HORIZON

by

Reggie Wade MacIntosh

A thesis
presented to the University of Waterloo
in fulfilment of the
thesis requirement for the degree of
Master of Architecture

Waterloo, Ontario, Canada, 2010

AUTHOR'S DECLARATION

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

ABSTRACT

THIS thesis proposes the design of a space exploration vessel capable of sustaining a community of 2000 inhabitants that will leave Earth and never return. The unique mission criteria will allow for the in depth study of fundamental architectural issues such as confinement, permanence, habitability, and wellbeing. The vessel, named *Horizon*, will address the social, cultural, and environmental systems necessary for maintaining a platform for an evolving community. Emphasis throughout the thesis will be placed on the human condition and social systems rather than technical details and specifications of the ship's construction. A human settlement travelling through the void of space and severing its ties with Earth creates an intense design challenge. How can architecture create a stimulating and humane environment without a traditional sense of site or any of the Earthly conditions that can influence memory, stimulate growth, and sustain culture?

The final presentation of the thesis will take the form of an illustrated narrative. This form of representation will allow for the blending of fact and fiction, producing a narrative in the tradition of science fiction that will explore the architectural implications of giving shape to a finite environment and its impact on the complex and ever changing lives of the inhabitants over successive generations. This thesis examines the implications and limitations of space travel but also casts light on our terrestrial understanding of the roots of architectural thinking.

ACKNOWLEDGEMENTS

A thesis is far from being a solitary task. To meet the massive challenge it puts forward requires a team (or in my case, an army) of the best, the brightest, most compassionate and experienced people possible. In the past two and a half years, many people have helped me to craft my very broad hypothesis into the final story I wanted to tell. I would like to take this opportunity to thank those people who were integral to the writing, illustration, and completion of this thesis.

First, I would like to thank my committee: to my supervisor, Andrew Levitt, for always being on the same page as me, if not a page ahead, throughout this story; to Robert Jan Van Pelt, for sending me down the path of ritual; and to Terri Meyer-Boake, for her enthusiastic knowledge of graphic novels, set design, and science fiction. I am eternally grateful for your guidance but more importantly, your willingness to work with me throughout this endeavor, trusting my instincts and having faith in my decisions. I would also like to extend my gratitude to my editors, Lauren Barhydt and Rebecca Zehr. Were it not for your careful eyes and minds like razor blades, this document would have overflowed with semicolons.

To my family, I want to express my unending love and gratitude. It is because of your love and support that I am able to move through life with confidence, strength, and compassion. Thank you for the occasional escapes to the sanity of home, the pep talks when I'm falling to pieces, the understanding when I'm speaking in riddle, and the support I needed throughout my education. Thank you for everything you've done for me; I only hope that I can do the same for you.

To my friends, on whom I've leaned heavily through university and well before; I cannot imagine life without your generosity and humour. Your tolerance for my flaring temper, obnoxiously loud voice, and often inappropriate choice of words is admirable to say the least, but from the very first days of knowing each of you, I have felt accepted, imperfections and all. In return, you have my love, my loyalty, and my will to pull laughter from every bone in your body… by any means necessary.

Finally, I want to thank my mother, Brenda Joyce MacIntosh (née Evans). Though I know she will never be able to read this, I want everyone to know just how much she means to me, and that my heart breaks every time I remember that she is gone.

DEDICATION

Earl Evans, **"Mother, Daughter, Father,"** *from a photograph* (Year Unknown), Author's own.

To those inspired by space and its infinite possibilities, to my family, and to those who left all too soon; I dedicate this to you.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

All images by author unless otherwise noted.

