HONORABLE MENTION

Project Title	**A Zero-Gravity Habitat**
Student Name	**Zachary Meade**
Level	**Graduate**
Course	**Architectural Masters Thesis Design Project**
Advisor/Instructor	**Kurt Hunker**
Principal Investigator	**Gil Cooke**
Department/School	**Department of Architecture,** **New School of Architecture and Design, San Diego, California**

Summary description of project:

The project is a conceptual twenty-person habitat that orbits the earth. The design merges realistic limitations and conceptual ideals in order to produce an attainable organizational strategy. The form of the habitat is based on the shielding and filtering of light, the implementation of structure, and the projectile movement of users as they maneuver through the environment. The design process began with many physical experiments, drawings, and models. The final design was produced entirely in **form•Z**. This allowed for a thorough design analysis of the interiors of the habitat, as well as the creation of details such as furnishings, lighting fixtures, and structural members. Interior renderings explore the actual dimensions and quality of the habitat. The integration of background imagery allowed for the illustration of view corridors. The habitat is one of many possible design strategies of this type that may be explored. It successfully illustrates that realistic concepts for zero-gravity spaces are within reach.

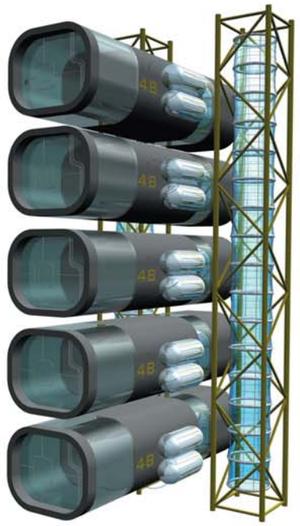
Reasons for the nomination:

This project is an outstanding introduction for architects in a field hitherto yielded to engineers and industrial designers. The execution was superior in every area in the eyes of the faculty and exterior reviewers. The project could not have been fully appreciated were it not for the outstanding computer modeling in **form•Z**. This proved the right program to delineate the very complex elements that created both the total imagery and details required to “tell the story” of a rich and artful thesis.

Architecture for Zero-Gravity

Architecture can be defined as the manipulation and organization of materials to delineate specific spaces that allow for new realities. These spaces spawn new sensory perceptions and emotions. They allow us to experience views, light, and the earth with new perspective. A simple tree house allows a child to see his own backyard from a new height. He is able to experience the leaves of the tree, the shade it casts, and the light as it trickles through the entanglement of branches and foliage. The tree house allows the child to experience what he has only aspired to experience before its existence. Such is the nature of architecture.

Gravity is an assumption that has always been a basis for architectural design. Architecture has formed over thousands of years because of this assumption. Gravity determines form, and it determines the nature of architectural space as we know it. If we take away this assumption, then it can be argued that we are able to study architecture in its purest form, this being a series of enclosures that define spaces in a three dimensional environment. This design project is a study of the nature of architectural space in its purest form. Without the constraints of gravity, architecture may grow in all three dimensions equally. There is no inherent limit to growth or difference between an arbitrary up, down, left, or right. Structures on earth are in the most basic sense a series of thrusts against the forces of gravity. Conventional architecture, then, is composed of materials that desire to be at rest. A building, however, is never at rest. It is in constant conflict with gravity. A building's components are in a constant struggle to return to their natural state of rest. This presents an optimistic view of design for zero-gravity. Structures in a weightless environment may become more natural, more organic; there is conceptually less strain on them to prevent growth. When we free architecture from the constraints that topography and gravity place on it, we see the generation of forms that result only in and of themselves and the functions that they serve their users with. Without these constraints and without the imposition of a predetermined orientation of form, architecture becomes a malleable instrument to serve human life in an artificial environment. Simple programmatic principles are pursued to their fullest potential; plan becomes section and section becomes plan. Adjacencies are realized, circulation paths conform to the human body, and new types of spaces emerge that take advantage of the attributes of zero-gravity. New architectural relationships are formed. These are but a few of the potentialities that exist in the design of spaces in a zero-gravity environment.

