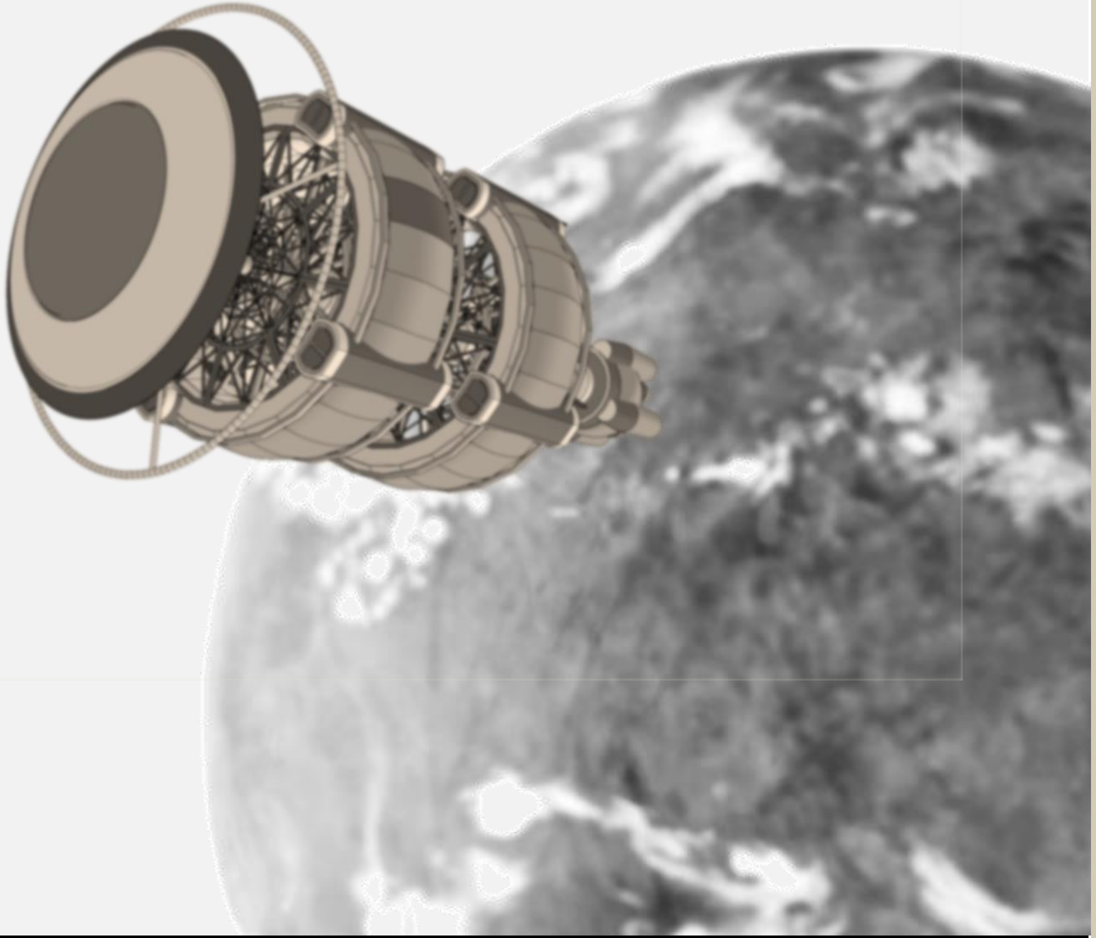
PHASE 2

PRINCIPIUM /HEREDITATIS

For your consideration for the Hyperion Project Architectural Competition

To the stars we offer wishes and desires. To the stars we send hope. We send the best of ourselves. We plant a seed.

CONTENTS – PHASE 2



PLANTING A SEED

Narrative and theory

INTRODUCTION

This booklet proposes an interstellar habitat titled ‘principium hereditatis’, which we chose to represent our stance on the project. Principium hereditatis means “the basis of inheritance” in latin. The booklet is a phase 1 showcase towards the development of a habitat for living within a generational interstellar space-ship.

Designing a habitat for the Hyperion Project competition has been a delightful challenge. Our team found it crucial to first consider the meaning of this proposed interstellar mission. Doing so helped inform our design decisions.

While the assembly of the ship, and by association the habitat, is an architectural and engineering issue, we found the form of said assembly is first and foremost a sociological issue. Of course, aesthetics and good design sense played their part in our process, but at the very heart of our proposal lies the question of human inheritance and social legacy.

“If we consider this ship a seed, planted by humanity, what shape does this seed take? What must it carry to truly represent all of us?”

In asking this question our team drew on the story of the biblical Ark. In the story of the Ark, a man named Noah is appointed the task of building a ship capable of traversing mythical flood waters that covered every instance of land.

In the myth of the Ark Noah is tasked with traversing this flooded world with his family and every animal species he could gather. There are huge differences between the story and this project, but at the heart of both efforts is this understanding such a journey is taken to preserve and extend survivability ushering life forward.

We understand carrying all the plants and animals of the earth would be highly impractical, however, the connection to earth such a commitment could entail resonated with all of us, It motivated us to develop our proposal as a habitat not just for humans but for earthly knowledge and genetic samples. A trove of earthly inheritance.

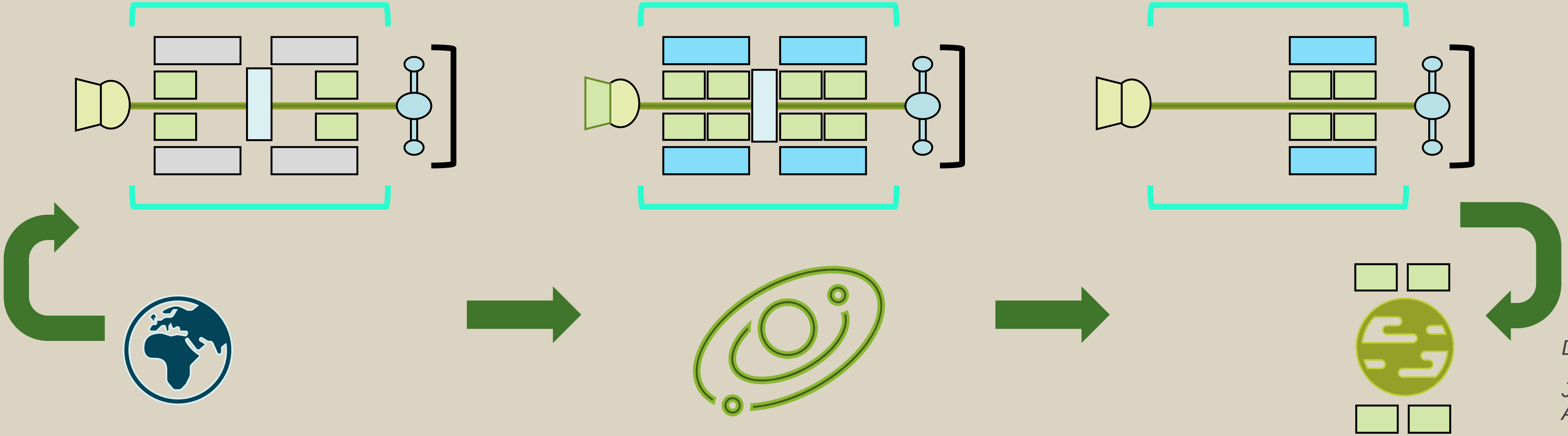
In our proposal we would like to maintain connections to human roots on earth, allowing the ship to be both a conservatory of knowledge but also a bank of genetic information. The crew would serve as stewards of this knowledge, practicing as much of the mundane as possible within the strict confines of an interstellar space craft.

It’s assumed by our team that the habitats play a part not just in the journey but also the arrival. We aim to keep the ship modular and adaptive to allow for configurations in balance. We also aim to allow for the ships fluctuation in shape, allowing the core framework to be resilient to failure, easy to compartmentalize.

illus. 1. Noahs ark in space, nightcafe.studio

JOURNEY

EMBARK | JOURNEY | ARRIVAL



Diag. 1.

Journey in 3 steps, Author

The journey is imagined as a three-step trip that begins with the ship's partial assembly in a kit of parts.

As such, all components are interchangeable with other parts. The crew would begin the journey in a framework with parts onboard to expand, as necessary.

A factory is imagined mid axis that would manage heavy industry and the in transit construction of the ships kit.

As the ship travels an optimization of weight distributoion and unit placement is envisioned. Subtle adjustments of the rotation speed of each “Hive” will allow the ship to right itself and avoiding drifting mid-course.

The ship will grow to accommodate new arrivals. Each hive is partitioned and enclosed by the outer research and services layer. In an emergency each quarter can sustain itself to a limited extent.

As the ship arrive at its destination some of the habitats can be repurposed to serve as planetside accommodation. Landing gear can incorporate the cross-star habitats which can be layered and packed to survive entry into an alien atmosphere.

Our team believes the ship should maintain a skeleton crew in orbit incase of emergencies and to begin taking advantage of resources within the star system.

A DAY IN THE LIFE ON THE PRINCIPIUM HEREDITATIS – PG1

The warm glow of fifty candles flickers on the faces of friends and family gathered around me. A hush falls as they wait for the age-old tradition: the birthday wish. This moment, steeped in quiet anticipation, doesn't just bring me to the cusp of another year; it launches me back decades, to my third birthday. I'm a child again, in a kindergarten classroom on the Principium Hereditatis, the hum of the ship a constant, familiar lullaby. Life back then felt as boundless and simple as the colorful bean bags we'd huddle on for story time. Our universe was the classroom, our ambition purely to play , and the biggest decision of the day was hoping the teacher would pick our favorite book from the stack. The weight of fifty years, the crises weathered, the quiet joys found – it all melts away for a second, leaving only the pure, focused intent of a three-year-old with a wish to make.

In those early years, the Principium Hereditatis was our entire world. Earth was a whispered myth , a place of longing for our great-grandparents, a setting in the endless digital collections we devoured in the library. Lunchtimes often found me wandering those virtual stacks, losing myself in tales of a planet I'd never known. I quickly claimed a quiet corner as my own , a spot where I could pore over catalogues detailing Earth's history and daily life. It wasn't so different from our existence on the ship , apart from the slight difference of being light-years away in the quiet vacuum of space.

It was in that very spot, surrounded by echoes of a distant past, that I first fell in love at thirteen. They were drawn to the same quiet corners and digital worlds. We didn't just read together; we dove headfirst into shared adventures, exploring the ship with the same wonder we found in stories. Our days became a blur of racing between our habitats , sometimes seeking the fastest route, sometimes the most scenic, guided only by our mood and the day's unspoken plans. On one such exploration, we stumbled upon a narrow tunnel, just wide enough to squeeze through. It became our secret hideout, a place where we'd spend hours mesmerized by the intricate network of wires connecting our homes to the ship's beating heart.

As our late teens arrived, our paths gently diverged. I pursued my training as a water scientist, drawn to the vital systems that sustained our lives. They chased a different dream, dedicating themselves to the vibrant world of art. Years passed, and then, at twenty-three, fate intervened. We reconnected at a party not unlike this one, though perhaps a bit louder, fueled by the easy camaraderie and freely flowing drinks. From that night on, we were inseparable once more.

A DAY IN THE LIFE ON THE PRINCIPIUM HEREDITATIS - PG2

My days settled into a rhythm dictated by my work below deck. Depending on my shift, I'd clock in at 8 AM or 8 PM , embarking on twelve-hour stretches punctuated by mandatory coffee and lunch breaks. Routine maintenance formed the bulk of my tasks , work that ironically led me to become intimately familiar with the very wires we'd marveled at in our teenage tunnel. The ship, a marvel of engineering, ran with predictable precision. Until it didn't.

The crisis wasn't a sudden, dramatic event, but a creeping dread. We didn't literally run out of water; the taps still flowed. But the water itself became a silent threat. The medical team was the first to raise the alarm. A wave of illness, particularly among the children, swept through the habitats. The number of complaints about stomach bugs climbed steadily until a quarter of the ship's population was confined to their homes, weak and sick. High alert rippled through the ship – something was terribly wrong with the water filtration system. The water was unusable, effectively cutting off our access as surely as if the taps had run dry. I imagined this was a fraction of the fear Earth must have known during a drought.

Initially, we suspected mineral scaling, a seemingly logical culprit despite our rigorous maintenance protocols. But the true cause was far more insidious. As we scrambled to diagnose the problem, life on the Principium Hereditatis fractured.

Those who had foresightedly installed independent filtration systems in their homes saw an opportunity in our desperation, selling the water that had always been freely available. Others, too, sought to profit from the crisis. My uncle, Malume – the name we used with affection – fell victim to one such scheme. Desperate for safe drinking water, his usual caution slipped when someone he recognized offered water for a fee. Having crossed paths before, Malume handed over the money, but the promised water never materialized.

Days later, the sting of being scammed settled in, amplified by my aunt's frustrated scolding. Embarrassed but determined, Malume headed to the police station in the civic hub. The station, usually a quiet corner of the ship, was teeming with others who shared his fate. It was perhaps the busiest it had been since the Principium Hereditatis first left orbit. Malume also brought the issue before the advisory forum , a body where adult members of the mission could participate in decision-making. As a member, this was within his purview.

But the outcome of that meeting was a stark illustration of how fundamentally the ship's social fabric had torn. While a desire for order and punishment for the scammers was voiced , a new, overt class distinction based on one's role and location on the ship – deck, above deck, or below deck – had taken root.

A DAY IN THE LIFE ON THE PRINCIPIUM HEREDITATIS – PG3

The ship's politics became dominated by certain groups , and chillingly, those selling the available water, many of them senior officials, faced no sanctions. Only the scammers were jailed. Law enforcement was tasked with recovering the stolen money where possible. Malume, sadly, was not among the lucky ones; his money was never returned.

While the advisory forum debated, my team and the water working committee toiled tirelessly. Twelve-hour shifts bled into sixteen. Days and nights blurred into a single, exhausting push. On the fourth day of the crisis, we lost our neighbor. Dehydrated and weakened, they had drunk the contaminated water. The loss rippled through us, heavy and grief-stricken. Soon, the blame for the crisis, and for this needless death, settled squarely on our shoulders.

Regardless of the weight of accusation, we pressed on, traversing the ship's labyrinthine pipe network, swabbing every inch. I found myself drifting back to memories of those in-between tunnels, the hidden passages that connected habitats, the places that were once our happy escape. Now, they felt like corridors in a nightmare, a stark reminder of how quickly comfort had turned to crisis. After a week of relentless work, we finally had an answer: biofouling. It might seem obvious in retrospect, but given the advanced state of our systems compared to the ship's launch, it wasn't our first thought

. It turned out that as technology advanced and the system was incrementally upgraded; microbial growths had taken hold on a remnant of the original setup. These growths spread, unchecked, throughout the system , the silent architects of our crisis.

Another week was spent on the arduous task of cleaning the system. As the initial panic subsided, those with independent systems lowered their prices , and water slowly became accessible to more people. But for our lost neighbor, this relief came too late.

I wish I could say life returned to normal once the water flowed clean again. It didn't. That year was shadowed by an uneasy tension. Witnessing our once-proud community fragment under pressure left a lasting scar, a constant anxiety that ultimately solidified our decision not to have children. To many, it seemed a selfish choice. But for us, it was the right one, a truth underscored on my 42nd birthday. The diagnosis – low vertebral strength and a high risk of early onset osteoporosis – landed like a physical blow.

The walk back from the medical center felt like the longest journey we had ever taken. Hand in hand, we moved in a shared silence, the weight of the diagnosis settling between us. What did this mean for our future?

A DAY IN THE LIFE ON THE PRINCIPIUM HEREDITATIS –PG4

That evening, back in the familiar comfort of our habitat, we decided on a conservative treatment plan. Medication to slow bone density loss became a daily ritual. Diet and even the job I loved so dearly had to change, all in a quiet battle to avoid a fracture. I was fortunate; my seniority on the ship granted me access to the best medical care available. The irony of this privilege, earned in part on the back of the water crisis that highlighted the value of my expertise, wasn't lost on me.

During that tumultuous year, I rediscovered the ship, experiencing it from a different perspective. Confined to a wheelchair due to the rapid progression of my condition, I could no longer run down the hallways. Instead, I zipped along on my mobility scooter , noticing details I’d previously towered over. It felt, in a strange way, like seeing the world through a child's eyes again. The viewing deck became my sanctuary , a place where I’d spend hours gazing into the infinite canvas of space while my partner painted beside me. And on the way back, we would pass the library , a building that held the echoes of so many cherished memories.

Now, back in this moment, standing at the threshold of my 50th year, looking back at the journey and forward to what's to come, a sense of hope, long dormant, begins to stir. I took a few years off to focus on my health, a necessary pause. But now, I am excited. I've made a decision that feels right, a return to a place of quiet joy. My mission from this day forward is simple, yet profound: to ensure the next generation finds as much happiness within the library's walls as I once did.

So it goes until our feet touch soil again.

SHAPE OF A CREW

"…You draw on the strengths of people with different backgrounds…

…Even when you're not the greatest of friends, you can work together for something that you both believe in and that has mutual benefits. Space is a great place to do that, because no one owns it. It's a common ground where peaceful scientific collaboration can occur."

- Cpt. Scott Kelly, astronaut, (2017) Harvard Business Review

The crew would be formed around family structures that boost homogeneity. It would thus be very good for the mission to be composed of ethnicities from around the world to offer the genetic diversity we as humans have learnt to draw strength from.

Variety can offer deeper insight into a problem. Resolution of singular concerns can be enhanced by new perspectives all offering a unique impression of certain situations. For this reason, social structures proposed in this presentation are hybridized from an egalitarian perspective.

Due to the complexity of the mission and the precarious conditions for survival we would still require some form of leadership in place to make decisions rapidly in the event of an emergency.

We submit the following criteria towards staffing the project and have designed with these points as a core consideration:

1. Global Recruitment and Transparent Selection is conducted with merit balanced with an intellectual baseline countered against an affinity for the rigors of space travel..