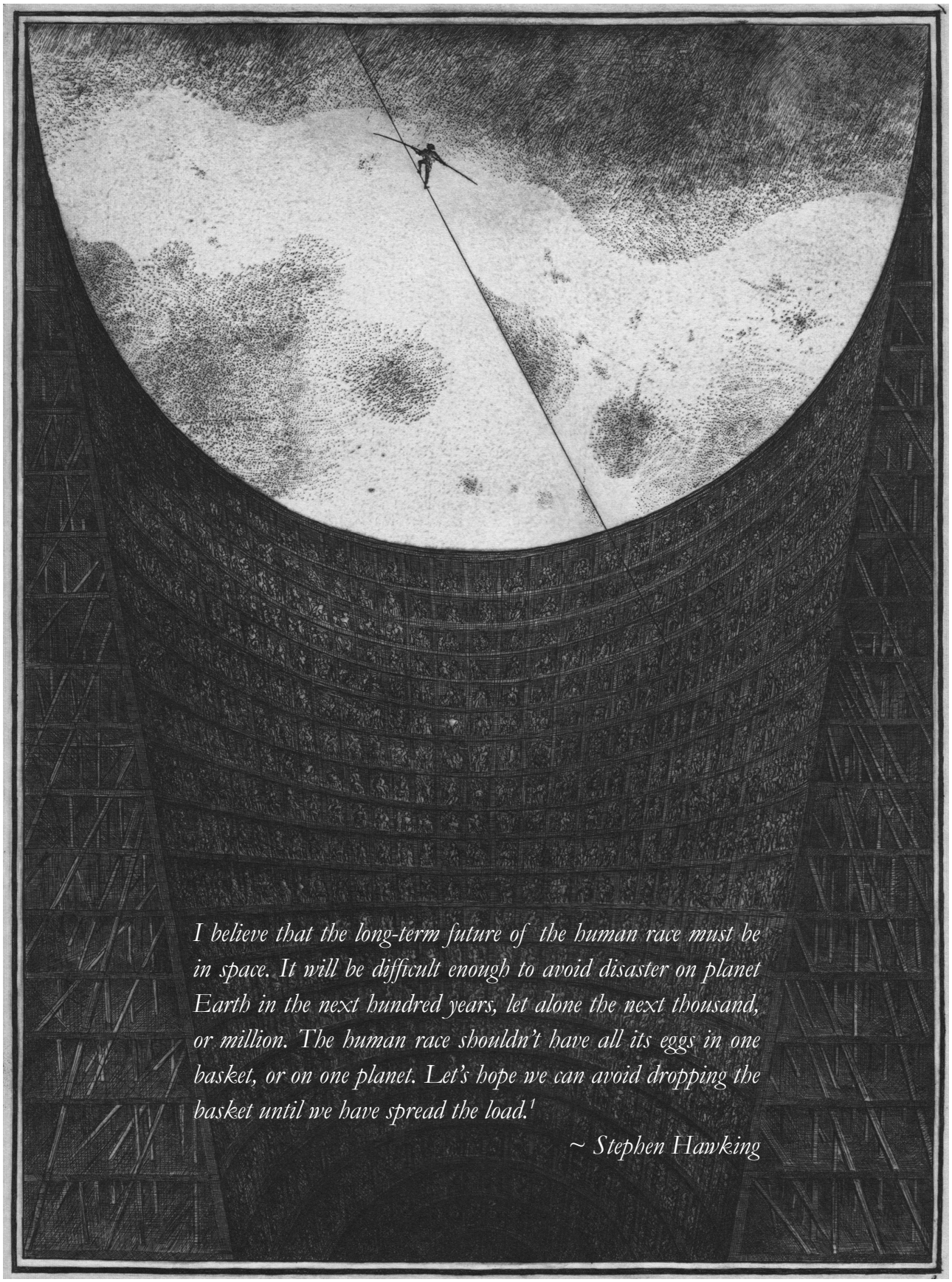


Fig. 1 ~ **Untitled (Amphitheater)** *by Brodsky & Utkin (1989/90).*

INTRODUCTION

"Space Pods... I'll make *Space Pods*!"

SITTING at the back of a darkened lecture hall, our school's director confronted my class with the question, "What will your thesis be?" The words above floated smoothly through my mind like a space ship that coasts in the silence of its planetary orbit. I'm not sure if I totally understood what I was thinking of at the time but I felt somehow that there was definitely a place for Space in Architecture, and Architecture in Space.

Not as simple a task as I had originally anticipated; that lecture was almost four years ago. Much has happened in the short period between the completion of my undergraduate degree and now. As I sit and type the beginning to the end of my university career, I look out from my office window at the frozen Grand River illuminated by the uneven pairing of the Wolf Moon and Mars, shining brightly to its left, and I listen to *The Blue Danube* for the umpteenth time. I think back to all the things that have had so much bearing on this thesis.

I am a space cadet. At the desperate urgings of my sister and I, my family did the *Star Trek Experience* while at *Disney World*; I played the Vulcan First Officer. I have touched two out of the three Moon rocks on Earth that can actually be touched by the public, and I participated in the International Space University's Summer Studies Program at the NASA Ames Research Center… Alright, it was adult space camp[2]. Just thinking about space, of its incomprehensible vastness and infinite mysteries, makes my jaw drop in wonder at all that we don't know. The immense void of space compels my curiosity.

My fascination with the cosmos began with the television and film that I watched from a young age: of *Star Wars*, *Alien*, and the idyllic societies depicted in *Star Trek: the Next Generation*. But when the television was switched off, I found that my imagination could be taken even further by the fictions on my bookshelf.

The ancient alien ships of the Frederik Pohl's *Heechee Saga* were the salvation of mankind. The story of *Nightfall* by Isaac Asimov recounted the disastrous reaction of an alien culture to the setting and eclipse of all six of its suns for the first time in two-thousand years. Mathematician and science fiction author Stephen Baxter brought life, excitement, and believability to his meticulous writings of galactic conquest through his academic background. And, of course, the story of Dave Bowman, in Arthur C. Clarke's *2001: A Space Odyssey*, whose journey beyond space and time is perhaps one of the most frightening and stirring stories of this century. Science fiction has always been a staple in my library, not just for the fantastic nature of its subjects or settings in space, but because the stories were always about

people. They were about the interactions and relationships between people, as single entities facing some unknown, or within the spectacular and foreign situations that they were cast. This sense of adventure, the untold stories, and the discovery of the unknown achieved through exploration have always been central to my interest in space.