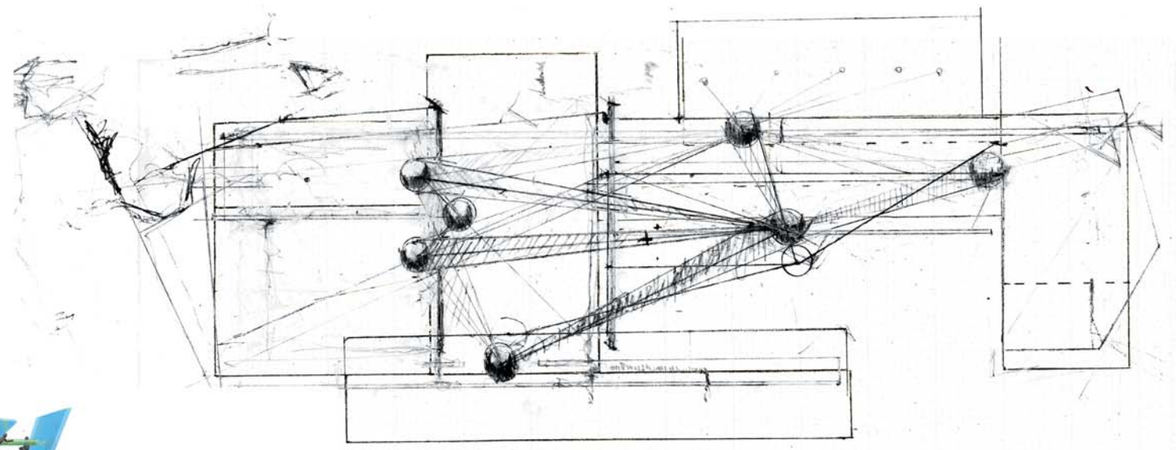


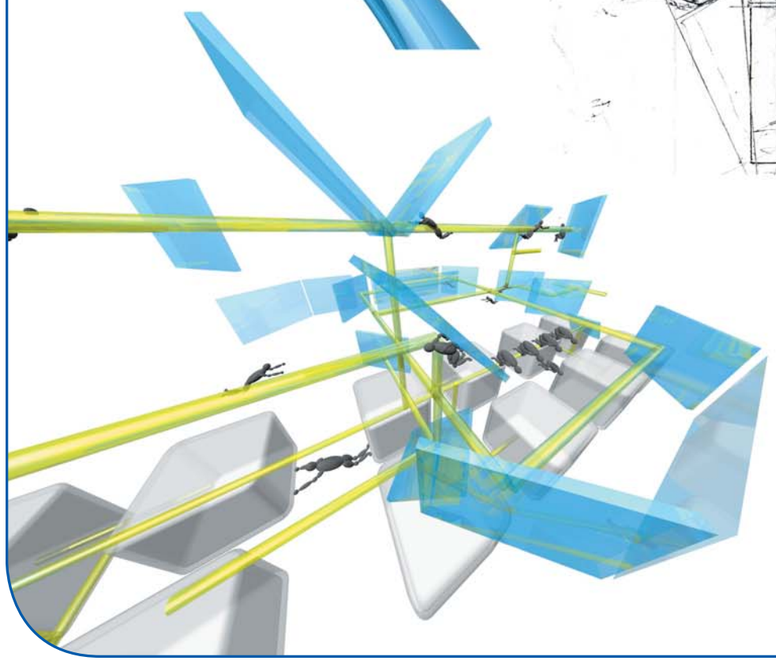
Problem Statement

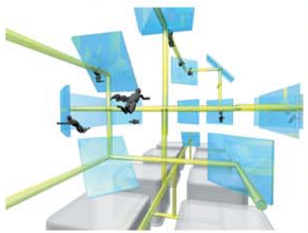
The design of spaces that are to exist primarily outside of the reach of the earth's gravitational pull has been pursued by a wide variety of architects, developers, and space agencies. The vast majority of the design work that this research produces consists of habitats that derive their forms from limitations. These limitations include funding, technological restraints, the implementation of life-sustaining systems, bureaucratic obstacles, and a general apathy towards space colonization that is displayed by a large percent of the world's population. Though many of these limitations exist as a result of logistics, most widely publicized zero-gravity habitat designs that exist in reality and concept are creatively stumped by them. These designs become functions of the limitations that inhibit their full development. The result is often a series of repetative modules that attempt to house differing functions in an antihuman arrangment of synthetic forms. An anti-aesthetic emerges which subjects humans to exist within the confines of an artificial cage.