2. Equitable training and resource allocation programs on a global scale. Understanding the need to nurture the best candidates from an early age.

3. Cultural sensitivity and inclusive mission design to reflect a global representation of the best and brightest while also bringing forth some of the social variety that made humanity so successful on our home planet.

Crew families would be a consideration in the shape and design of certain accommodations. Allowing the natural occurrence of nuclear families seems prudent. A strong motivation for the modularity our habitat designs attempt to follow.

Excellence

Open minds

Cultural seeds,

fig. 2. Astronauts and interns,

Source: scottkelly.com. Nasa.gov

HYPERION SOCIAL STRUCTURE

Background

This project researching interstellar travel is one of many in the history of outer space research and development. Many such explorative processes have occurred globally. These processes include, but are not limited to, geostationary orbit, low Earth orbit, and near-Earth orbit. To date, there are two distinct phases of space development that can be defined. The first phase, which began in the 1960s (expanded 1980s) entailed the development of satellite telecommunications above earth in the geostationary region and the exploration of celestial bodies, exemplified most notably by the 6 moon landing missions by the Apollo series.

The second phase, which is currently underway, has been accompanied by the emergence of new industries that offer space travel-related goods, products and services. The objective of these new industries is to make outer space travel both cheaper and faster in addition to creating life supporting systems, space habitats, and space mining technologies. The Hyperion mission fits into this wave, and begins to define a third.

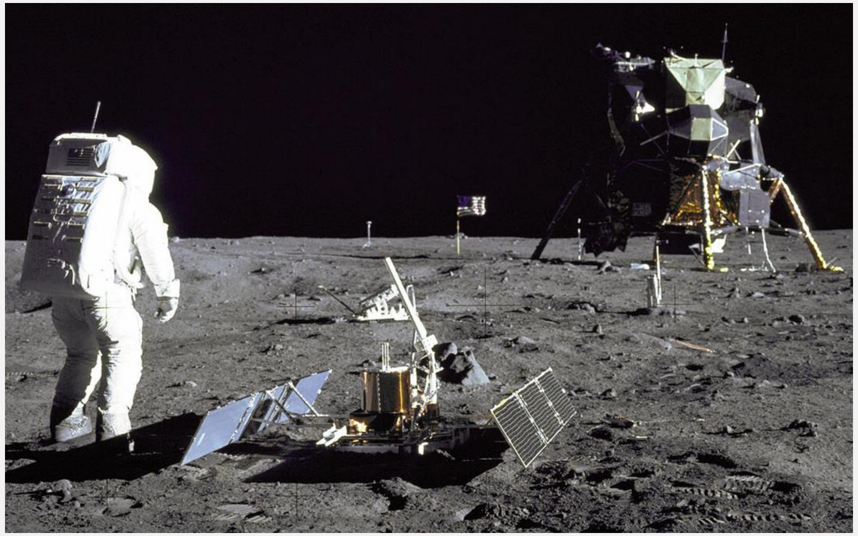


fig. 3. Apollo moon landing

Source: amnh.org

Hyperion: A Total Institution

It is important to note at the outset that the length of the journey necessitates the incorporation of a certain level of adaptability through incremental upgrades or repurposing in the habitat design. This is to accommodate the unexpected ways that space exploration shapes worldviews, changes cultures and, inter alia, changes behaviour (Dick, n.d.). Moreover, the fact that the Hyperion is a mobile space has played a significant role in shaping our perception of how we should inhabit and interact in the space.

Although the habitat is designed to foster integration and inclusion amongst the diverse groups of voyagers, we are also anticipating – based on research examining experiences of seafolk on ships – that within this mobile space the initial framework for social relations will be organisational in nature. That is, the fact that the Hyperion is a working organisation (Aubert & Arner, 1959) and “total institution” (Goffman & Helmreich, 2007). As a ‘total institution’, the Hyperion does not have the distinct separation of land uses that is characteristic of the spatial layout of human settlements on Earth. Put differently, with the overall drive for work-life integration, there is no clear physical separation through distance between the places within which individuals sleep, work, and play. Individuals conduct these activities more or less in one (confined) space. Additionally, neighbours, colleagues and friends are all the “same people to whom he has a clearly defined work relationship” (Aubert & Arner, 1959: 201).

HYPERION SOCIAL STRUCTURE

Versatility

To address the perceived need for versatility, the Hyperion's habitat is modular. This allows for work, recreational, and residential spaces to evolve as needed and as technology evolves. There are spaces (pods) within which individuals can retreat to get some privacy or to perform cultural or spiritual rites (Refer to design elements). There are also shared maker spaces, laboratories, and farms within which collaborative practices can take place.

It is within the shared (communal) spaces that informal groups structures and collective formations are formed on ships (Aubert and Arner, 1959). These multipurpose spaces, which can also be used for communal practices such as religious, cultural or celebratory events in addition to recreational areas such as gyms, theatres and digital simulation rooms will be central to staving off the loneliness that some may feel on the journey. The Hyperion is a place of work – all members of the crew are on board to fulfil the mission that dictates organisational culture on the first leg of the voyage – that is isolated from (extended) family members and loved ones back on Earth. Furthermore, the crew are isolated from their primary local community networks, whereby community is here defined both in terms of shared interests and geographical proximity. This physical separation, which in the case of this voyage is a permanent separation will potentially have significant psychological impacts on some voyagers.

Aubert and Arner (1959) argue that physical separation from family and community networks means that we can anticipate a high level of crew turnover per occupation. These findings have influenced how we have thought about education and knowledge transfer more broadly (cf. Hein, DATE), skills training, and staffing on the ship. This is discussed in the next section.

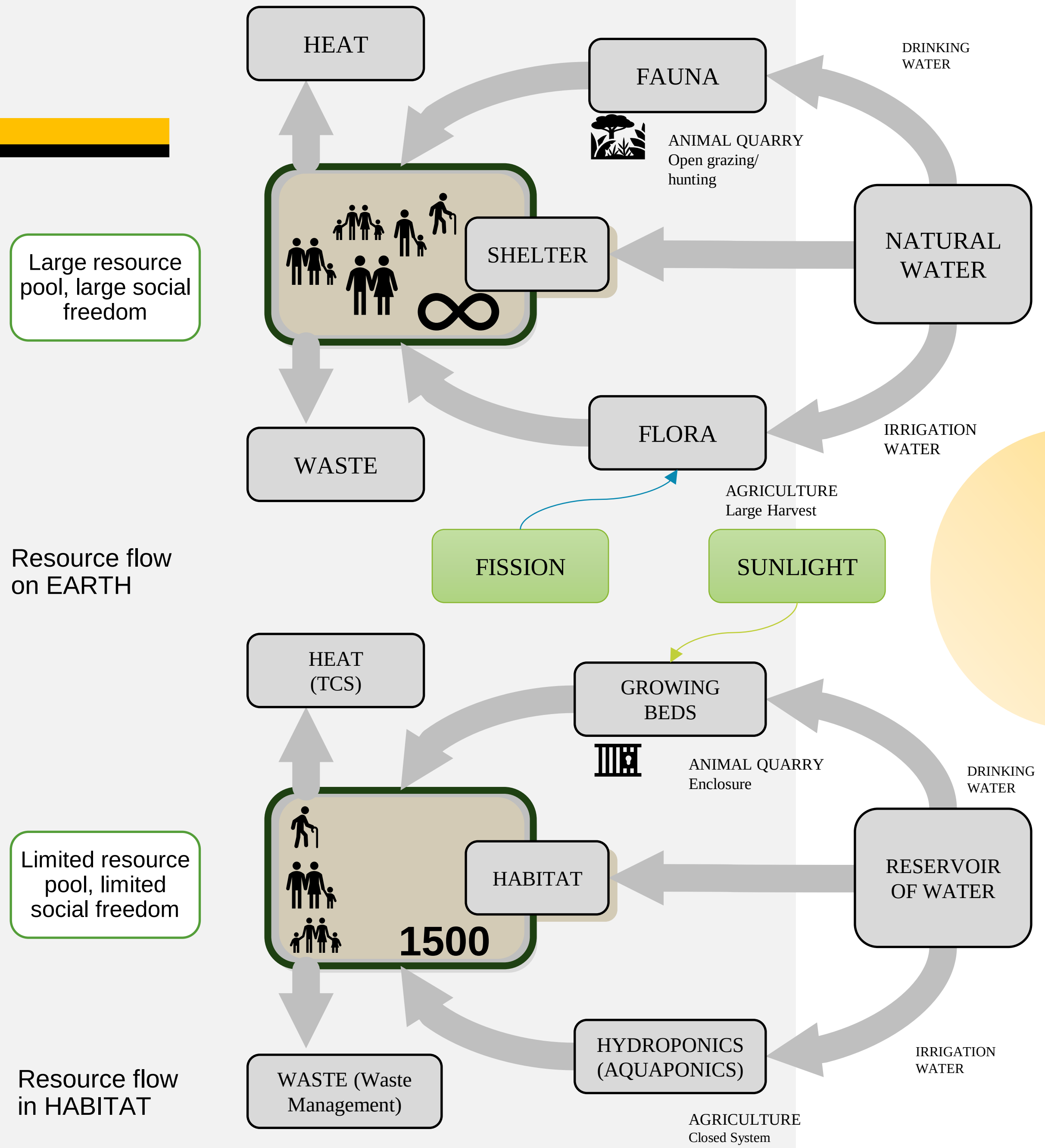


Fig. 4. limited vs open system effects on habitation, source: author

HYPERION SOCIAL STRUCTURE

Education

The specialised nature of the positions on the ship means that any personnel changes could cause great instability. Therefore, it is imperative that, and as Weeks & Faiyetole (2014) note

“students, at all levels, be introduced to space studies as part of their overall required curriculum. We are further suggesting that all people […] be exposed to the knowledge and information concerning the development of outer space.”

But, whilst this is evidently a positive requirement in relation to the need to ensure that there is always an adequate ‘supply’ of qualified personnel on board, this rapidly changes.

This new society will also have ample opportunities for self-education, an often-overlooked process of self-development (Znaniecki, 1930) and lifelong learning (Gibbons & Phillips, 1982). This is pivotal in a context such as this where specialist training, of the level required on board to ensure a good supply of personnel, is faced with the additional challenge of ensuring that the intellectual basis of this new society continues to evolve through the development of new technologies.

Here, the human-computer (digital interfaces), which are discussed below, are critical. Leaving room for self-education also offers one additional avenue for breaking the monotonous nature of the living conditions that are associated with the confined nature of space on the ship (Freitas et al., 2021).

Fig. 5a. Depiction of a classroom interior, *Nightcafe.studio*

Fig. 5b. Depiction of a student learning on their own, *source: hospitality insights.ehl.edu*

HYPERION SOCIAL STRUCTURE

Governance

The history of outer space development processes is recounted above is told to situate the current project. And, whilst many of these space development processes are not transparent (to the ordinary person), they can be delineated through an examination of the international and domestic laws, policies, and economic initiatives that have been promulgated to support outer space development. These include the: - Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (referred to as the “Outer Space Treaty 1967”)

Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (referred to as the “Rescue Agreement 1968”)

- Convention on International Liability for Damage Caused by Space Objects (referred to as the “Liability Convention 1972”) Convention on Registration of Objects Launched into Outer Space (referred to as the “Registration Convention 1976) Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (referred to as the “Moon Agreement 1984” These treaties will form part of the core structure of the hybrid community governance structure on the Hyperion. Grounded on the principle of egalitarianism, the Hyperion will be a pluralist democracy. Within this. Model of democracy everyone is involved in the ship’s politics, with different actor groups and/or interest groups competing (equally) to influence policy. That is, the ship’s politics and policies will be dominated by one group.

A key assumption we are making, however, is that all (adult) members on board will be interested in participating in (political) decision-making processes We also do anticipate that this model of democracy will, at times as the journey progresses, operate through groups that are formed in relation to specific causes. In the Hyperion, pluralist democracy is enacted within what we are referring to as the advisory layer. This is one of three governance layers delineated on this mission. The other two are the institutional layer and the operational layer. It is at the nexus of these three intersecting layers that the Hyperion’s governance framework is situated (figure 6).

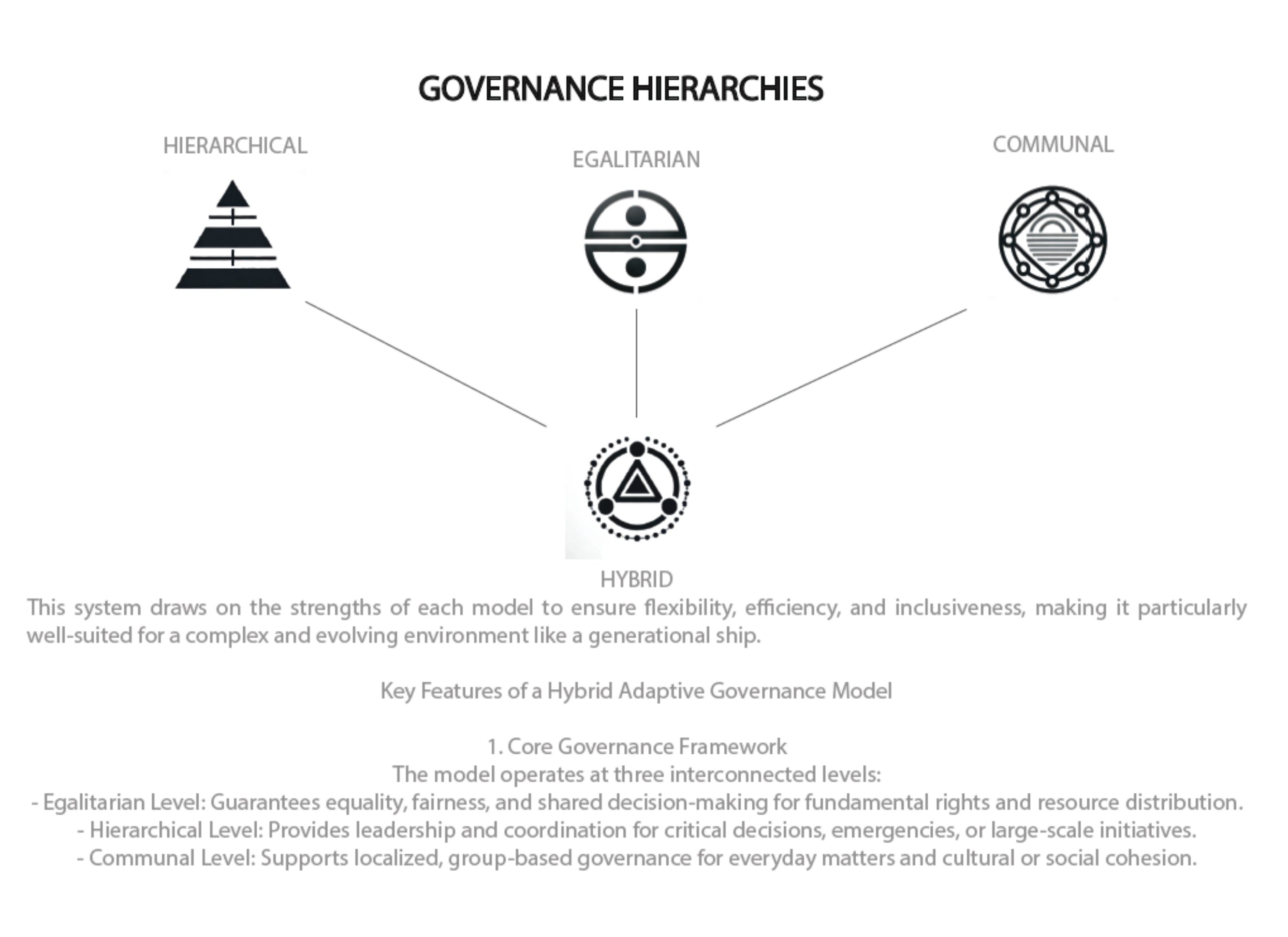


Fig. 6. Governance hierarchies considered

HYPERION SOCIAL STRUCTURE

Advisory

Institutional Operational

The advisory forum is the layer that truly enables all (adult) members on the mission an opportunity to take part in decision-making processes. In this regard, all individuals on the mission are engaged and are tasked with providing advice and guidance to the institutional and operational layers. To this end, subsequently, problem solving occurs at the community level through a horizontal platform – the advisory layer. The advisory layer determines the rules, policies, and procedures for both participation in the advisory forum as well for how people should conduct themselves on the Hyperion. This becomes critical in later years as the impact of the journey's impact on the socio-cultural and political landscape within the ship becomes more evident.

Given the context – a space craft – and the need for a quick response in the event of an emergency the operational layer, which is supported by sector specific working committees, is responsible for ensuring that everyone's needs are met. They also have oversight of ship repair and maintenance in addition to the important role of responding to emergencies. In terms of how governance decisions flow, the operational layer undertakes the activities and programs that give effect to the strategic objectives crafted by the institutional layer. The institutional layer, in turn, translates the policies and proposals made by the advisory layer, into strategic objectives. Thus, the institutional layer is responsible, alongside ground control, for defining the strategic objectives of the mission.

Conflict Resolution

Individual and group breakdowns in long-term space travel (Almon, 2019) Individual psychological health is critical to mission success Group maturity is also just as important Additional impacting factors are physical health, culture, grief, and gender relationships.

It is as yet unclear if this will extend to a penitentiary function as our team believes truly fundamental crimes might relegate offenders to a level of resource denial as practiced on sea faring vessels.