Before enrolling in the Masters of Architecture Program, I spent time talking to other people, friends, co-workers, other professionals, and anyone else interested in listening to my ideas of the future, society's thoughts on exploration and the space industry. I spoke to them informally and in hopes of understanding the views of people without an architectural or a scientific background. In most conversations my opinions were met with interest and optimism. My proposition was to launch a small population into space with no plans or provisions to return to Earth, the idea was intriguing but also

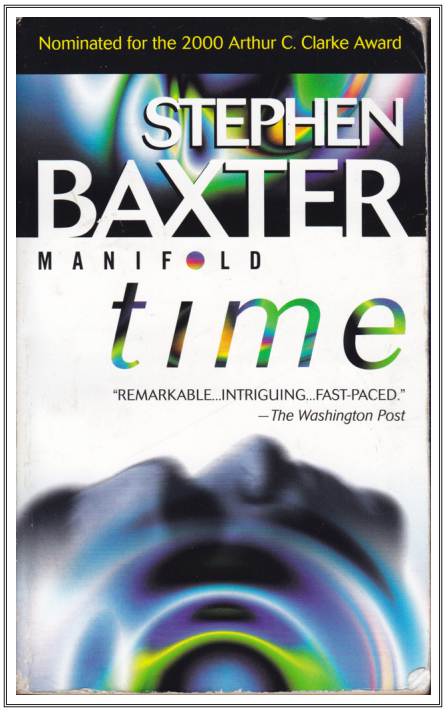


Fig. 2 ~ **Manifold Time** *by Stephen Baxter (2000).*

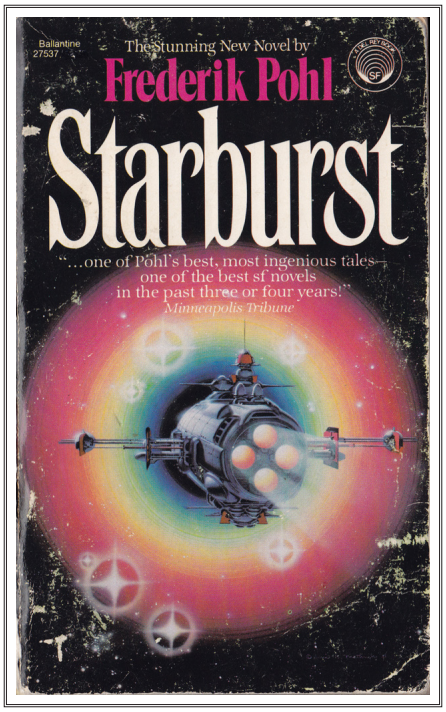


Fig. 3 ~ **Starburst** *by Frederik Pohl (1982).*

proved to be controversial. Initially, I had been explaining the thesis as a kind of "Plan B", another option for humanity if and when everything on Earth goes to hell. But the questions that this proposal elicited suggested that my ideas to were not entirely convincing. The most common response I got was, "What about the problems here and now? Why would we put so much energy into leaving the planet when we could be focusing those resources on fixing the global crises we face every day?" My viewpoint was seen as selfish, hedonistic, ignorant of current events, and appeared to turn a blind eye to the struggle for survival that the Earth's population faces. Though I wasn't willing to abandon the underlying concepts of the thesis, I was well aware of its hedonism and frankly I enjoyed that aspect of the idea. But, I knew that I had to rethink my approach in order to create a thesis that was not only of interest to me, but that also addressed universal issues in a world quite unlike

anything we know today. In a place where no one can "run away" from his or her problems, the proposal would have to deeply consider current issues of society; issues of tolerance, ritual, privacy, monotony, health, well being, and so many more. All would have to be considered in order to sustain culture within the finite environment of a space ship. To consider an idea such as this is to examine culture, attempting to learn from its past, present, and its future plans, and to take further leaps into imagination. This thesis does not propose to "run away" from problems; this thesis proposes to push outward in order to explore, to better understand ourselves and our universe, and to reap the benefits of that great journey.

Once I began my Master's Thesis, I dove into the problematic aspects of isolative conditions that I was proposing for the crew and inhabitants of the vessel. I looked at examples of habitats from the National Aeronautics and Space Administration (NASA), Biosphere 2, and ICEs (Isolated Confined Environments) from Arctic and Antarctic research stations. I attempted to establish an understanding of isolation, of countermeasures to take against isolation related health matters, of selection criteria for crews, and of design specifications to aid in the acclimation and adaptation of the crew to new restrictive habitations. All of these precedents were a wealth of knowledge provided by decades of accomplished research and the success stories that have made the scientific field so exciting and adventurous. However, none of those examples addressed the challenge of permanence. They were examples of space dwellings, built to be temporarily occupied by small crews who would rotate in and out of service over the course of a few short weeks to stays as long as a year. No space agency or research center ever intended these spaces to be inhabited for someone's lifetime, or for the lives of the generations to follow.