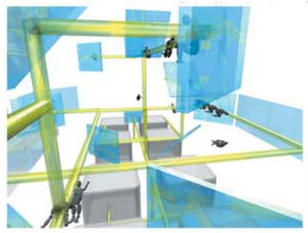
Thesis Statement

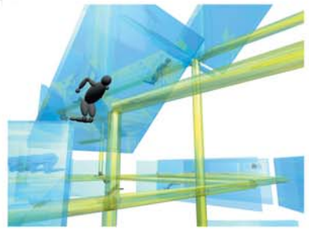
Despite the reality, conceptions of how spaces in zero-gravity ought to be designed in an ideal situation should exist. These conceptions allow us to maintain a fixed object towards which we can drive our research and design processes. The purpose of this thesis will be to address this challenge with the schematic design of habitat in a zero-gravity environment set in low earth orbit (LEO). The hope is that by presenting a conceptual framework that exploits the exciting potentials that exist here, design processes will be influenced and full conceptions of what architecture can provide for this challenge will emerge.

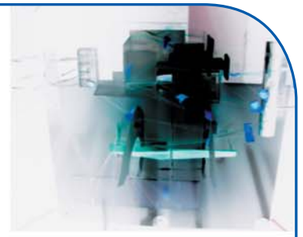


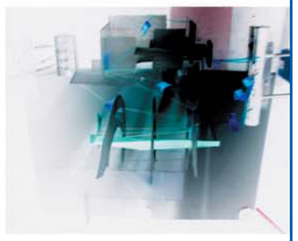


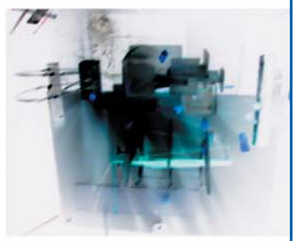


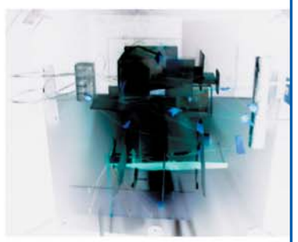


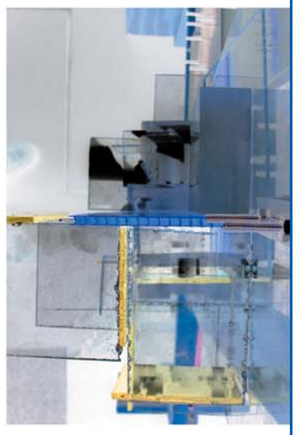












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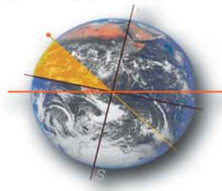
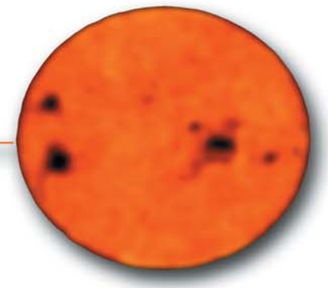
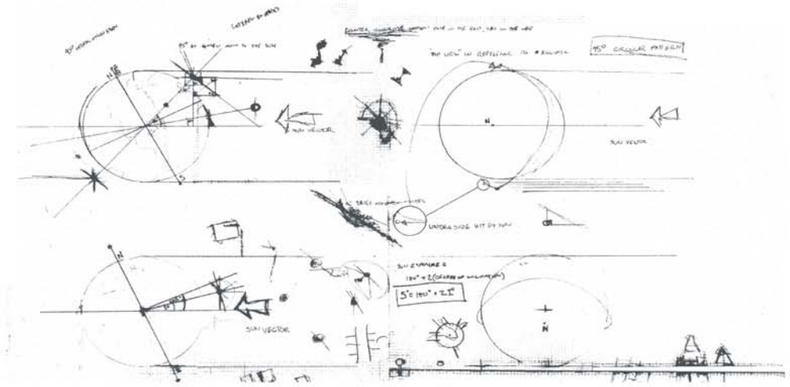
The Site and Design Ideas