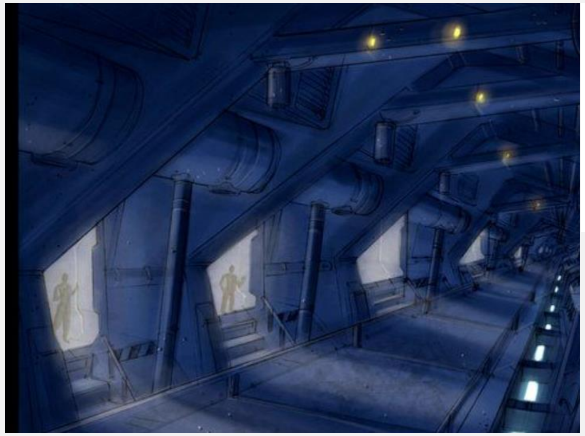


Fig. 7. Jail as a consideration in space akin to a brig on a ship, Source theuncannyken. DA

HYPERION SOCIAL STRUCTURE

A micro-society with artificially intelligent systems and machines in its midst

Throughout the journey, human-computer (digital) interfaces and social interfaces are critical in this environment. Here, interfaces are defined as:

"[C]ommunication mediators, representing information between two parts, making them meaningful to one another (Johnson, 1997; Lévy, 1993). The concept of a human-computer interface traditionally defines a communication relationship between a human and a machine. In this case, the role of the interface is to translate digital information from computers to humans to make it understandable to us."

(de Souza e Silva, 2006: 261-262)

Of equal importance in this environment are social interfaces, which de Souza e Silva (2006: 261-262) defines as a:

"[D]igital device that intermediates relationships between two or more users. Within this context, social interfaces not only reshape communication relationships but also reshape the space in which this interaction takes place. It is important to highlight that interfaces are also culturally defined, which means that generally, the social meaning of an interface is not always developed when the technology is first created but usually comes later, when it is finally embedded in social practices."

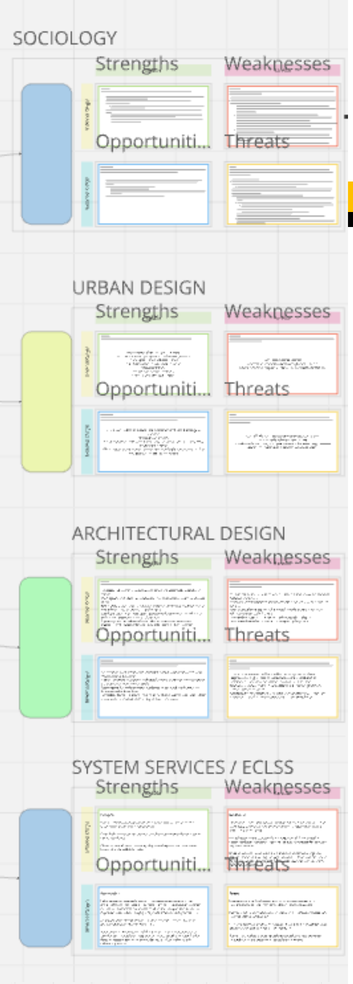
At the heart of each of these interfaces will be artificial intelligence (AI) systems. AI systems will be integrated into many processes on the craft from launches to in-space operations from guidance systems to exploration (Heckel, 2023). The wide range of applications that AI has not only allows for faster and more proactive maintenance of the craft (ibid.), it also becomes vital for the maintenance of human health – both mental and physical. With respect to mental health, the potential health risks of long duration space flight include, but are not limited to, depression and psychologic distress that is exacerbated by confinement and low(er) or lack of social interaction on the craft (Krittanawong et al., 2023). Decline in mental health can be detrimental for the mission as it not only impacts an individual, it can also lead to group breakdowns (Almon, 2019).

But, the maturity of the group as a whole – as reflected by the decisions taken in the advisory forum as the key dispute resolution mechanism – in addition to factors such as physical health, culture, grief, and gender relationships (ibid.). Physical health, on the other hand, is also impacted by these factors but equally so by shifts in gravity. Changes in gravity have an impact on several different organ systems within the body (Krittanawong et al., 2023). Consequently, AI systems can be used to improve the accuracy of medical screenings, model an individual's risk for contracting a certain illness and assist in the (tele)diagnosis of patients (Krittanawong et al., 2023). Over time and as the systems develop even further, both digital and social interfaces will become almost inseperable from life on the Principium Hereditatis.

DESIGN/

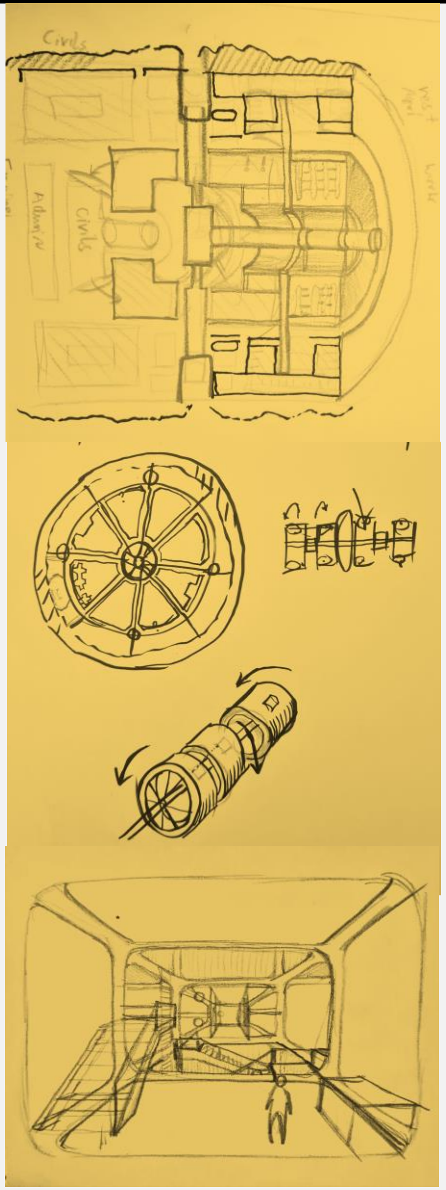
Design and construction of Habitat and components

INTERDISCIPLINARY REFLECTIONS



Our team's approach to designing this habitat is rooted in baseline discussions of strengths, weaknesses, opportunities and threats affecting our proposal across all 6 of the disciplines we represent.

Architectural considerations spanned across scales of Urban Design, Environment and Systems design and building design. Interiors were considered but are open to development later in the project. We resolved that the buildings provided must be buildings that overlap habitation with purpose-built specificity. Each building thus offers the option to function as auxiliary units during the day and double up as accommodation units during the night.



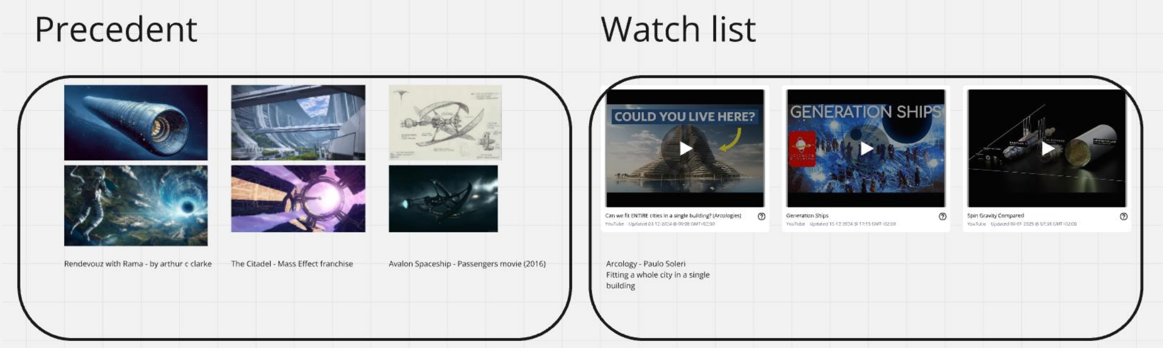
We found working across disciplines on a topic where no single participant possesses complete expertise presents a unique set of challenges.

It felt like navigating a ship where no one knows the entire map, and each crew member only understood a specific section of the coastline.

To overcome these challenges, a structured and collaborative approach became essential. This involved a combination of SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) applied to each discipline and a commitment to collaborative mapping and brainstorming.

Designers worked with engineers and social scientists at all levels of interrogation to articulate the complexities of the habitat design as clearly as possible.

We all as a team acknowledge we have a lot left to refine but have found this project exciting and hope to offer more regarding the multiple ideas we have unpacked.



PRECEDENT EXPLORATION

Basis of ideation

Principium Hereditatis Livelihood
Landscape

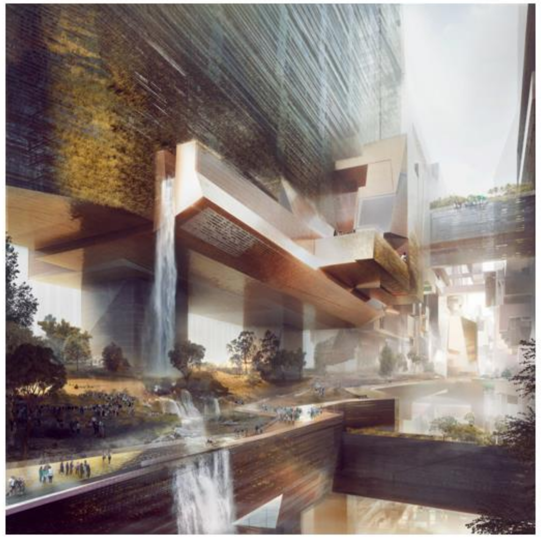


Image sources; Neom

- Nature preservation and conservation
- Liveability and technological advancement
- Integrated systems
- Co-Learn-earn-educate system
- Pedestrian mobility is prioritized
- Living supplemented by pods operating at various heights to provide accessible transportation between spheres/layers

Principium Hereditatis Livelihood
Dwelling typologies

Image sources; Lost in Space

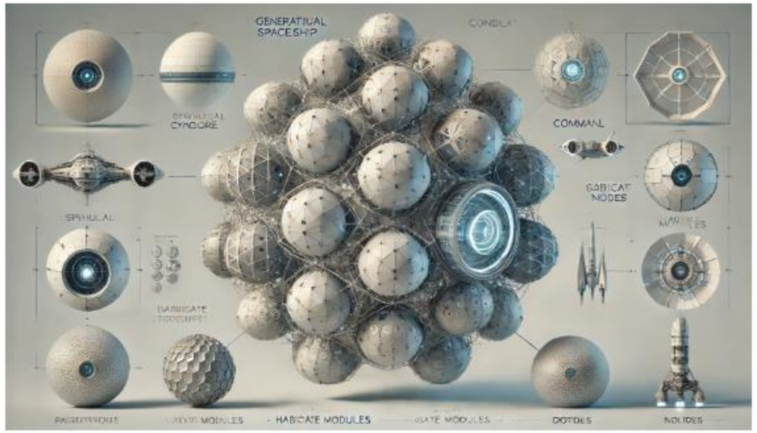
Main navigation / command
Gathering area for the Robinson family, this area was stocked to adust to the Robinson's every need, kitchen, science lab, workstation, main navigation, even breakfast table – Lost in Space.

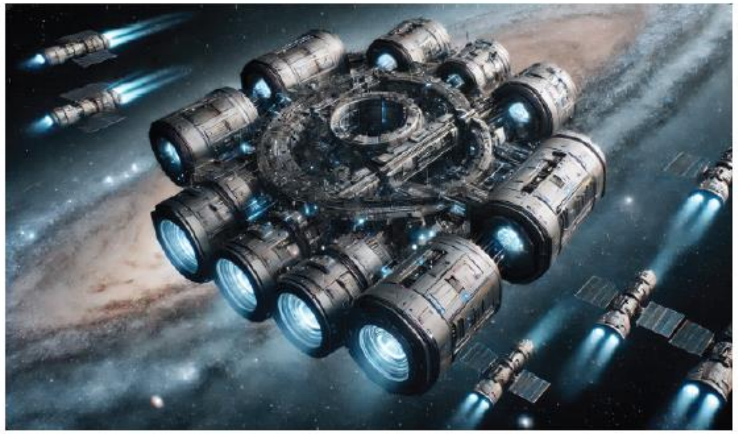
CORRIDORS OF LIFE

HABITAT
Landscape
Dwelling typologies
Knowledge base
Society

MODULE FOR A FAMILY OF 5 CAPSULE

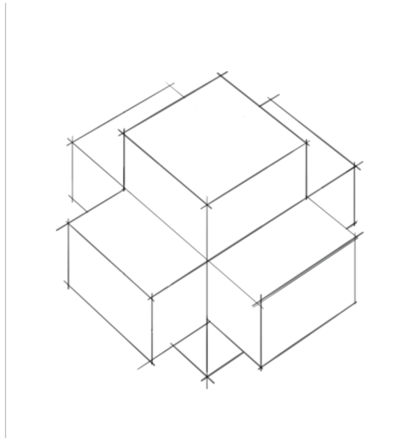
Our team drew from multiple influences including AI imagery, comics, magazines, movies, artbooks and books. We explored three alternative arrangements before arriving at our simplified Hive system.