It was at my final review of my first semester in Masters that someone asked, "If you are so interested in isolation, why don't you design a monastery?" Indeed, a monastery is a place where someone lives in a tight knit community, almost entirely self sufficient, while completely isolated from the outside world for the rest of his or her days. Of course, no matter how deep a person's faith went, there was always the option of abandonment, of quitting the confines of the monastery's high walls and stepping back into the folds of society. That is not an option in space. Also, I didn't want to design a monastery. But I began to see the importance of a place like a monastery or convent, how the people inside do not simply cope in its remoteness from society, but are nourished by its isolation and are comforted by their personal faith, safe in the knowledge that their work is truthful to their cause and in the name of something far greater than themselves. The importance of *ritual* and *faith* within these houses is what preserved their existence through centuries of piety, worship, labor, and silence. Time is the issue to challenge in seclusion and likewise, on an unending voyage through space. And by studying the chosen solitary lifestyle of a monk, I started to understand what existence might be like as the distance between my imaginary population and the Sun grew over time.

This thesis does not claim to be the single solution to any worldwide issue of humanity's struggle for peace and harmony. It does not propose to be economical nor environmentally sustainable, especially considering that it would require launching millions of tons of material into outer-space, never

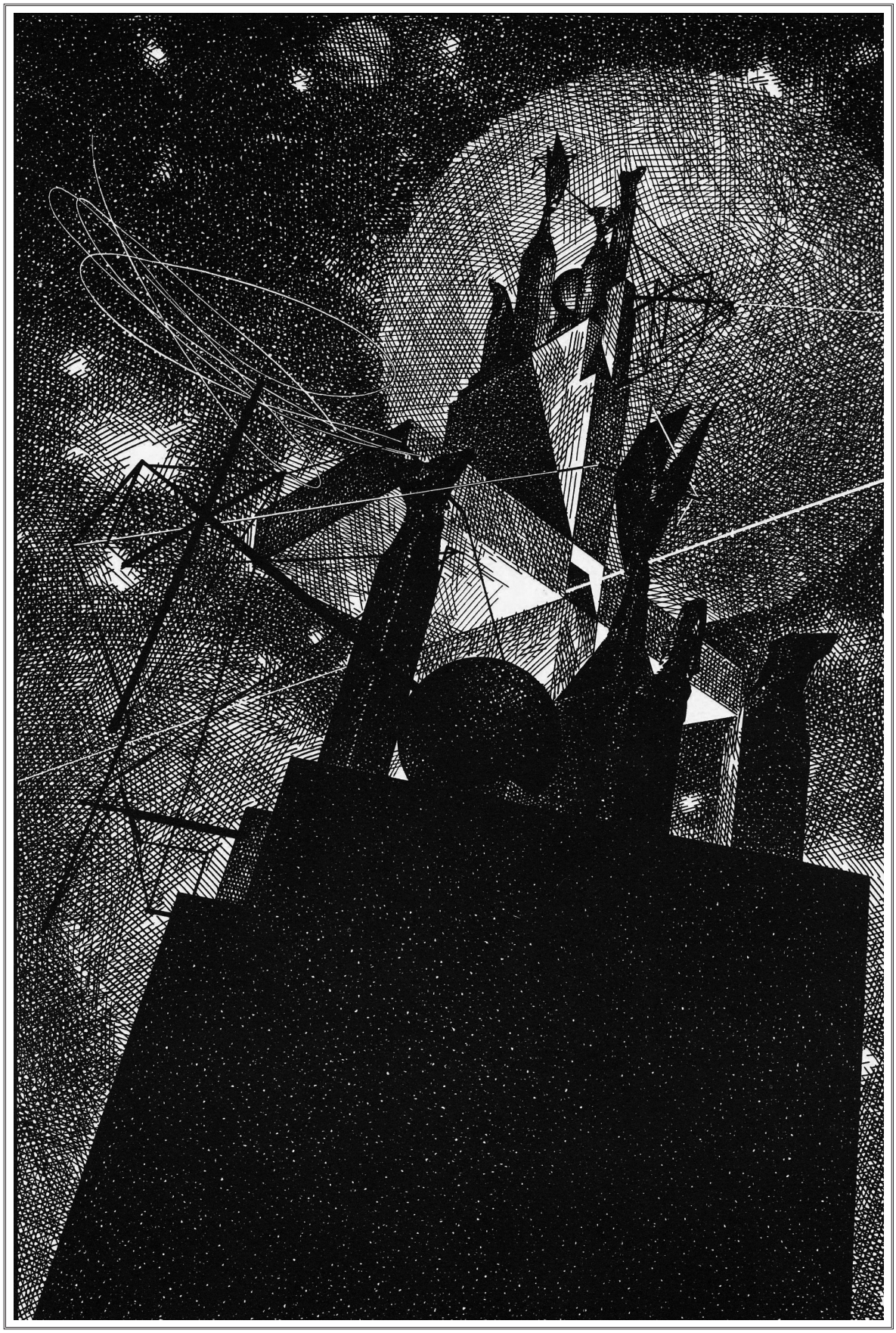


Fig. 4 ~ **The Einstein Tomb** *by Lebbeus Woods (1980).*

to be seen again. On the contrary, it works on the rather large assumption that humanity is able to undertake a scheme of this magnitude without placing great strain on the Earth's population and her resources. And finally, this thesis does not present a complete design strategy for a space ship, the complexities of which are so great that to tackle it for a Master's degree in architecture would be impossible and beyond the point of the exercise.