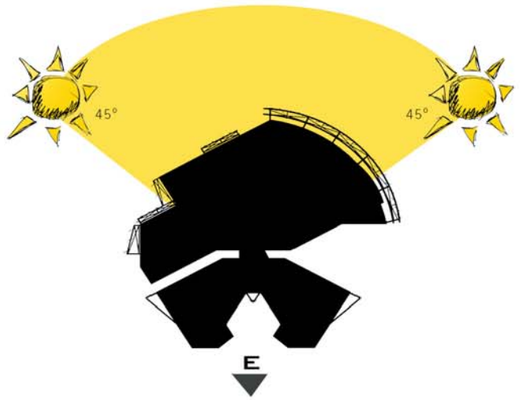


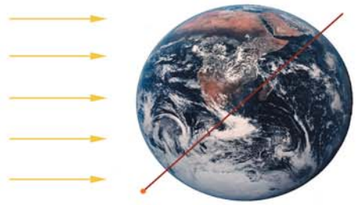


The site for the thesis design project is earth's obit at an inclination of 45 degrees (the vertical angle taken from the plane of orbit around the sun) and at a height of 350 miles. Since the earth rotates at an angle of 23.5 degrees with respect to the sun, thus structure will orbit at an inclination of 21.5 degrees from the equator. This will allow for approximately 90 minute revolutions around the earth. This means that there will be consistent and sequential sunsets and sunrises every 45 minutes. This orbital inclination allows for a broad range of earth views, and will made calculation of a sun path uncomplicated. Since the earth's diameter is over 7,000 miles, the structure is relatively close to the earth. Views to earth are beautiful and vast, and are exposed whenever possible. A symmetrical arrangement of spaces ensures that the the structure's placement will remain constant within its orbital path. One side of the structure will always face the earth, and one side will always face away from the earth.

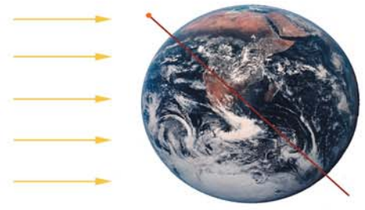
Simple geometry was used to identify the sunpath. From this, a simple algebraic formula was also developed that allows for an orbiting object's sunpath to be identified if its orbital inclination is given. It can be simply illustrated that the full sun exposure to an orbiting object over the course of the year is twice the degree of orbital inclination of that object. This range of exposure is centered on the objects vertical in relation to the earth. The sunlight that reaches an orbiting object is just as bright as normal daylight, but because of the accelerated periods of light and dark, it is not be considered as a consistent source of lighting for interior facilities.



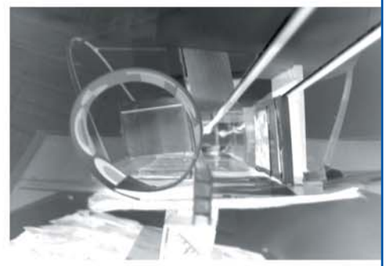


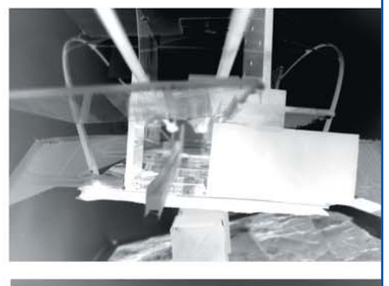


summer solstice

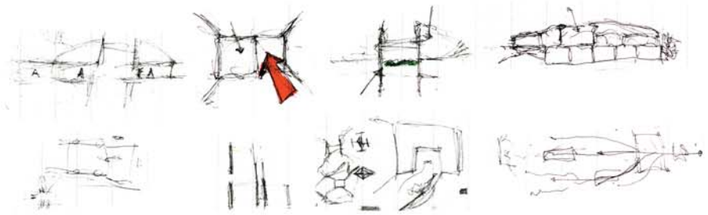


winter solstice





The thesis design project is a small habitat capable of supporting 20 people for periods of up to three months. The users of this habitat exist only to experience a zero-gravity environment. Living spaces as well as spaces for conducting research are included, but the purpose of the users in the habitat is left intentionally vague. The habitat contains everything that the users need to live, as it will be the only environment that they experience during their stay. Ideas about the actual use of space within a zero-gravity habitat were explored with the design of "furniture" fixtures which allow for user-control and maximize the versatility of the environment for the user.



