pollination)

8. Resource extraction

- Exploration of the Kuiper Belt (30-55 AU from the Sun) requires the development of fully autonomous in situ resource utilizing systems (ISRUs). Kuiper Belt objects contain volatiles (frozen water, methane, ammonia) and non-sheathed materials, making them attractive for resource extraction. During resource extraction in extremely low-gravity environments (in the range of centimeters per second^2), proposed systems for resource extraction include towing systems, enclosed dome structures, and robotic arms with active stabilization. In-situ processing includes water electrolysis, cryogenic fractionation, diversification control in additive manufacturing, and other in-situ component creation technologies. The transportation of autonomous towing units with electric rocket engines using locally available fuel will enable inter-object transit. Ground-based autonomous systems will power a compact nuclear reactor and radioisotope thermoelectric generators (RITEGs) at low solar radiative power levels. Full autonomy will be set as a goal

distributed systems due to hours of communication delay with Earth due to self-replicating and self-healing robotic systems.

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9. Autonomy and durability

- Autonomy and durability of the stations are supported thanks to the use of self-healing materials and backup systems that ensure sustainability and complete technological independence from external sources.

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10. Ecology and waste

- The stations operate a recycling cycle with minimal emissions, and biotechnology is used for recycling and reuse organic waste.

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11. Cultural and social life

The colony will operate within a system whose primary goal is human development within society through interaction with like-minded individuals, as well as events aimed at promoting a person's well-rounded development. Discrimination based on religion, skin color, and so on will be eliminated on the ship, and everyone will feel safe within.

12. Conclusion

- The project demonstrates the possibility of creating an autonomous space colony, capable of supporting the life and development of a large human community beyond Earth. It combines the achievements of astroengineering, biotechnology, and life support systems that ensure a closed cycle of water, air, and food.

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