What I hope to accomplish with this thesis is to outline the role of design and architecture within the finite environments of spacecraft; to use architecture to help sustain a population as it copes with monotony, promotes cultural evolution, change, and avoids stagnation. And if architecture can succeed at satisfying the needs of the *Horizon*'s population, they will have the capacity to explore indefinitely. Beyond our world and our solar system, humanity may gladly discover that the internal struggles of our society have finally lead to something astounding.

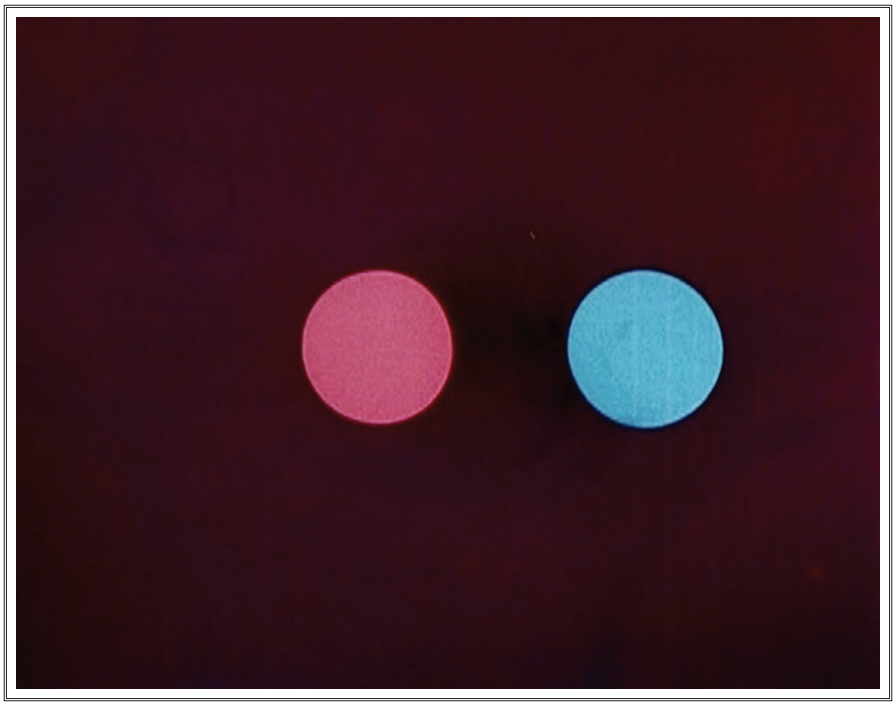


Fig. 5 ~ Still taken from: **An Optical Poem** *Produced by Oscar Fischinger for Metro Goldwyn Mayer Studios (1938).*

Yet, to create a fulfilling existence in space for a human population is not a simple task. It is one with an unpredictable outcome that skews with the passage of time, the death of the population and the waning enthusiasm for the mission. Perhaps, the endeavor will be a failure: the vessel could fall into disrepair; there could be some unforeseen calamity; there could be an uprising from within; disease, famine, or war could decimate the population. All of the challenges that humanity has ever faced on Earth could follow *Horizon* on its lonely voyage. However, that is the chance that every mission of exploration and discovery has had to take in the search of knowledge. This sacrifice, the knowledge that there may be no reward, no cause for celebration, no return, is contrasted and compensated by the possibility of discovering so much more.

Fig. 6 ~ **The Desire** *by Moebius (Jean Giraud) (Year Unknown).*

Considering the complexity of this proposal and how it relates to the function of social order, time, and architecture, I have divided this thesis is into four parts. Part One will discuss the culture of exploration and the search for settlement. There, the importance of exploration throughout the history of civilization will be addressed, as will the history of the idea and its impact on culture; this will also include the effect of science fiction and storytelling on our perceptions of reality. Part Two shall be dedicated to the critical analysis of ten case studies of vessels and habitats created for exploration, all of which will have specific impact on the final design and story of *Horizon*. Each case study will be concluded visually by the illustration of key concepts as a prelude to the final portion of the thesis. Part Three will introduce the final section by briefly discussing *Horizon* as a site-less entity whose manner of design and graphic presentation must be deeply considered in order to provide insight yet, continue to raise questions. Part Four; *The Journey ~ Face to the Horizon*, will take the form of an illustrated narrative, depicting the conditions and stories of *Horizon* over time.