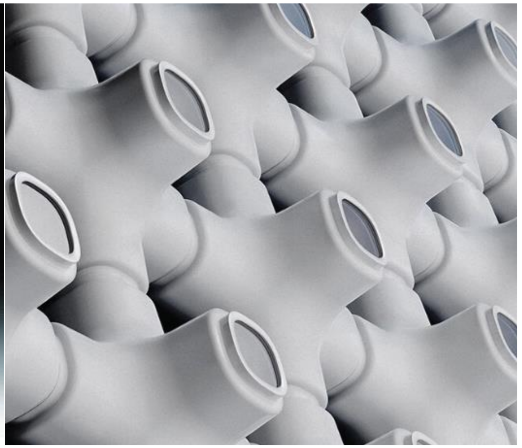


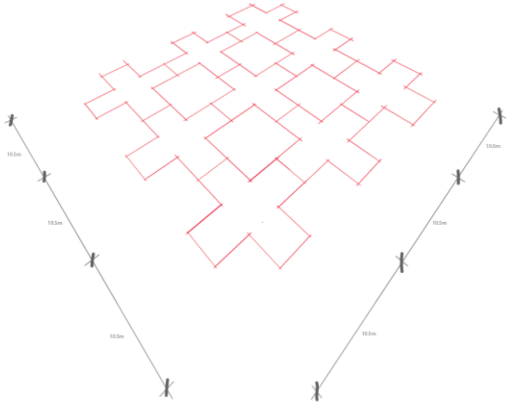


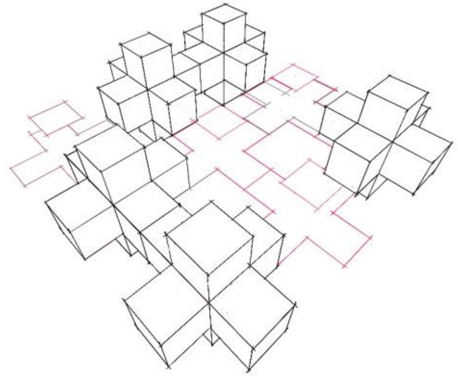
FORM EXPLORATION

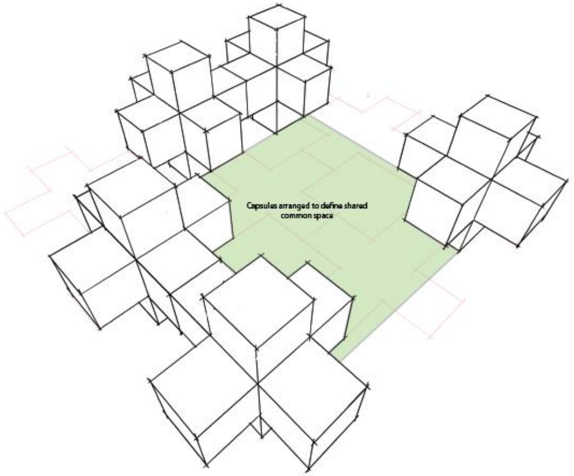
Basis of versatile arrangement



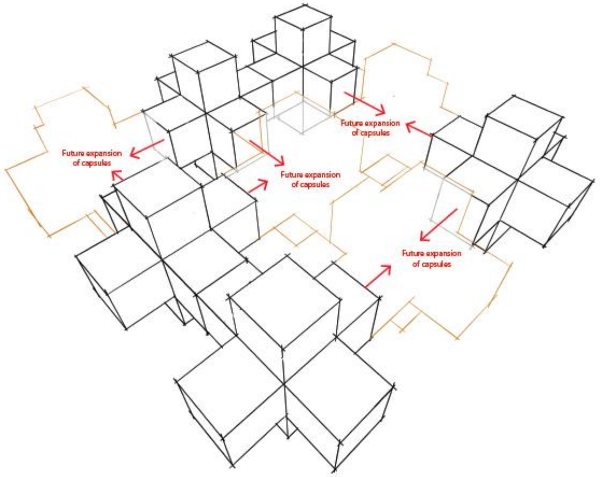




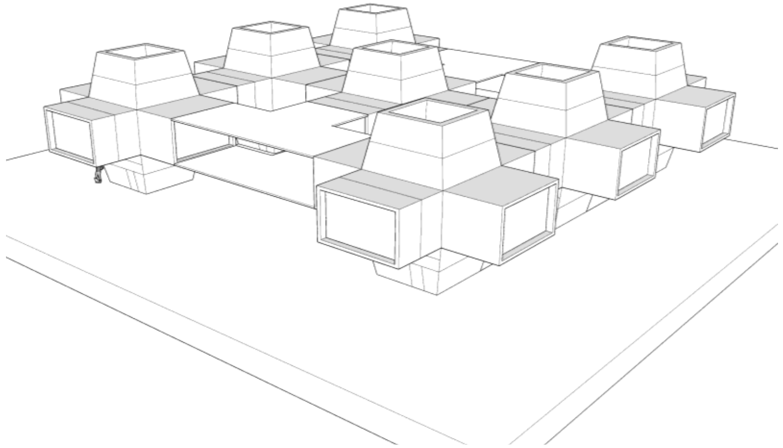




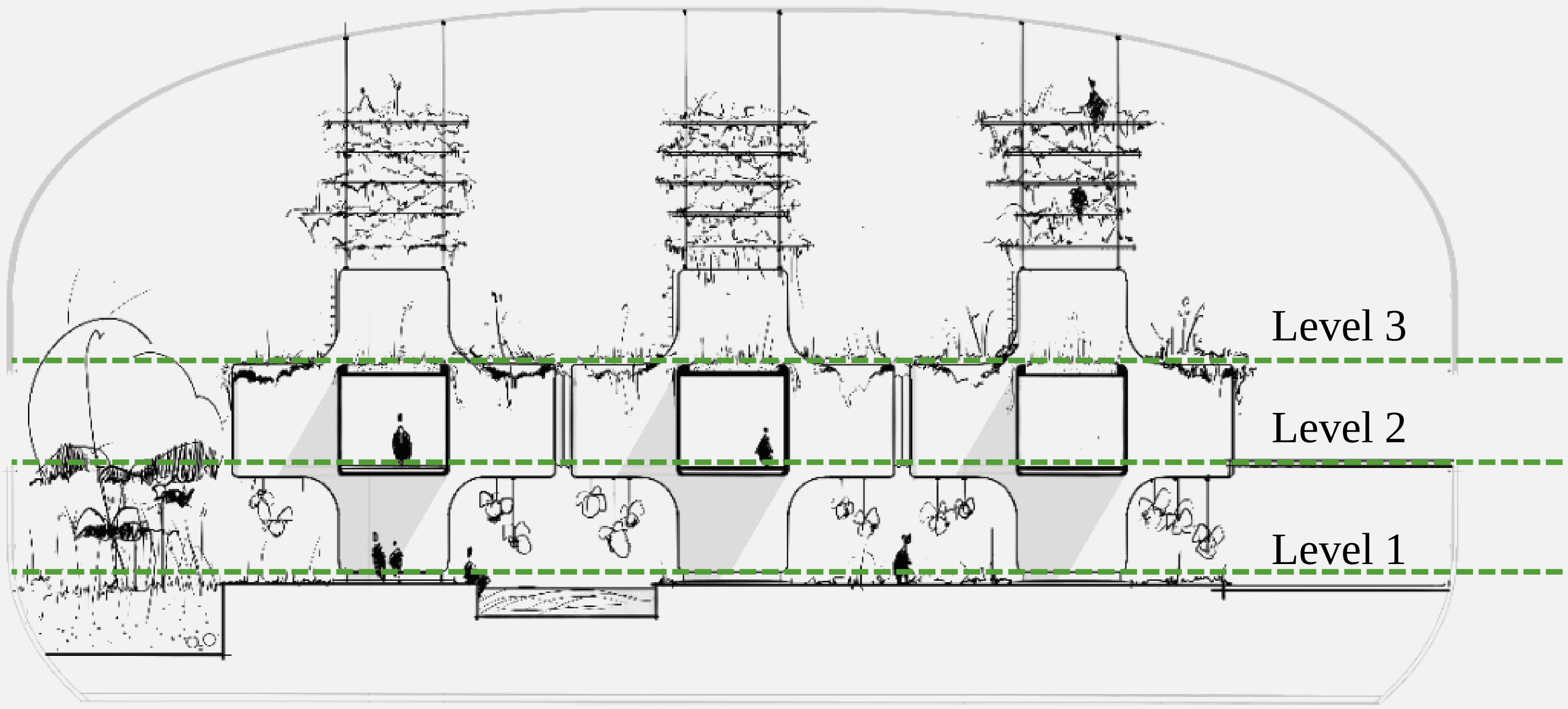
CAPSULE COMMUNITY



EXPANSION OF CAPSULE COMMUNITY UNIT



HABITAT

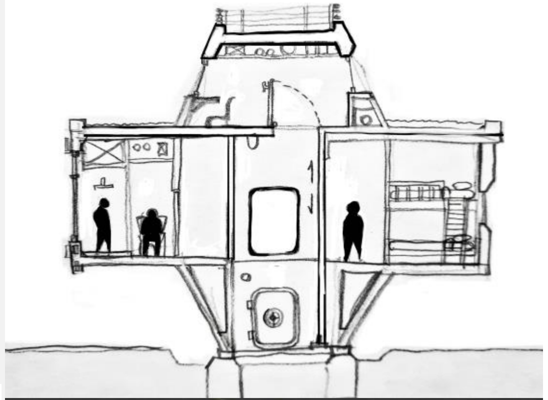


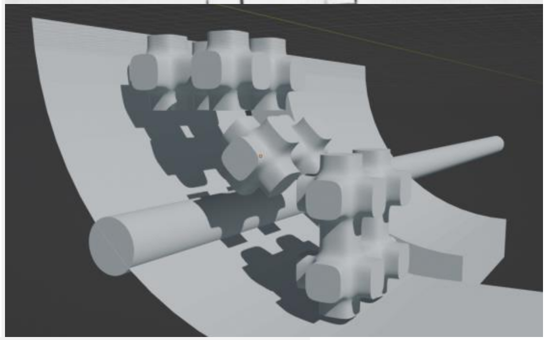
Premium suites include:
- Big gathering space as main space
- Fully kitted kitchen
- Personal science lab
- Workstation
- Individual private sleeping pods

Entry level pods include:
- Big gathering space as main space
- Kitchenette 1 per 10 individuals
- Shared science lab
- Communal Workstation
- Individual private sleeping pods

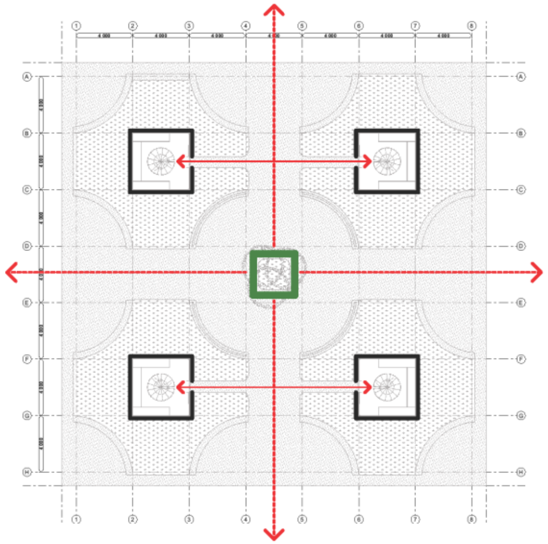
HABITAT STRUCTURE

Design: Services remain present in most internal systems. Living is conducted on the second level with access on the first. Special functions like work and recreation are delegated to the 3 level.

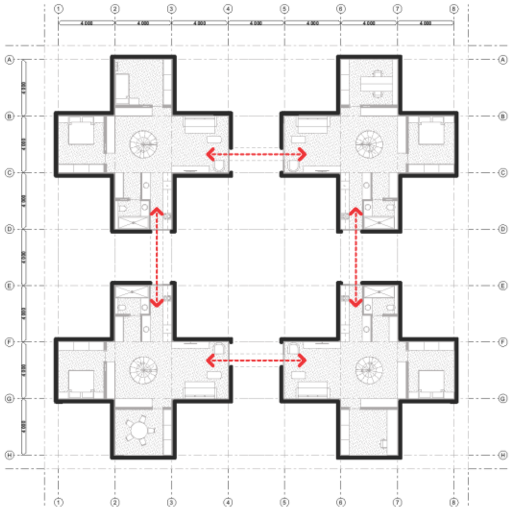




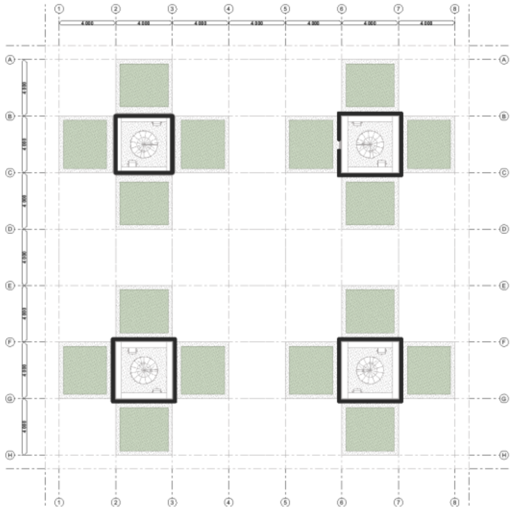
HABITAT – PLAN DIAGRAMS



LEVEL 0



LEVEL 1



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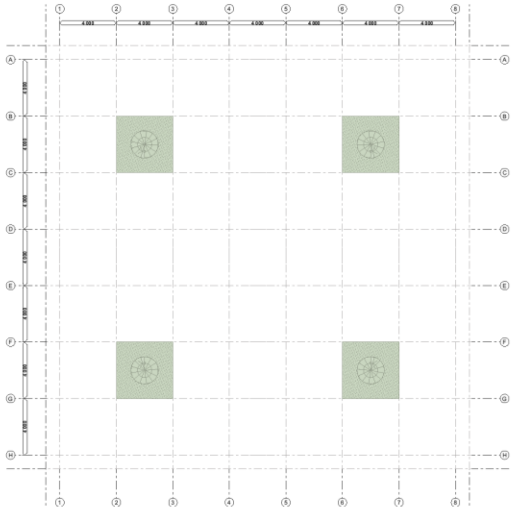

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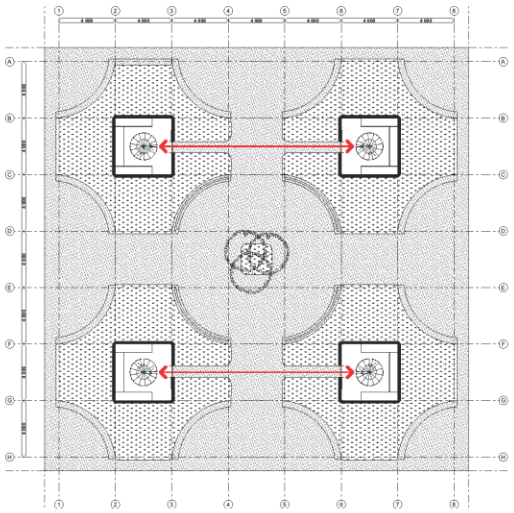

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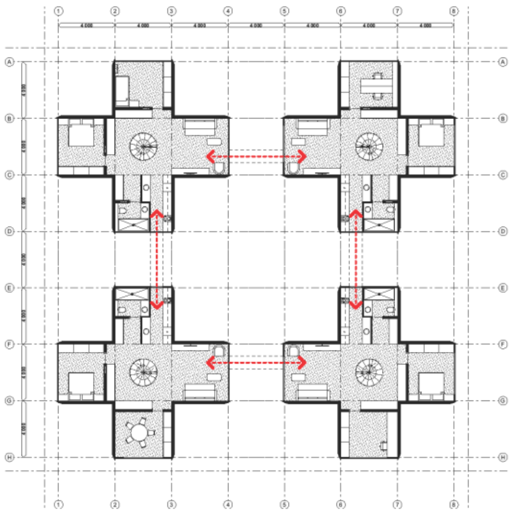
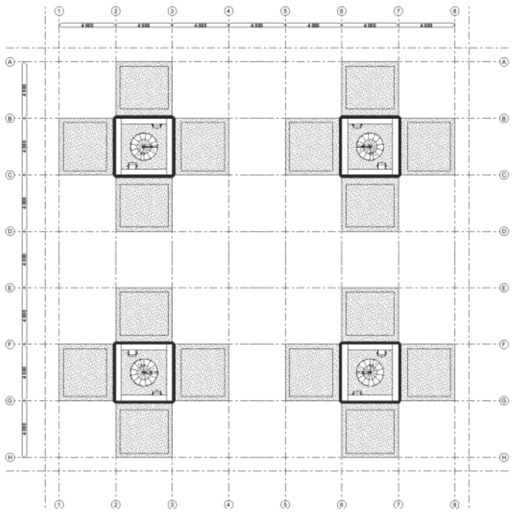
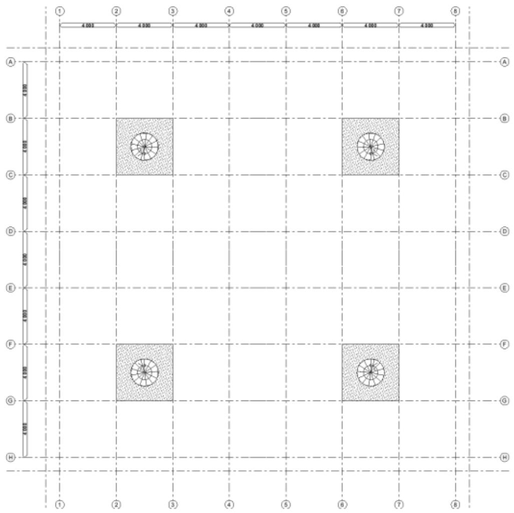