rotating dining chair

observation chair

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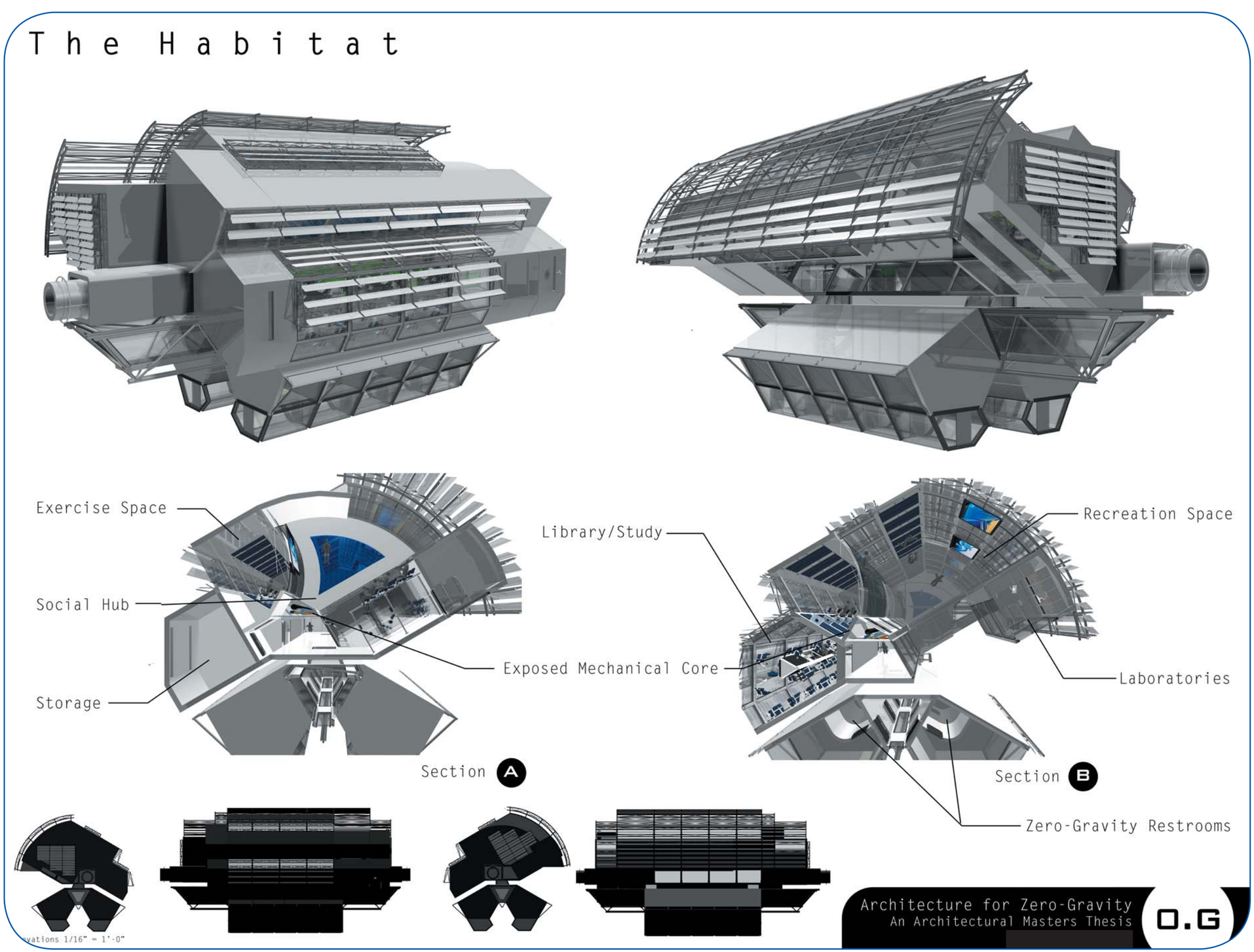
Jury comments:

The project premise is utterly captivating. The notion of architecture without gravity, and as the designer proposes, without technological or logistical limitations, would have been very interesting.

However, despite the claims made in the project narrative and nomination statements, the project falls short on many accounts. Firstly, the notion that there is an “ideal case” without limitations of any sort other than the absence of gravity would have been interesting if the designer took a Stanley Kubrik-esque stance. There can be no architecture without constraints. Choosing the right set of constraints would have led to a better design project.