Finally, I think it would be remiss if I did not discuss the naming of the vessel: *Horizon*. I wanted the name to be elegant, meaningful, inspiring, and to be unrelated to an historical ship. I fumbled through etymology websites, searching for the Latin origins of semi-appropriate words so that they might sound more interesting than would a mere English name. I hunted for the history and roots of words like; flight, migration, daughter, exploration, mother, egg… *Egg*!?!? It was not going well. But luckily, being a part of an academic community has its benefits; when you find yourself in a bind, you'll usually know *somebody*, who knows *somebody*, who knows *something* about what you need to know. So let's just say a little bird (Caroline Disler: Humanities PhD Candidate at York University and translator of modern and ancient languages) suggested that *Horizon* might be an appropriate name. And when I thought about it, it really was. What word could better embody the sense of adventure and excitement one would feel when confronted with his or her first obstacle in a great journey? What word could better imply the dogged persistence required of an explorer on her expedition into foreign lands that hide untold secrets and undiscovered mysteries? It is the horizon, the edge of the known world, the boundary beyond which no person can see even after he takes his first stride.

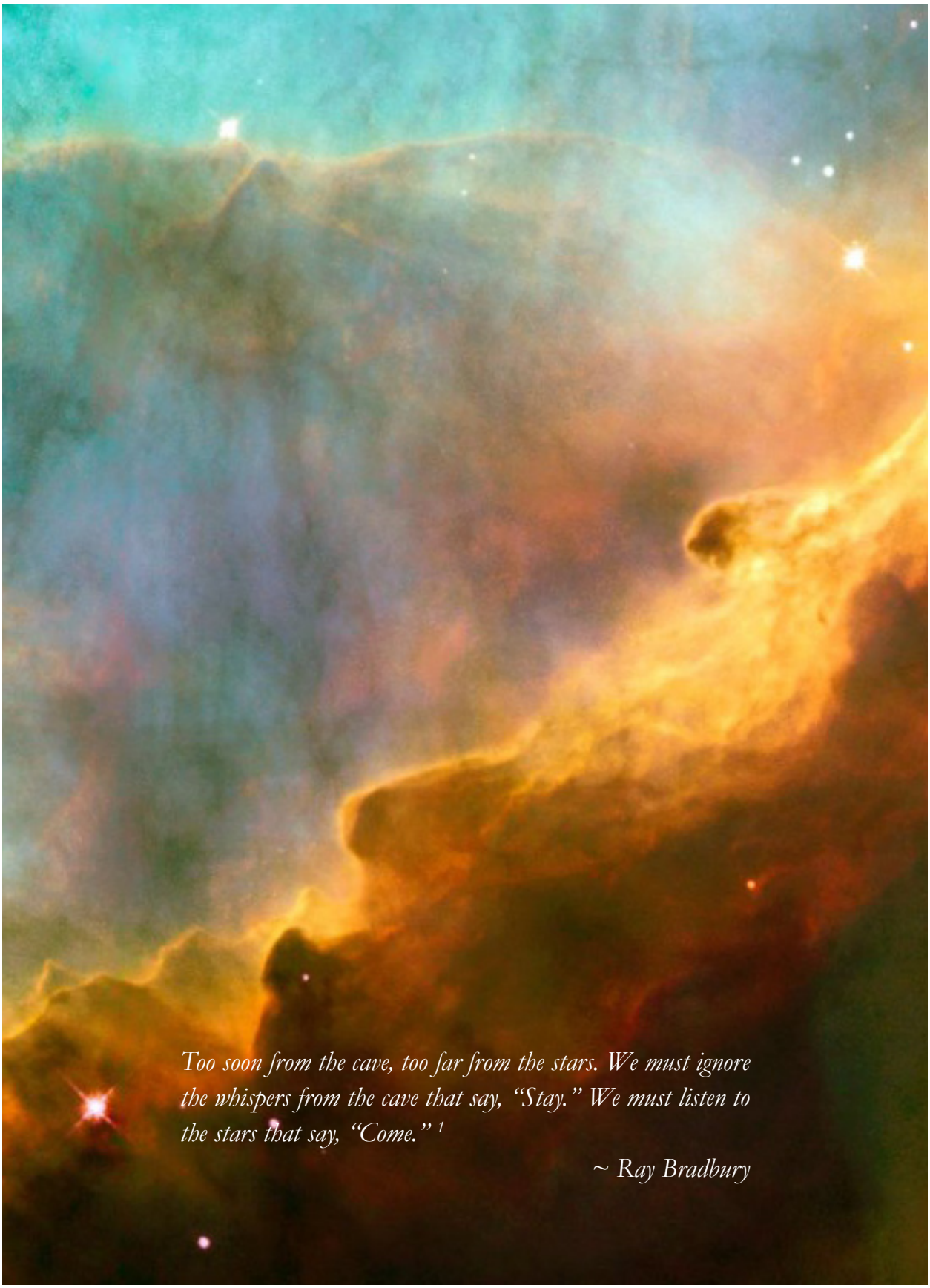


Fig. 7 ~ **M17 - Omega/Swan Nebula** *from the Hubble Space Telescope - NASA, ESA & J. Hester, Arizona State University (2003).*