LEVEL 1

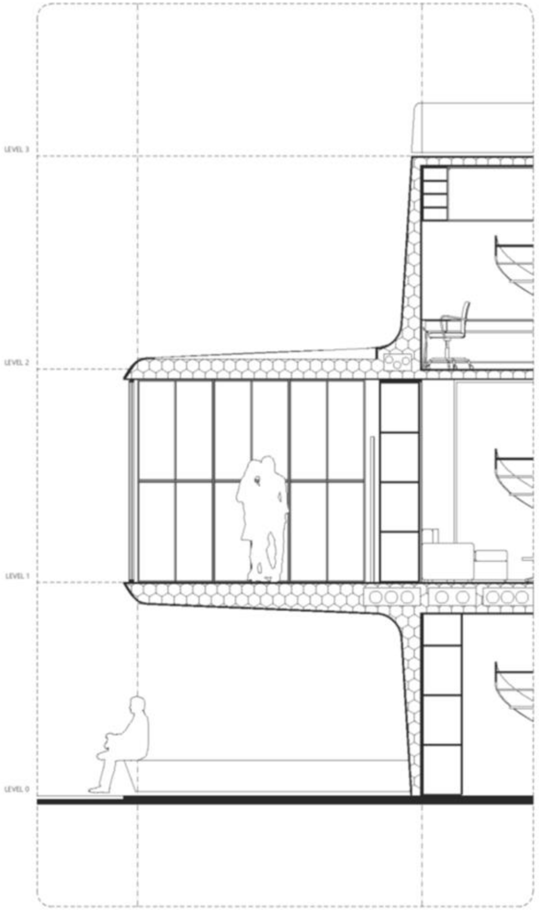


LEVEL 2

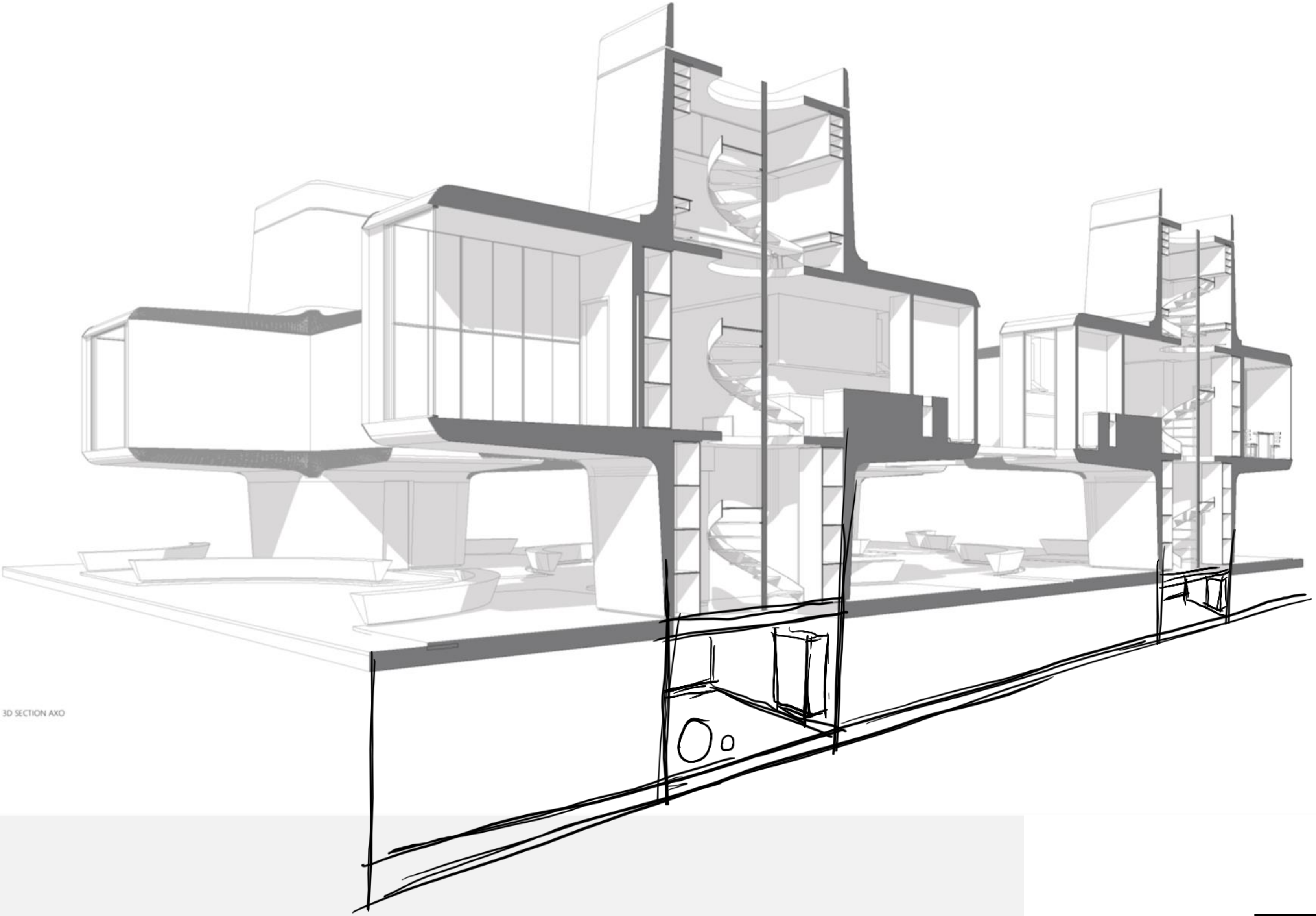


LEVEL 3

HABITAT – SECTIONS



DETAILED SECTION

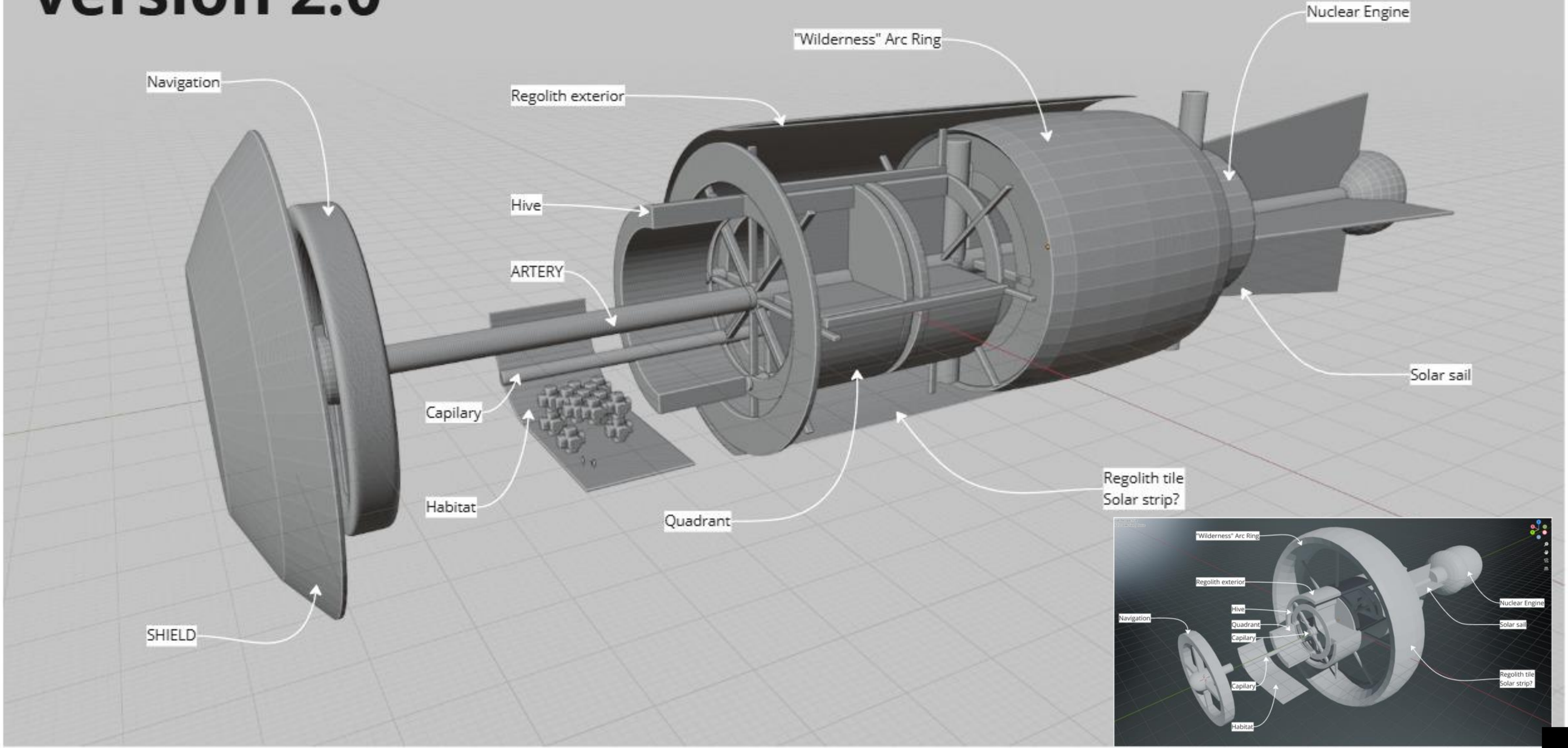


3D SECTION AXO


9

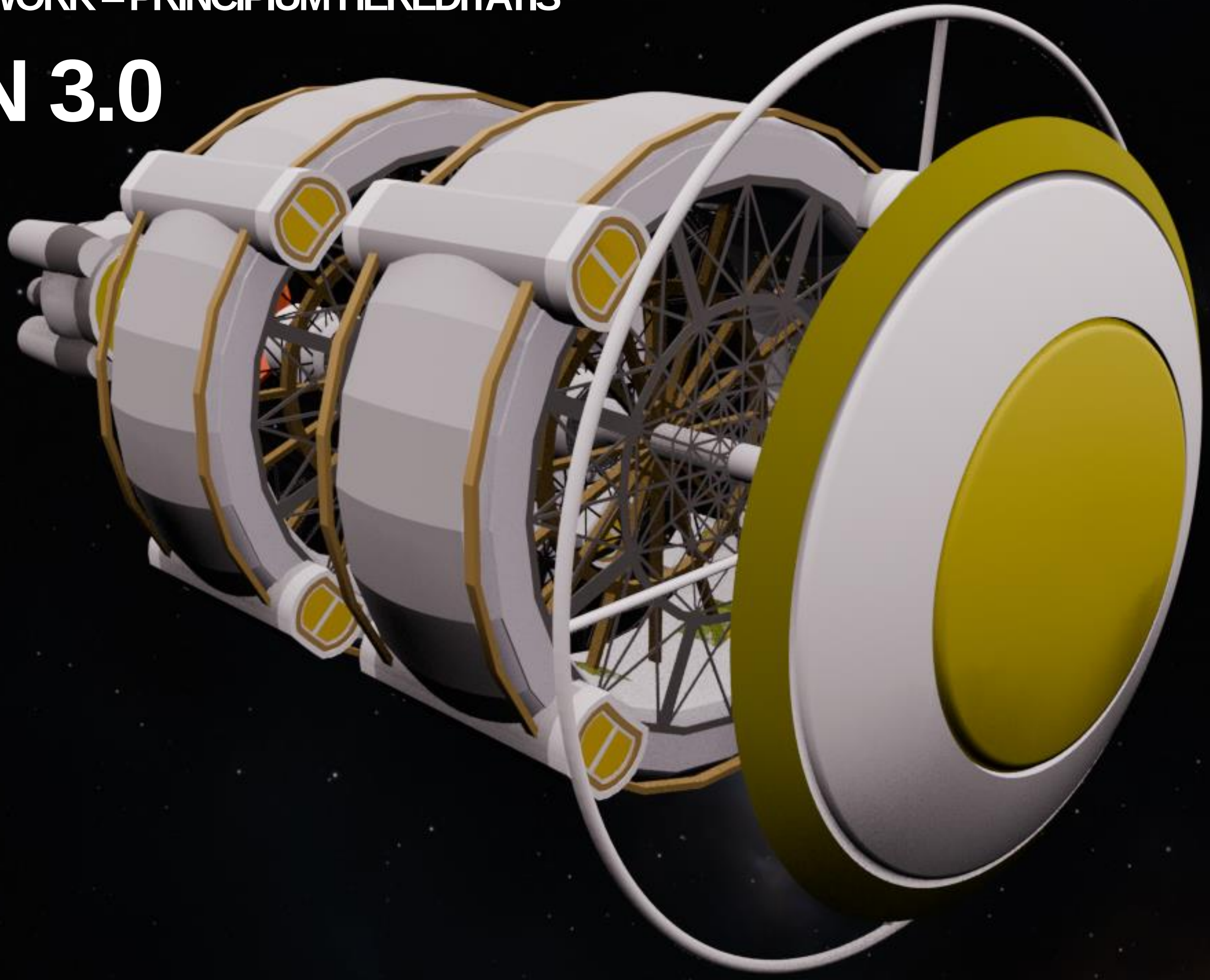
Spaceship framework - Principium Hereditatis

version 2.0



SPACESHIP FRAMEWORK – PRINCIPIUM HEREDITATIS

VERSION 3.0



ROTARY HIVE DESIGN

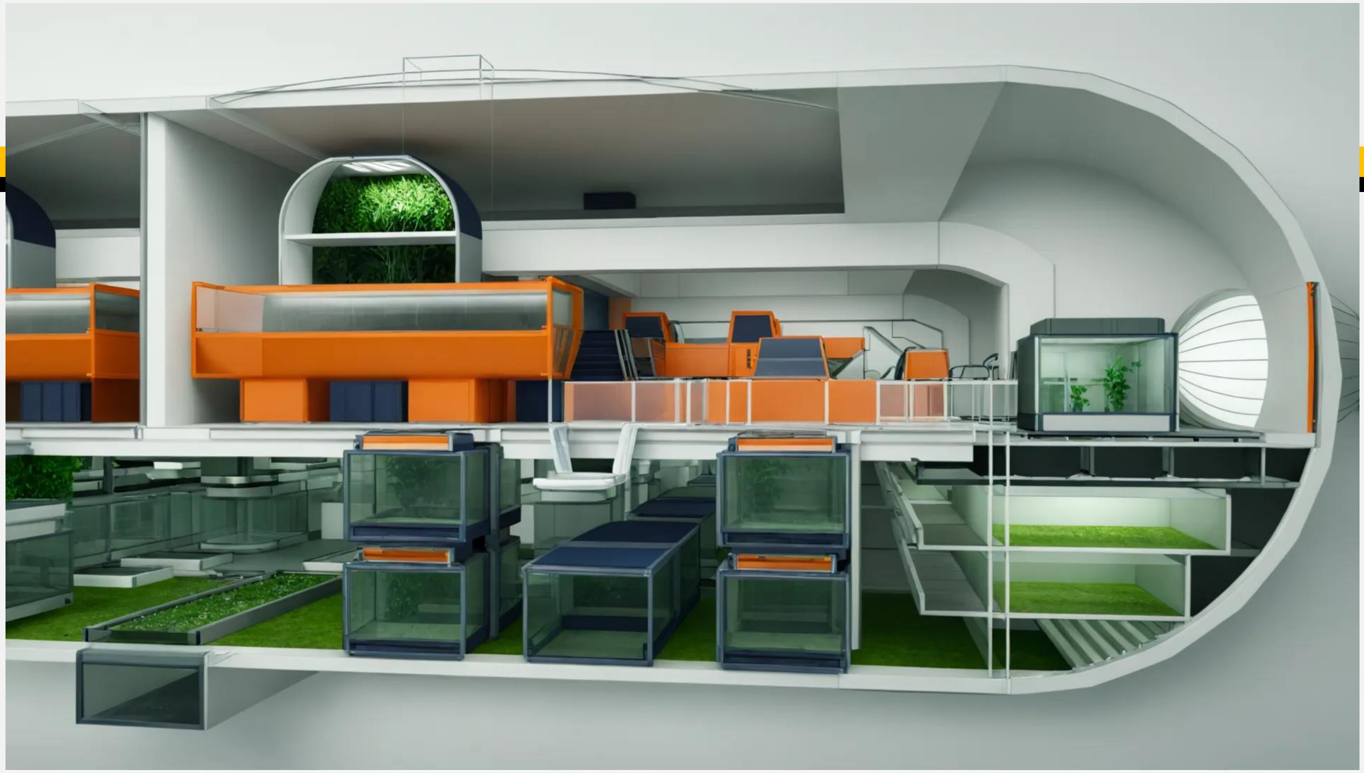
SECTION OF ROTARY HIVE

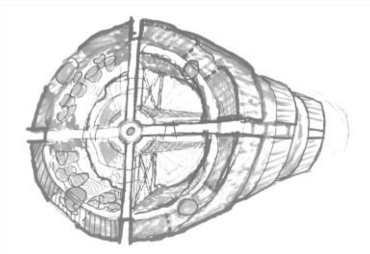
The Hereditatis Habitats are sectioned into 4 parts grouped into 2 rotating wheels; each part is sectioned further into self-contained Quadrants designed to balance perfectly with the opposite quadrant. This ecosystem forms what we will call a “hive” system.

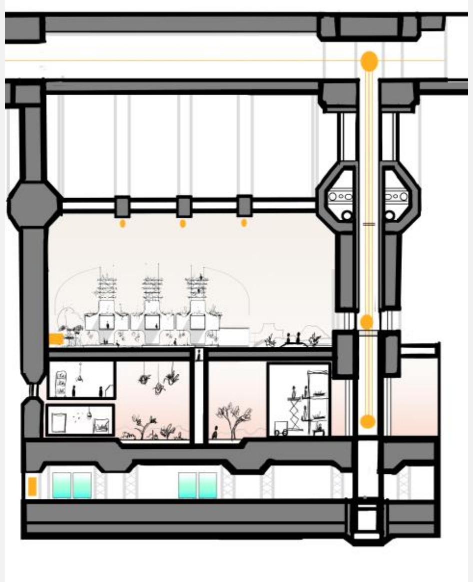
Images to the right illustrate a cross-section through a hive, illustrating the layering of components that make up each rotary hive.

Sections are listed as follows from the outside:

Axis (shored up with regolith).
Space [struts]
Living Quadrants,
Artificial "Wilderness",
Services (wet & Dry)
Framework,
Regolith panel,







3. Living Quadrant

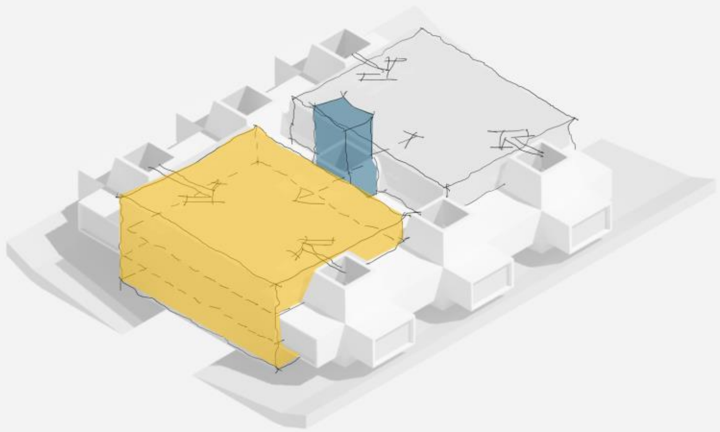
4. Artificial “Wilderness”/ Research centre

5. Hull interior/ Framework

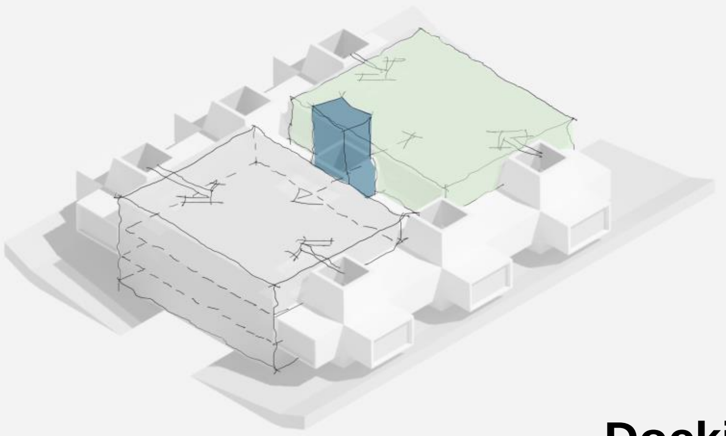
6. Services (Wet & Dry)