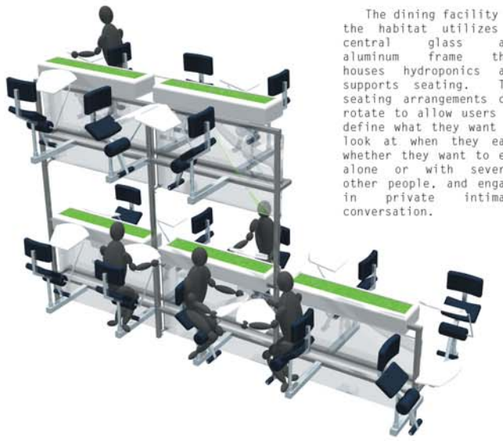
Moreover, the notion of “idealness” has not been defined either in the narrative or in the manifest form of the project. Many key questions remain unanswered. How would a transportation system such as a space shuttle dock with this station? Although the designer makes an “aesthetic” argument, the end result is utterly uninspiring. Digital medium would have been the “ideal medium” to explore zero gravity! But in the absence of the “gravity of constraints,” the project falls flat and fails to fulfill the promise made in the narratives. **–Mahesh Senagala**

A thoroughly detailed design—well thought out, and beautifully presented. **–Ruth Gless**



Specific Design Strategies

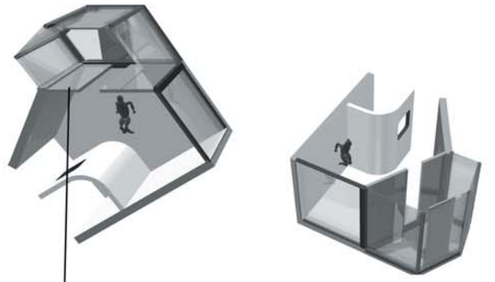
Dining Facility User-Defined “Seating”



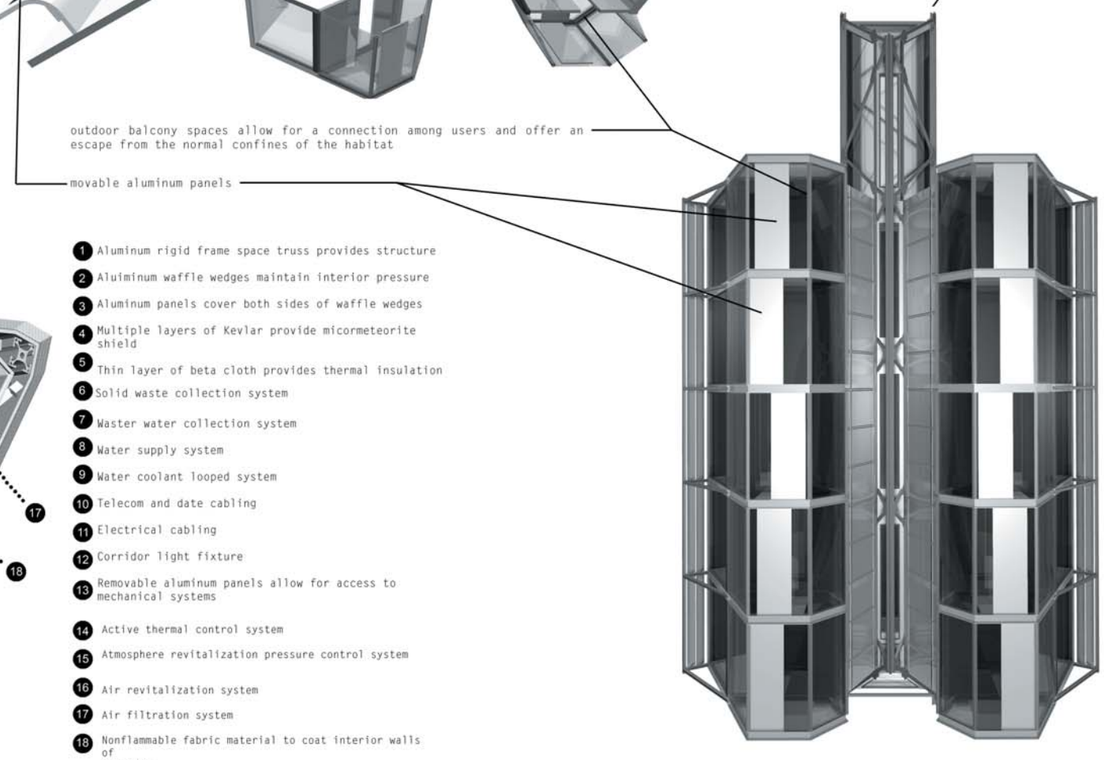
The dining facility in the habitat utilizes a central glass and aluminum frame that houses hydroponics and supports seating. The seating arrangements can rotate to allow users to define what they want to look at when they eat, whether they want to eat alone or with several other people, and engage in private intimate conversation.