EXPLORATION 1

Because the partial theories that we already have are sufficient to make accurate predictions in all but the most extreme situations, the search for the ultimate theory of the universe seems difficult to justify on practical grounds… The discovery of a complete unified theory, therefore, may not aid the survival of our species. It may not even affect our life-style. But ever since the dawn of civilization, people have not been content to see events as unconnected and inexplicable. They have craved an understanding of the underlying order in the world. Today we still yearn to know why we are here and where we came from. Humanity's deepest desire for knowledge is justification enough for our continuing quest. And our goal is nothing less than a complete description of the universe we live in.[2]

~ Stephen Hawking

Fig. 8 ~ **5th Birthday** *by Rebecca Zehr (2010).*

MY five year old niece loves to play. She builds cities and landscapes in the sand box with her shovel and bucket, telling stories to herself in a quiet whisper, giving life to the inanimate sand. Without thinking, she is both the creator and destroyer of the worlds known only to herself and her playmates. She plays games endlessly and ropes me in whenever I am not too busy "*typing, typing, typing*," as she says. Demanding that I spin her around, we hold each other's hands tightly as the centrifugal forces lift her feet off the ground, kicking wildly. She squeals with excitement. Like all children, she is born an explorer. Whether it's an expedition to the neighborhood playground or simply challenging my expectations, she ventures to the edge of her reality in order to understand how much of this world can be hers, and what she can do to bend it to her will. Growing and changing with every game, every victory, and every failure, we are all born explorers. We all start knowing nothing about our world and grow by overcoming the obstacles that stand before us. Children, with their innocence and objectivity, are spectacu-

lar evidence of the innate ability to learn through exploration and play. As we develop into adults, we build upon those rich childhood lessons that are grounded in exploring an ever changing world.

> *Explore* ► *verb [with obj.] 1 travel through (an unfamiliar area) in order to learn about it.* ■ *[no obj.] (explore for) search for resources such as mineral deposits. 2 inquire into or discuss (a subject) in detail.* ■ *examine or evaluate (an option or possibility). 3 examine by touch. 4 Medicine – surgically examine (a wound or part of the body) in detail.*
> *~ ORIGIN mid 16th cent. (in the sense 'investigate (why)'): from French explorer, from Latin explorare 'search out', from ex- 'out' + plorare 'utter a cry'.*

Fig. 9 ~ **The Primitive Hut** *frontispiece to Abbey Marc-Antoine Laugier's* **Essai sur l'Architecture** *by Charles Eisen (1755).*

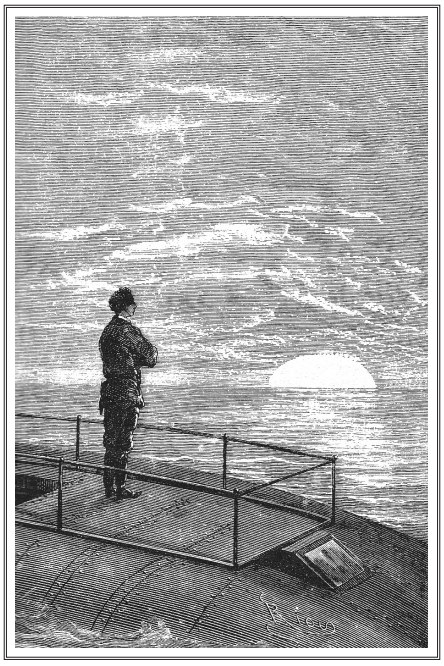


Fig. 10 ~ **"La mer s'enflamma à son regard"** *from 20,000 Leagues Under the Sea Original Plate (1870).*

Derived from the Latin, *explorare*, or *to cry out*; the act of exploration rests on something instinctive that has always been present in life. From exploration we acquire the courage to stand, and face the dangers and difficulties that come with the discovery of anything new. This thesis is not asking "if', or "why" we explore, as it is a part of all of human nature. It only imagines the possibilities of *when* we choose to explore.

Dwelling, the counterpoint to exploration, is the "pause in movement" where the occupied space becomes well-known, endowed with the values, meaning, and the collective memories and practices of the culture[3]. Engraining into society over time, these practices are tethered to daily life through memory and ritual. "So it is with memory: it is a complex and deceptive experience. It appears to be preeminently a matter of the past, yet it is as much an affair of the present. It appears to be preeminently a matter of time, yet

it is as much an affair of space"[4]. To dwell and to explore are two opposites that we have always cycled back and forth between. These two instincts; to discover new lands, establishing settlements, and to acquire new knowledge, have always framed human existence. Carried with the explorer on his travels are the rituals, memories, and artifacts that are part of his home. The past experiences of the explorer infuse the empty places he visits with life and meaning while they enrich the culture of his home upon his return.