Lunar Regolith panel

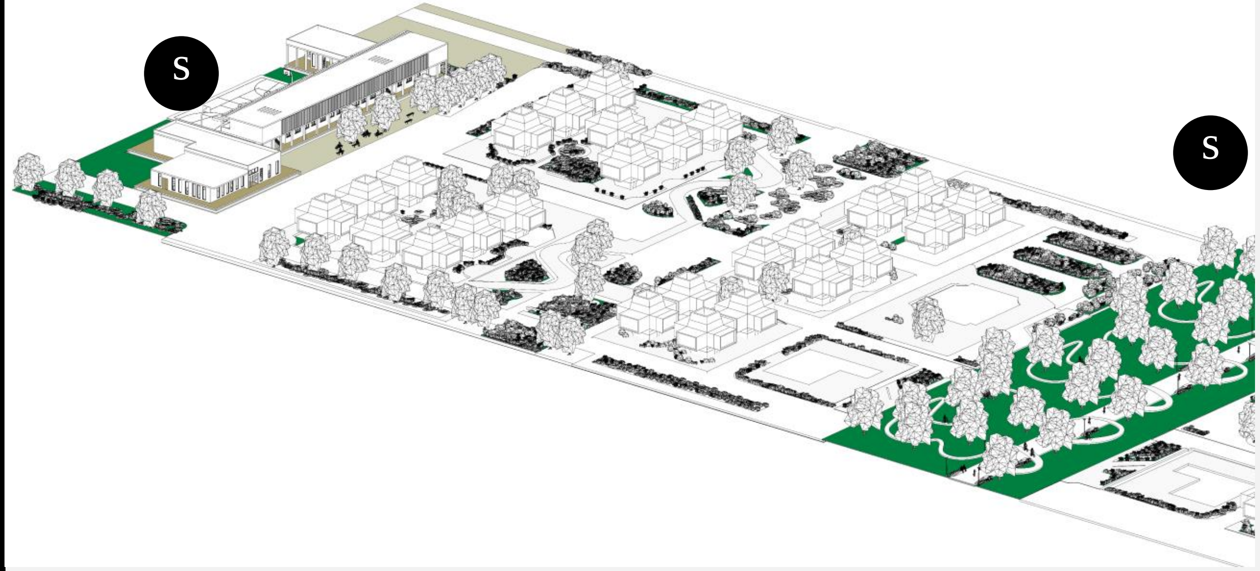
ROTARY HIVE DESIGN : A-TYPICAL MODULES

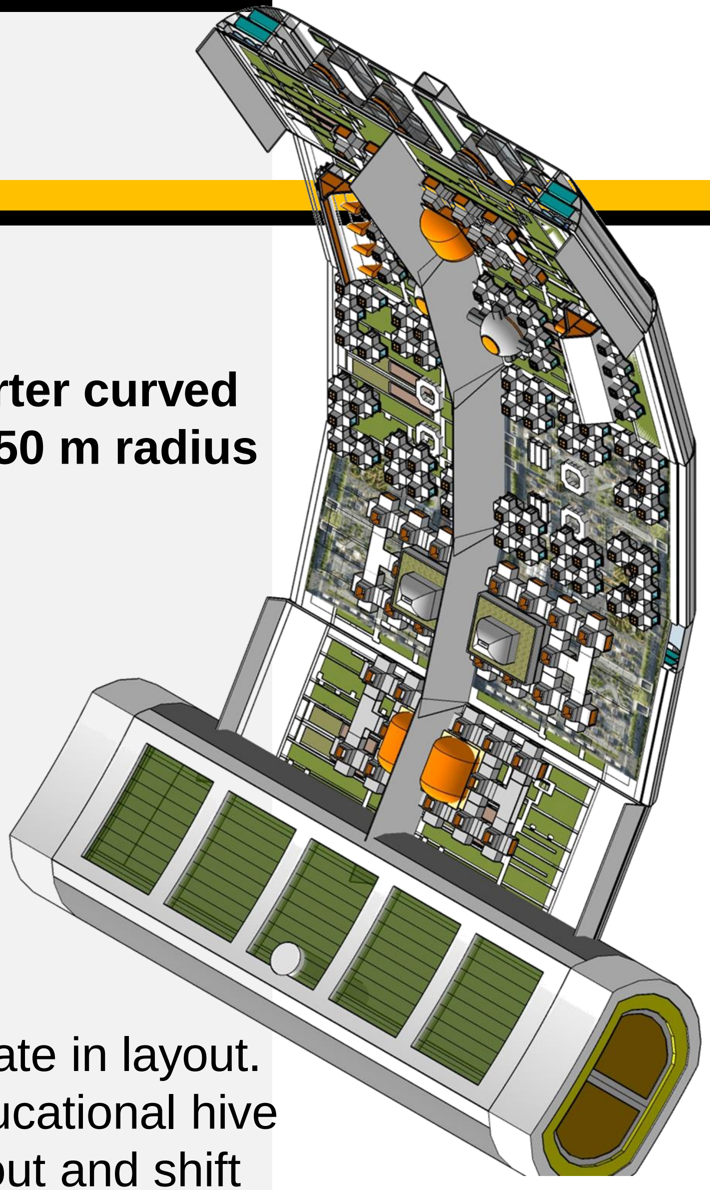


Lifestyle & Livelihoods



Health





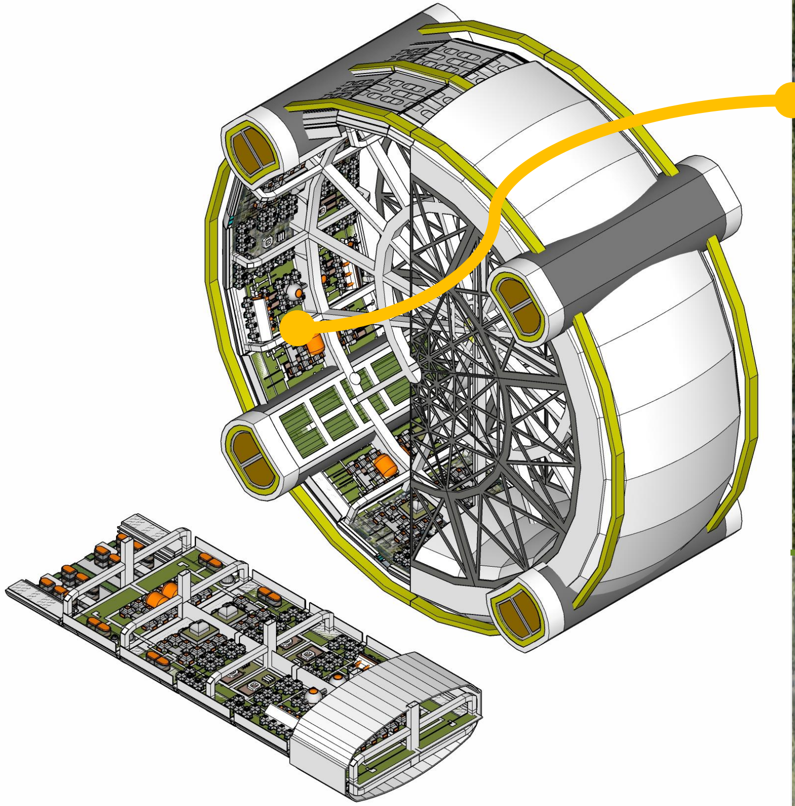
Quarter curved To 250 m radius

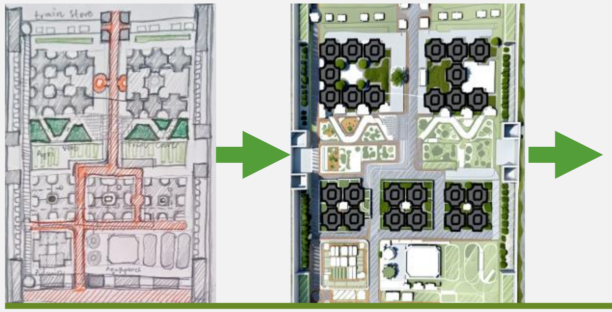
Docking area /Industrial zone

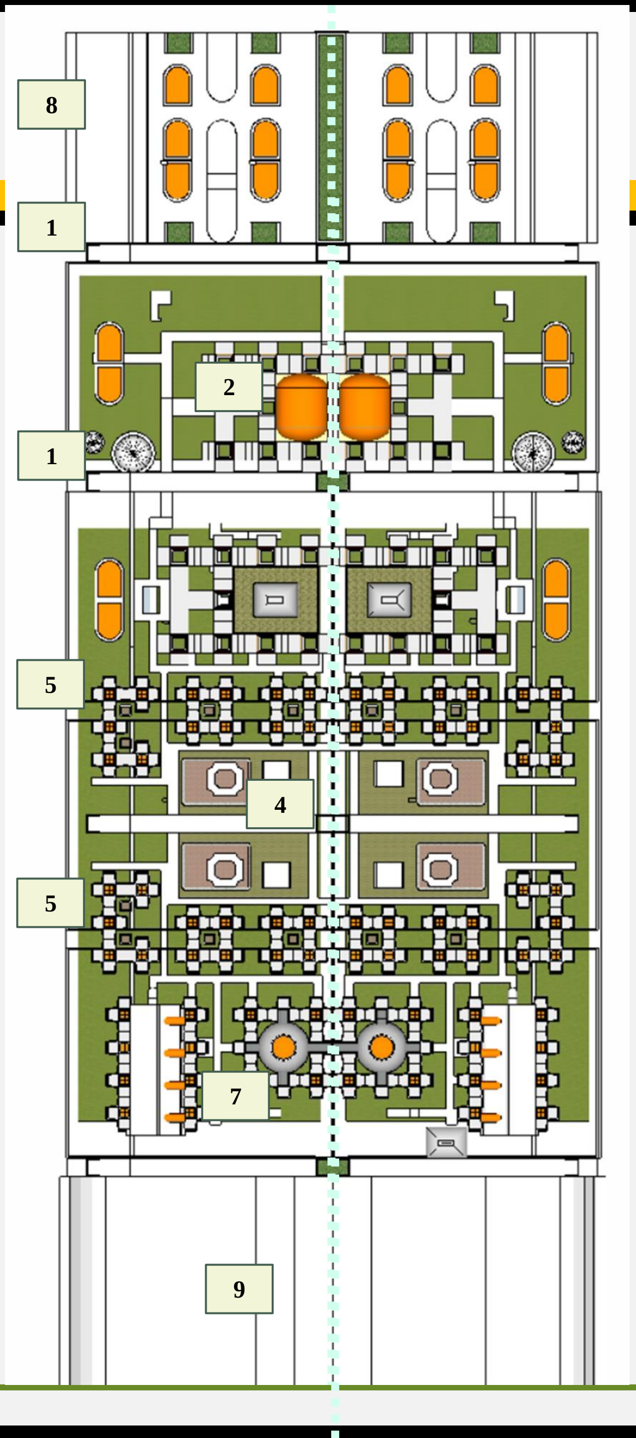
Specialisation

Hive quarters may fluctuate in layout. In example above an educational hive may rak a traditional layout and shift towards specialties.

QUADRANT URBAN LAYOUT







8. Aquaponics/ Wilderness (Below Decks)

1. Conveyance

2. Public building(s)

5. Habitats

3. Garden

4. Growery

5. Habitats

7. Admin/ Storage

Specialization

9. Industry

QUADRANT ACCOMMODATION SCHEDULE

Quadrant

Quadrant

Building List – Hive typical layout:
Quadrant 1: Sector Alpha
•**Level 1 - Habitation:**

- Office 1A4 (Attached to Habitat 1A1-6)
- Recreation Center (Above Office 1A4)

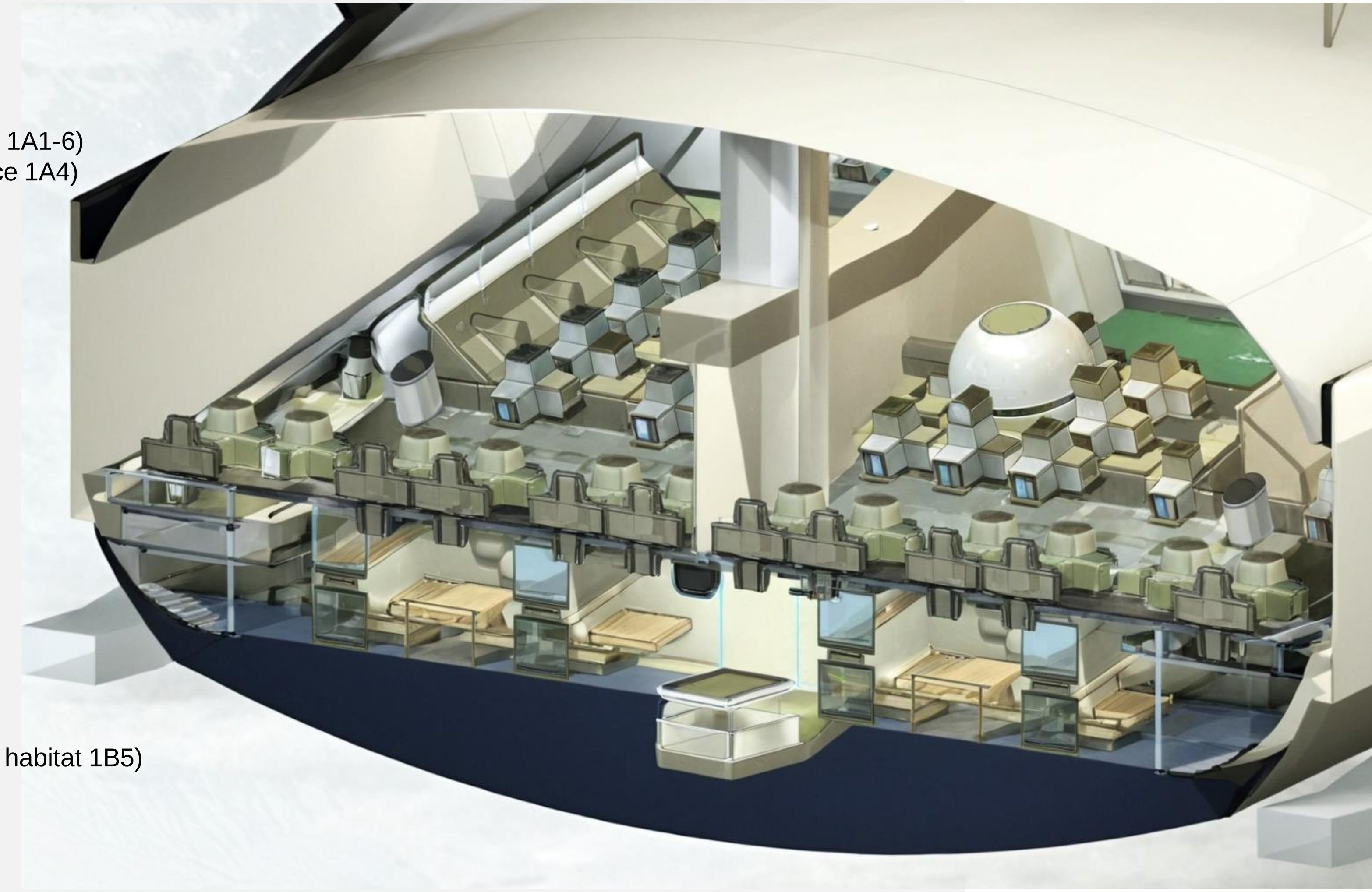
- Habitat 1A1
- Habitat 1A2
- Habitat 1A3
- Habitat 1A5
- Habitat 1A6