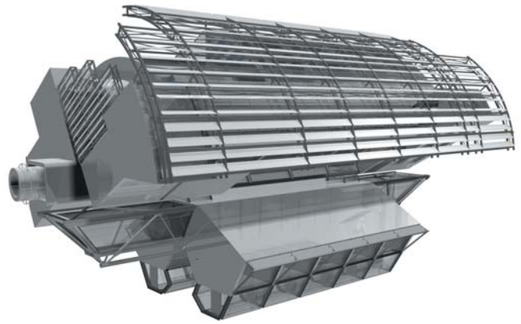
Residential Nodes -Varying Orientations

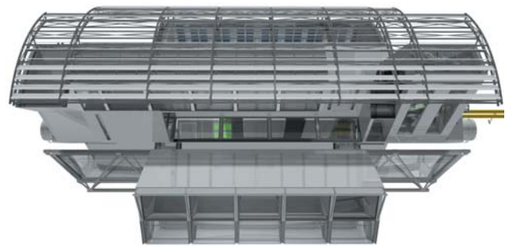
The ten residential nodes in the facility have been designed so that their forms can be utilized in many possible orientations. These, the most private spaces in the facility, become totally user-defined. Inhabitants decide how they wish to view the earth from their private windows. Movable aluminum panels help accomplish this goal, and attempt to create entirely unique environments. "Outdoor" balcony spaces completely surrounded by glass allow the users to escape form the confines of the habitat.



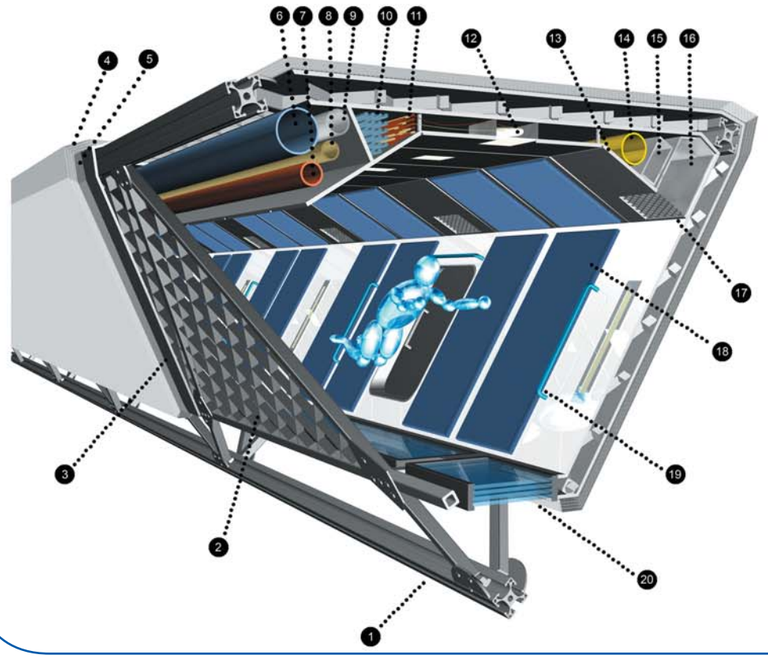
At the ends of the corridor, the mass opens up to reveal the structural delta truss beneath, and allows the user to float effortlessly over the earth.







Residential Corridor Section - Exposed Portion



1. Aluminum rigid frame space truss provides structure
2. Aluiminum waffle wedges maintain interior pressure
3. Aluminum panels cover both sides of waffle wedges
4. Multiple layers of Kevlar provide micormeteorite shield
5. Thin layer of beta cloth provides thermal insulation
6. Solid waste collection system
7. Waster water collection system
8. Water supply system
9. Water coolant looped system
10. Telecom and date cabling
11. Electrical cabling
12. Corridor light fixture
13. Removable aluminum panels allow for access to mechanical systems
14. Active thermal control system
15. Atmosphere revitalization pressure control system
16. Air revitalization system
17. Air filtration system
18. Nonflammable fabric material to coat interior walls of corridor
19. Handrails spaced at even intervals allow for movement
20. Window system composed of four panes: one scratch window (interior), two pressure windows, and one debris window (exterior)

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