- Habitat 1B1
- Habitat 1B2
- Habitat 1B3

- Growery / aquaponics
- Admin building
- Conveyance hub

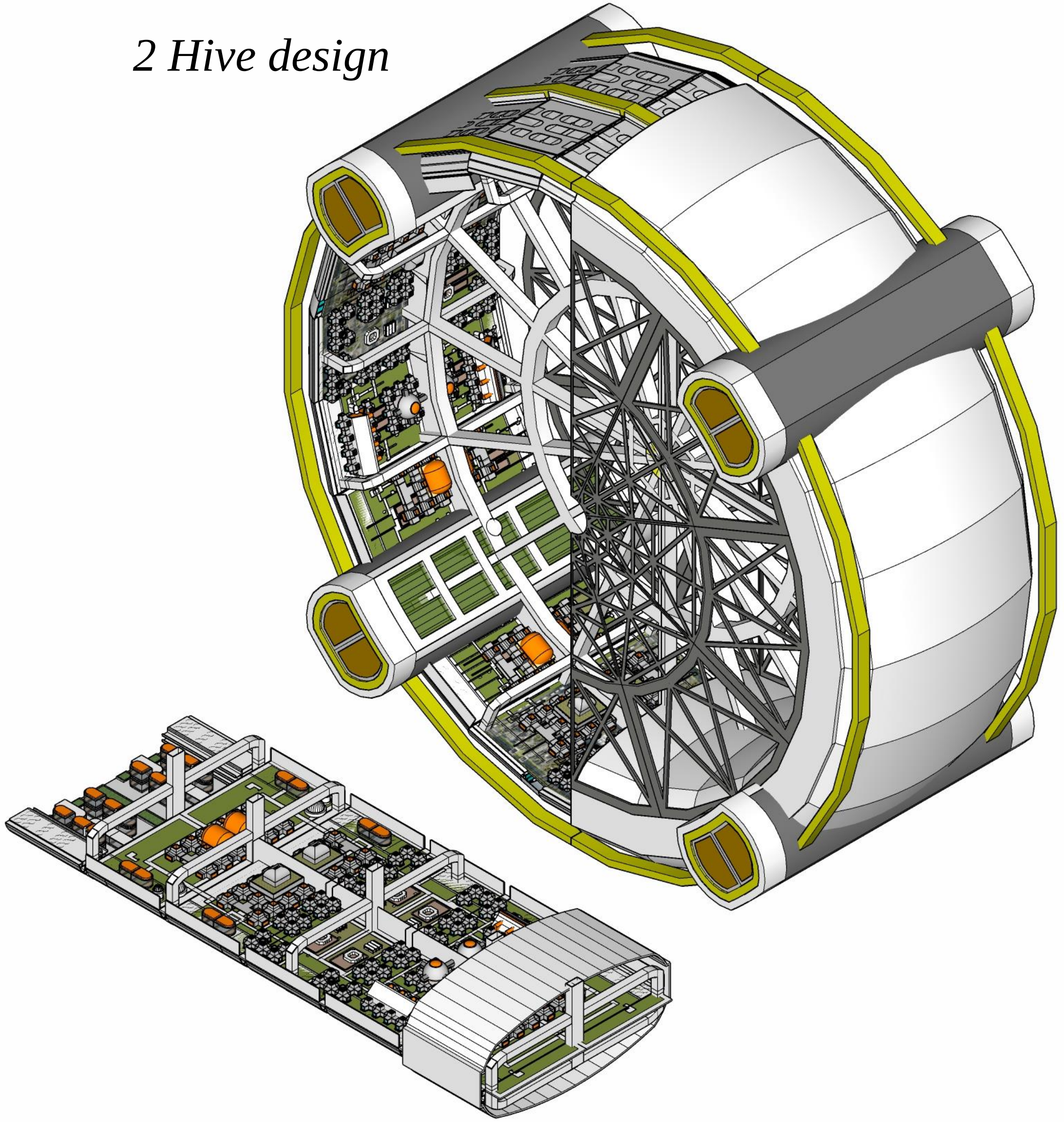
•**Level 2 - Wilderness:**

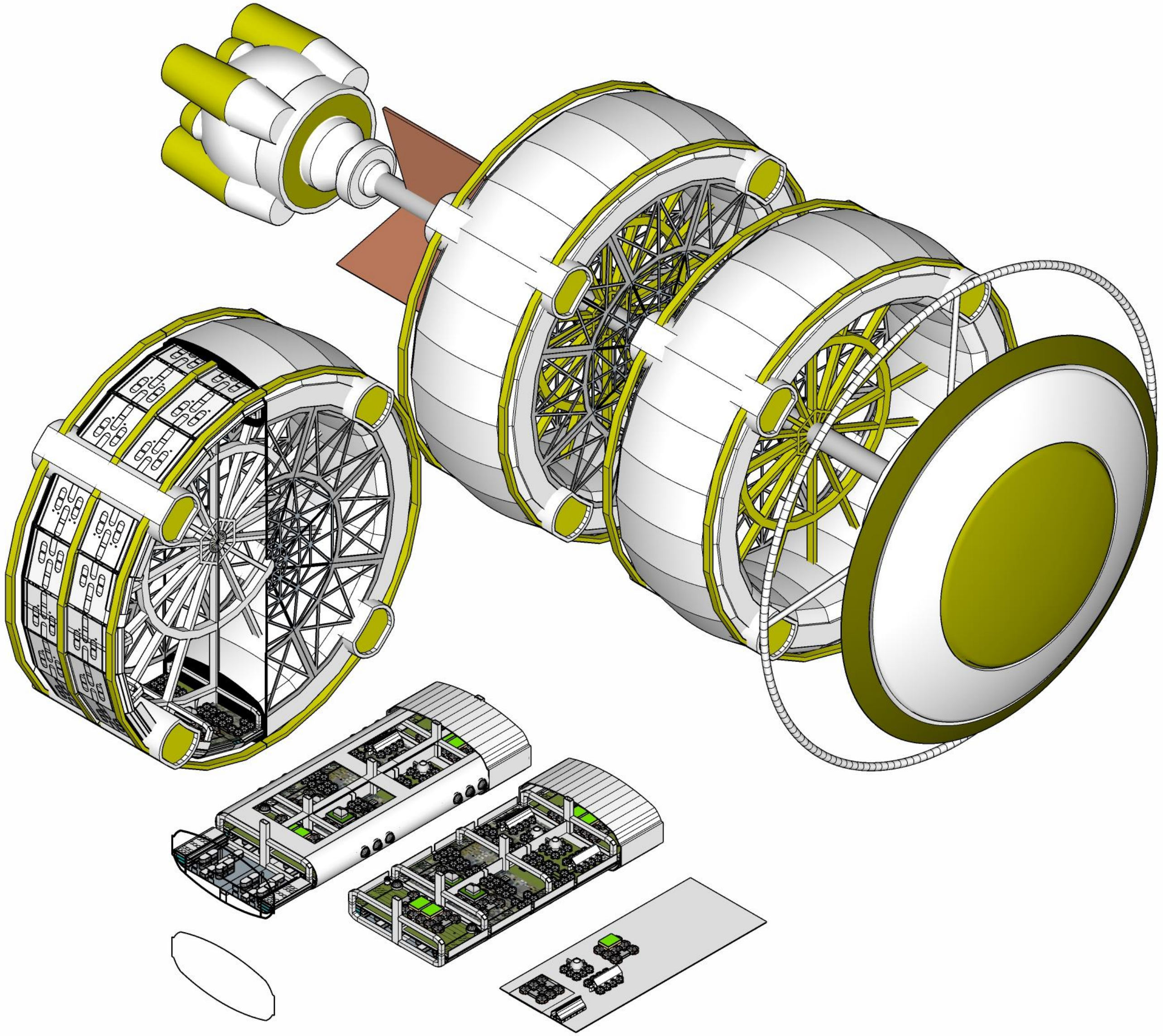
- Research building (Attached to habitat 1B5)
- Apiary
- Vertical garden
- Plant systems (CEA)
- Water Storage
- Lower aquaponics system
- Seed bank
- Observation pods



PHASE 2 REDESIGN

2 Hive design





FRAMEWORK (REVISED)

Lunar Regolith Panel: The outer layer will be constructed of regolith tiling to spaceship designers' specifications.

Framework: This outer layer will be layered with temperature collection and insulation to assist the ship's temperature control.

Fig.y See diagram of a stylized ship's structural framework

It is vital for the framing to incorporate wiring present in various levels of the ship's infrastructure. These frames act as bone and marrow, connecting both structure and services to the primary axis which will relay wires to radial elements to the fore and aft of the spaceship. The frame of the ship will extend from the regolith envelope to the structural axis. The axis is a structural base for the entire design and will be designed to account for torsion from revolving moments acting upon "axial-anchors".

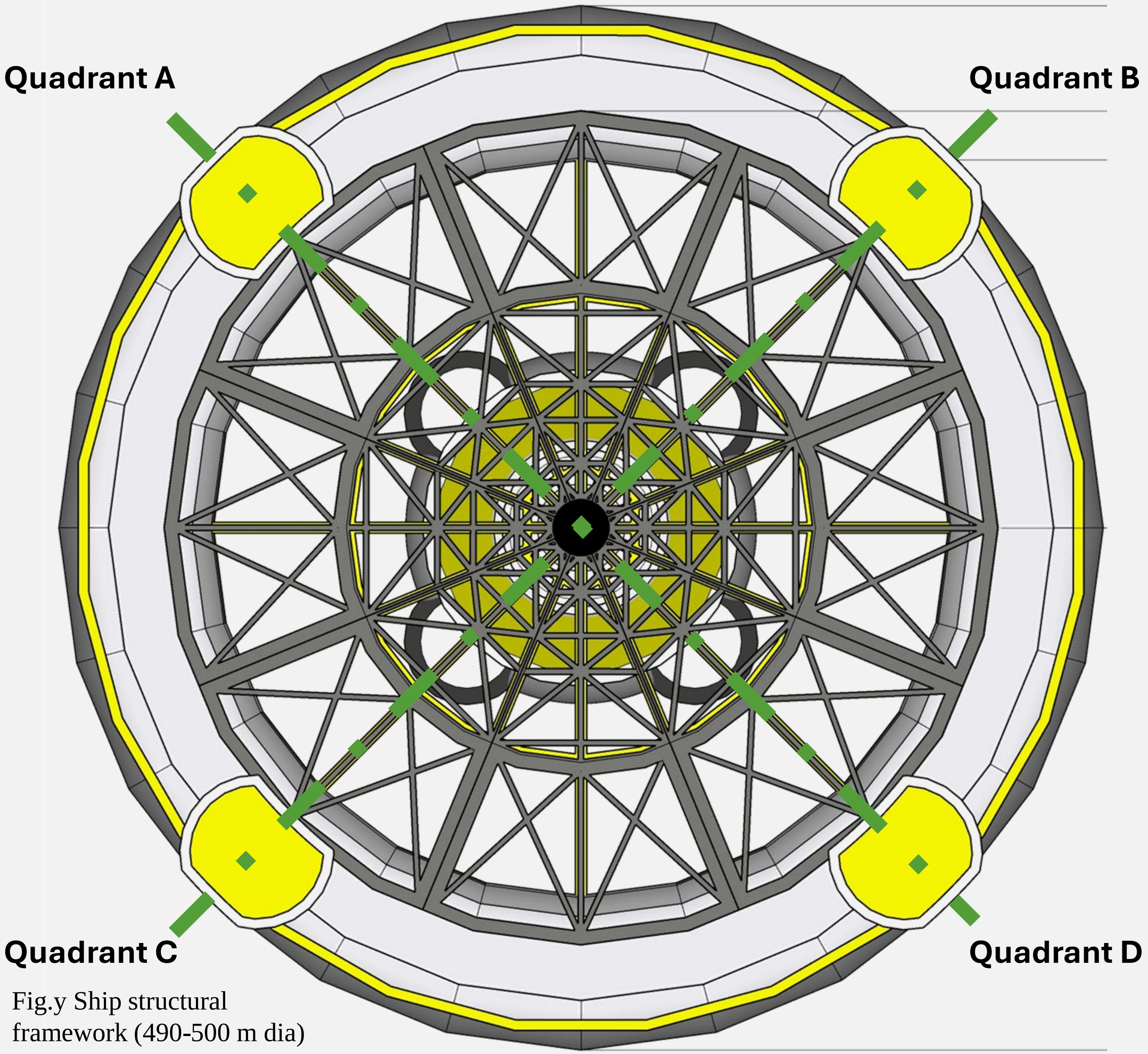
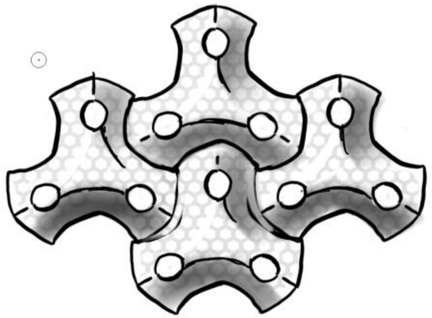


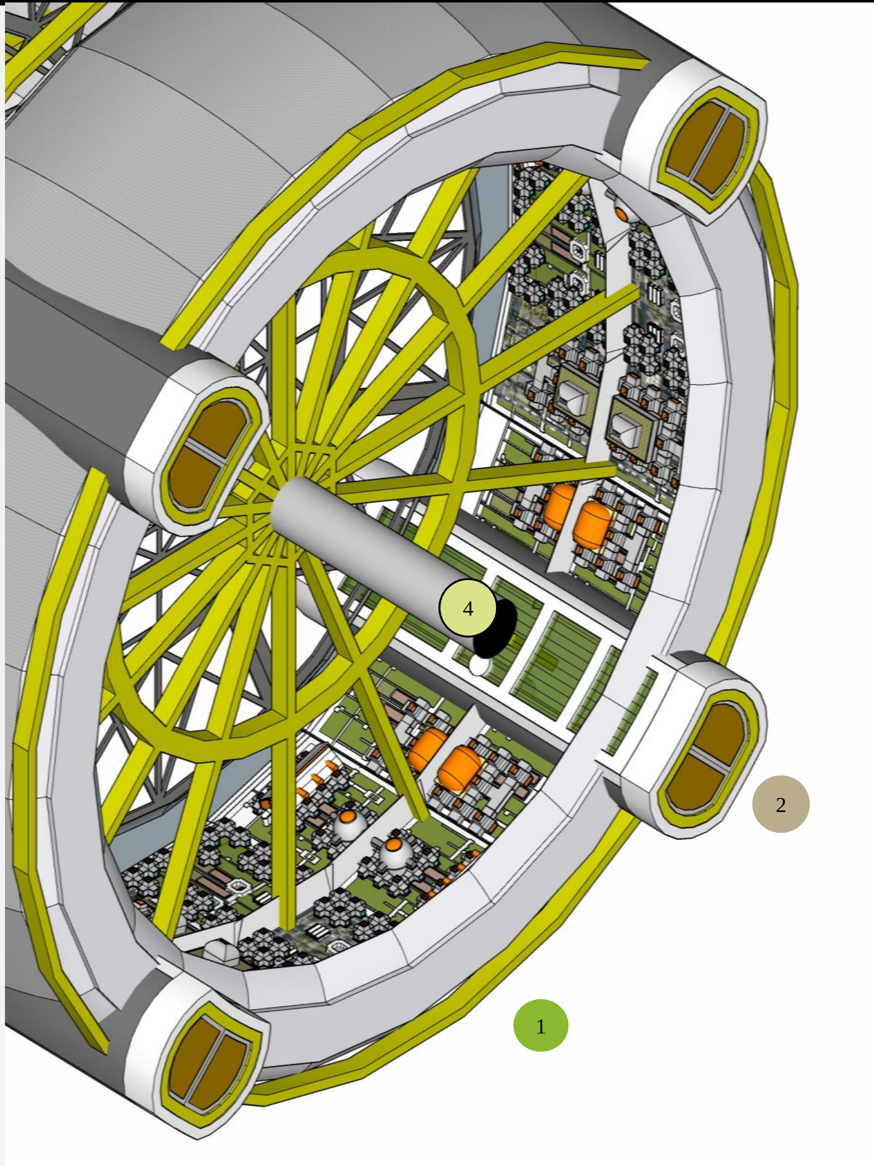
Fig.y Ship structural framework (490-500 m dia)

(b) Interlocking tile



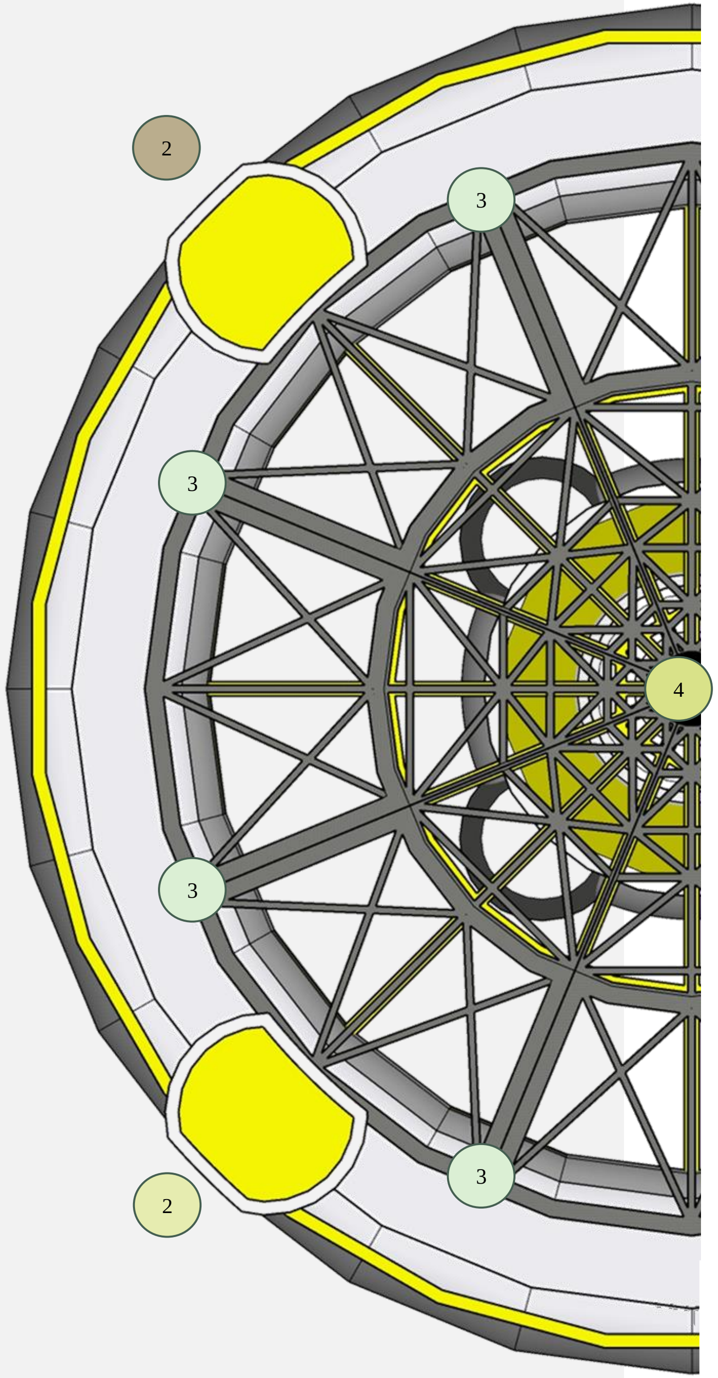
Lunar Regolith Panel

FRAME AND SERVICES



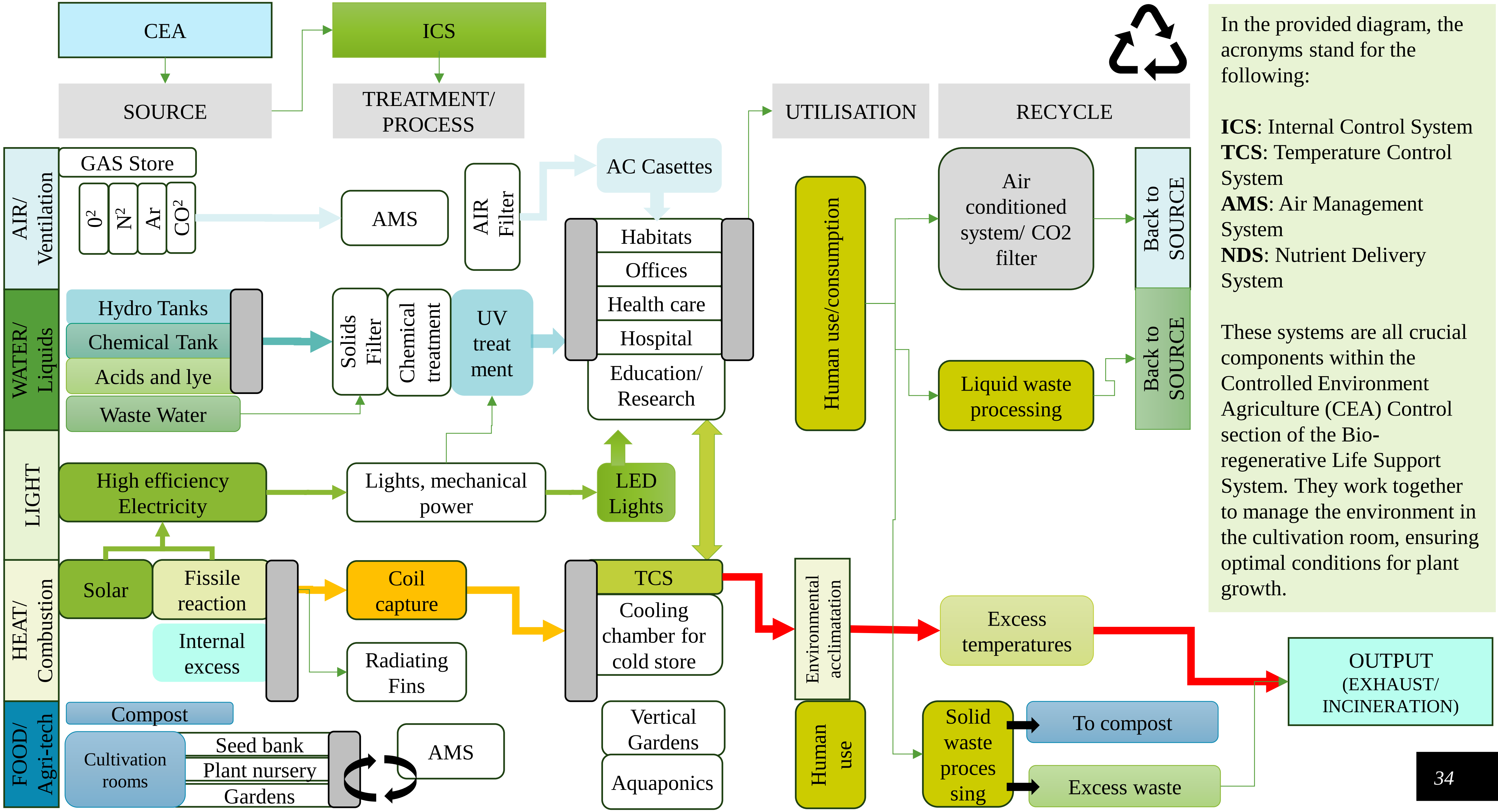
Services: Services remain present in most internal envelopes within the habitat structure. Primary service ducts run between the structural framework and the outer habitat framework dubbed "the Wilderness". Secondary and tertiary services will network between ground layers or floors, allowing the cross-shaped cuboid habitats a point to connect into a “Hive” capillary service line.

Services carried, split into dry services like gas, electricity and heating and wet services like water, black water and chemical compounds. Parcel transit may also run in service space allowing for conveyance of materials and resources between buildings and quadrants. This network of systems is broken down further in the First order Mass Budget model.



1. Hive 500 000 mm
2. Factory and store
3. Service Capilary
4. Axis “Artery” (Power and moterization)

FIRST-ORDER MASS BUDGET MODEL



In the provided diagram, the acronyms stand for the following:

ICS: Internal Control System
TCS: Temperature Control System
AMS: Air Management System
NDS: Nutrient Delivery System

These systems are all crucial components within the Controlled Environment Agriculture (CEA) Control section of the Bio-regenerative Life Support System. They work together to manage the environment in the cultivation room, ensuring optimal conditions for plant growth.

PRELIMINARY ASSUMPTIONS OF WEIGHT

HABITAT WEIGHT ASSUMPTION:

Family cell restricted to 4 modular units for 5 people.

Unit size: 4m x 4m x 4m (LxWxH)

Cell Size: module of 4
Approx 8m x 8m 3m
Or 16m x 4m x3m

Cell structure = 2,000 kg
Life support system = 500 kg
Furnishing = 500 kg
Cell module = 3,000 kg

Number of modules = 4 units

Full Habitat = 12,000 kg

:. Total Habitat = 12,000 kg x 300
= <u>3,600,000 kg</u>

Weight assumption:

1500 people / 5 People per cell
= 300 family cells

Average person weight + Personal belongings
= 75 kg + 25 kg
= 100 kg
= 100 kg x 1500 pax
= <u>150,000 kg</u>

Total habitat weight including occupants
= 3,750,000 kg
= **<u>3,750 Metric Tons</u>**

Assumption would be to split this quantity evenly across the living quarters provided.

WATER REQUIREMENTS

DAILY WATER CONSUMPTION PER PERSON

Water Usage Category	Liters per Person per Day	Explanation	Reference
Drinking & Cooking	3L	Water consumed directly for drinking and used in food preparation.	NASA ECLSS Overview: NASA Life Support
Sanitation (Toilets & Cleaning)	25L	Water used for toilet systems, waste processing, and general cleaning routines.	NASA ECLSS & ISS Data: NASA Life Support
Hygiene (Showers, Handwashing, etc.)	30L	Water used for personal hygiene such as showers and handwashing. (On long-duration missions, astronauts use no-rinse products to conserve water.)	NASA Studies on ISS Hygiene Practices: NASA Life Support
Agriculture (Food Production)	50L	Water needed for hydroponic and closed-loop agricultural systems to grow food in a controlled environment.	NASA Advanced Plant Habitat: NASA Plant Research; ESA MELiSSA: ESA MELiSSA
Miscellaneous & Losses	10L	Accounts for losses due to leaks, system inefficiencies, and water used in scientific experiments.	Estimated based on inefficiencies reported by NASA/ESA: NASA Life Support; ESA MELiSSA
Total =	**118L per person**		

Water requirements for the 250-year interstellar trip for 1,550 people.

Summary Calculations for the Generation Ship (1,550 People):

Daily Total: 118L per person × 1,550 people = 182,900L/day

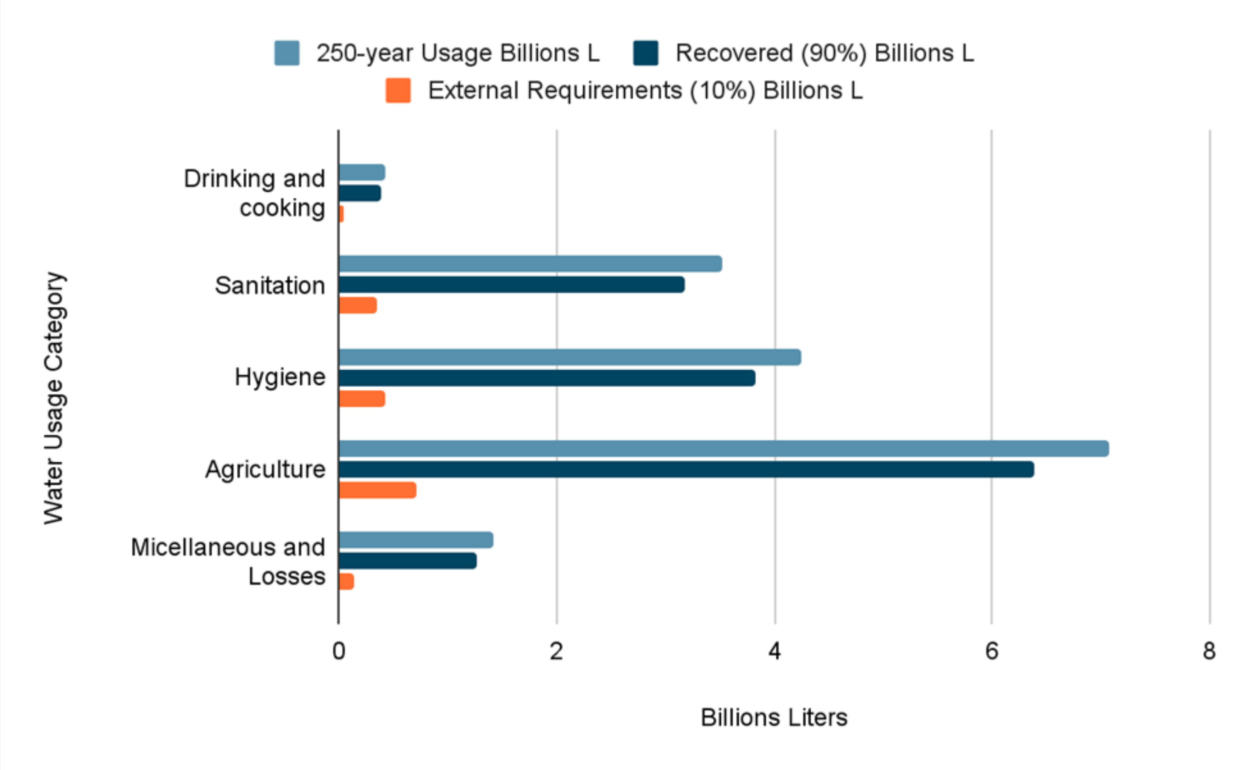
Annual Total: 182,900L/day × 365 ≈ 66 million liters/year

Over 250 Years: 66 million L/year × 250 = 16.5 billion liters (before recycling)

If this is to be stored it would be close to the habitats. It would contribute significantly to the overall weight of the habitat. Luckily this can be mitigated.

WATER REQUIREMENTS

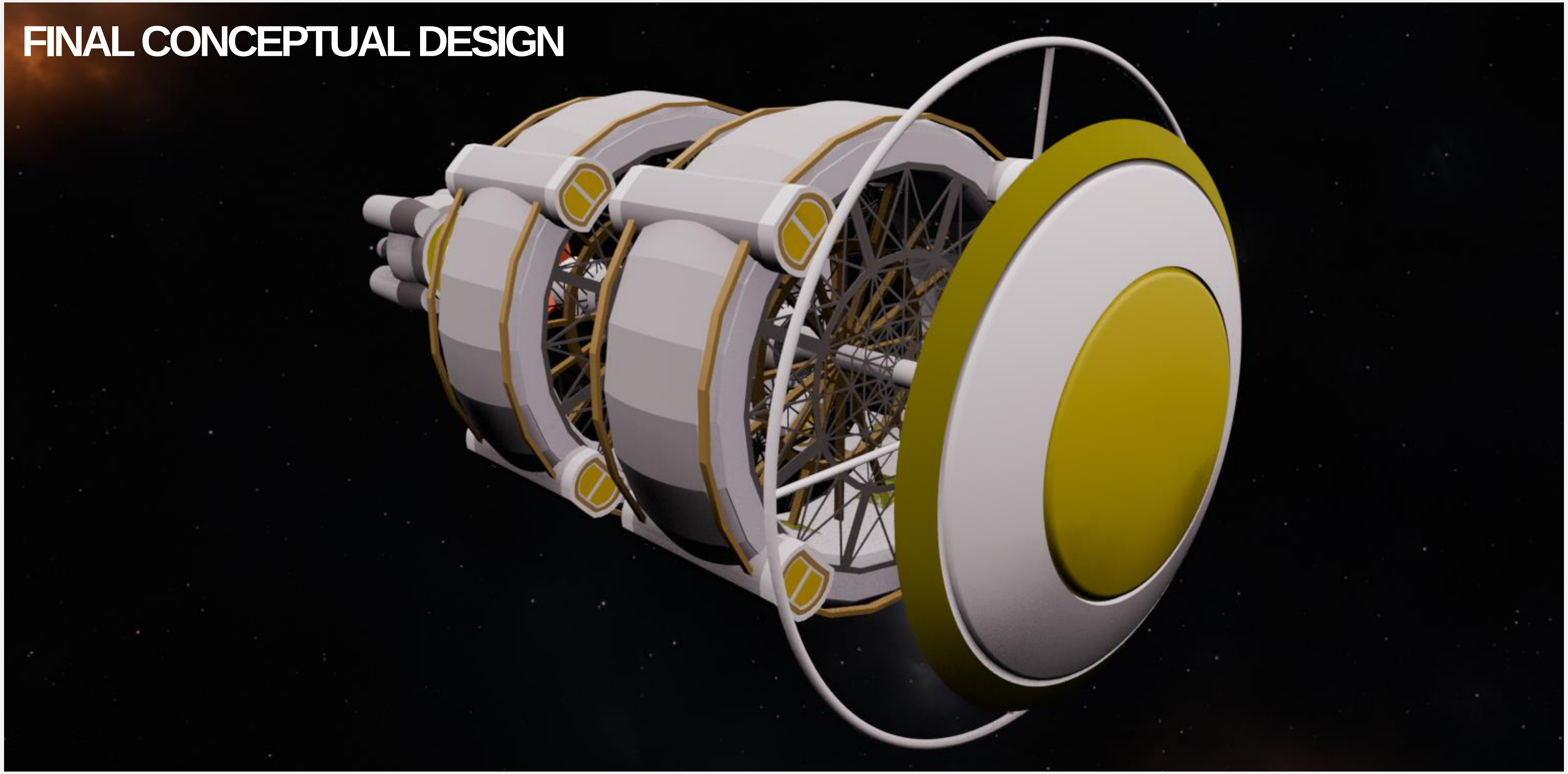
Water Recycle System: The International Space Station (ISS) employs an advanced Environmental Control and Life Support System (ECLSS) that recycles approximately 90% of the water used onboard. This system captures moisture from cabin humidity, astronaut sweat, and even urine, purifying it through filtration and distillation to make it safe for reuse

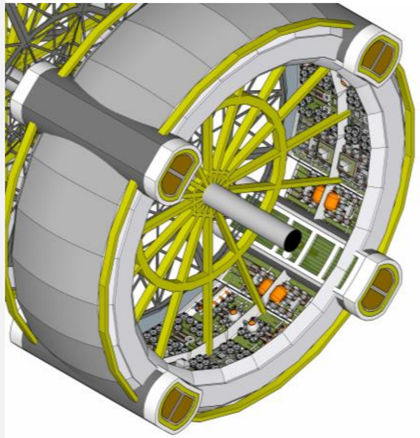


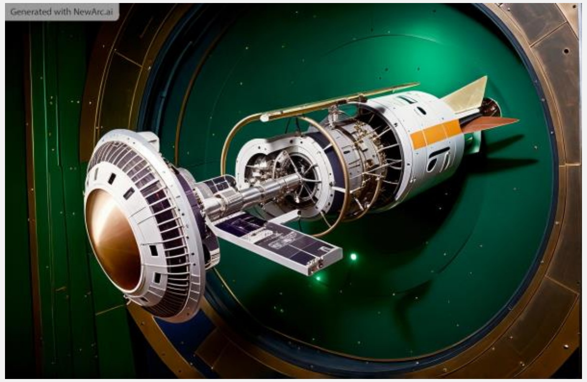
Given the ISS's proven ability to reclaim nearly all of its water, a 90% reclamation rate is a reasonable assumption for a generational closed-loop system. Over a 250-year mission. This efficiency dramatically reduces the need for stored or externally supplied water, ensuring long-term sustainability while minimizing resource depletion. With 90% Recycling: Only 10% need to be stored/replenished, ≈ **1.65 billion liters**

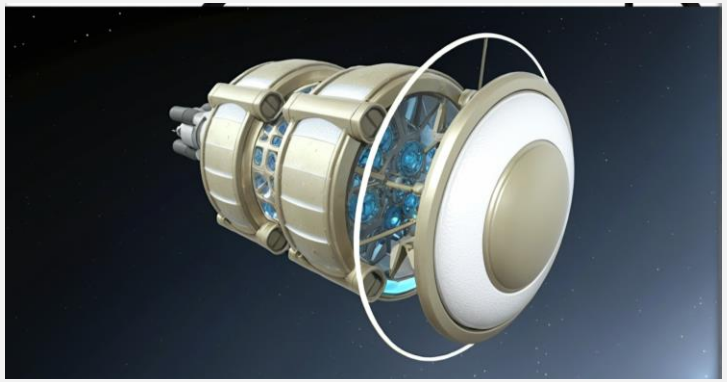
Summary: The analysis demonstrates that for a generation ship carrying 1,550 people over a 250-year mission, efficient water management is paramount. With a daily consumption of 118 liters per person—spanning drinking and cooking, sanitation, agriculture, hygiene, and miscellaneous losses—the total water demand initially appears immense. However, the implementation of a 90% recycling system drastically reduces the requirement to about 1.65 billion liters over the entire mission duration. This underscores the importance of advanced recycling technologies and careful planning to ensure sustainability on long-duration space missions. The major concern then is the safety of what water is present onboard. Centralisation should be avoided, water should be internalized under shielding as much as possible.

FINAL CONCEPTUAL DESIGN







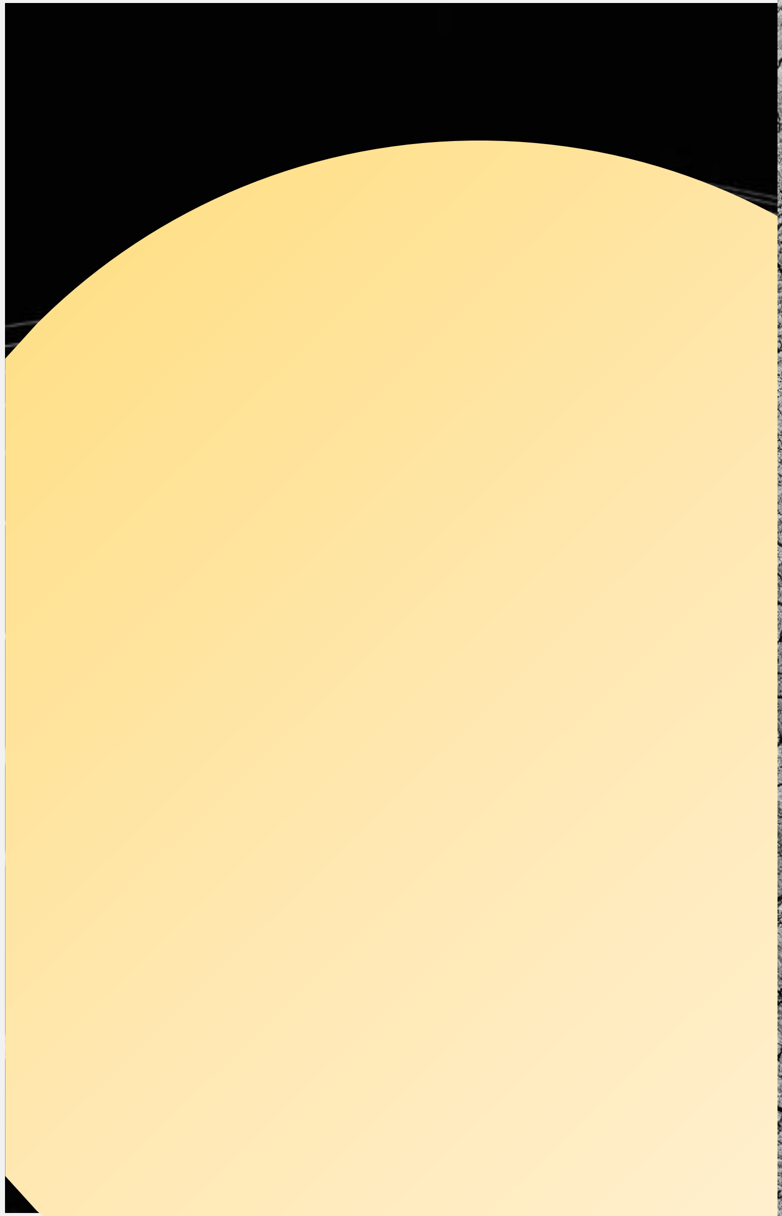


Our key takeaway from the project is a keen appreciation for the risks a generational spaceship faces embarking on a long journey into the unknown. We believe our phase 2 design manages to offer several opportunities for risk reduction. This is the driving force behind our core strategy and our hive-based compartmental modular design.

We understand the life of a space-farer on our Principium Hereditatis proposal will be challenging for the body and the soul. If our thoughts and designs make the burden of such a journey even a little bit less dire we feel we have cause for celebration.

In closing, our team would like to say thank you to the organizers of the Hyperion project for the opportunity. We have enjoyed tackling this complex problem. We hope our proposal adds another step to humanities ladder to the stars.

THANK YOU/



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