The basic reasons for exploration are simple and always stand as initiatives. Yet, when the field of view is narrowed to examine the motivations of the individual, the specific grounds for exploration become endlessly personal and too numerous and varied to compare. That being said, certain events in human history and exploration stand as pivotal moments that have altered the global understanding of the world and our position and relationship within the universe.

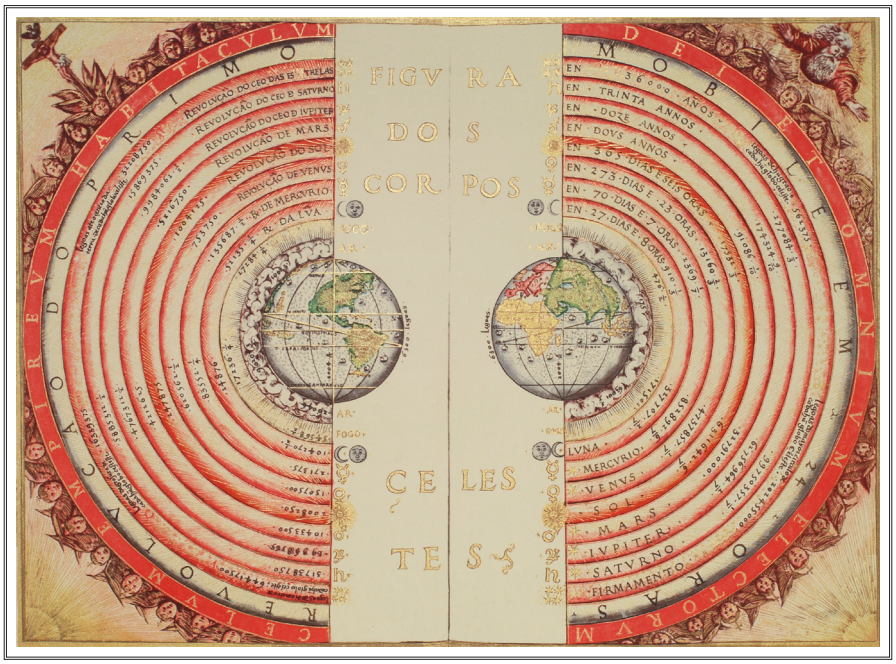


Fig. 11 ~ **Carta General do Orbe** *by Bartolomeu Velho (1561).*

When Aristotle wrote his treatise, *On the Heavens*, he presented evidence arguing that Earth's form was spherical instead of flat as was the accepted theory. The answer seems simple. How could the Earth be flat when the shadow cast during a lunar eclipse was round? If the world was flat, why was the pole star at different inclinations in the sky at the same time of year in different parts of the world[5]? Looking back, we may wonder how anyone could have assumed the Earth to be flat; to us, it is inconceivable. Though at the time, the revolutionary thinking came not from satellite imagery but from long term observation of celestial events and exploration of geographical phenomena. Understanding of the solar system and its arrangement in the heavens changed again during the time of Copernicus and Galileo when the Geocentric model of the universe, that described a universe orbiting about the Earth, was refuted giving rise the Heliocentric view, a Sun centered uni-

verse[6]. Galileo's sound concepts and far more elegant solutions became the accepted model upon which all future models were based.

Driven by religious conviction and in the hope of finding the "Promised Land" that had been shown to him in a dream by God, the legend of St. Brendan the Navigator remained "one of the most widely known voyage-tales of the Middle Ages" up until the Age of Discovery in the fifteenth century[7]. First recorded in the tenth century, the monk, St. Brendan (b. c. 484; d. c. 578), was fabled to have sailed and rowed from Ireland to the distant islands of Iceland, Greenland, and astoundingly even the mainland of America sometime in the sixth century, two centuries prior to the Vikings[8]! Despite the lack of evidence of St. Brendan's voyage to Canada, his tale of belief, trust in God, and sea exploration engrained itself in Indo-European culture for hundreds of years. The Age of Exploration, through the 15th, 16th, and 17th centuries, yielded further understanding of our planet's geography,

Fig. 12 ~ **Sankt Brandans Seefahrt** *by Anton Sorg (1476).*

though it was often appropriated through the suffering and even annihilation of indigenous cultures, ravaging their natural resources and plaguing them with unfamiliar disease and conquest. But, beyond the onslaught of brutality and acquisition, the first purely scientific and exploratory voyages were launched. The first circumnavigation of the globe was completed by the crew of Ferdinand Magellan in 1522, taking three years and suffering heavy losses including the death of the voyage's leader, Magellan[9]. The expedition was "plagued by dishonesty on the part of jealous Spaniards and with deliberate armed opposition by the Portuguese government" and so, the completion of the world's first circumnavigation is all the more legendary in the realm of exploration[10]. With strong support from The Royal Society, Edmond Halley and Benjamin Middleton "proposed to undertake a voyage around the world to improve geographical knowledge, [and] to observe the magnetic variation

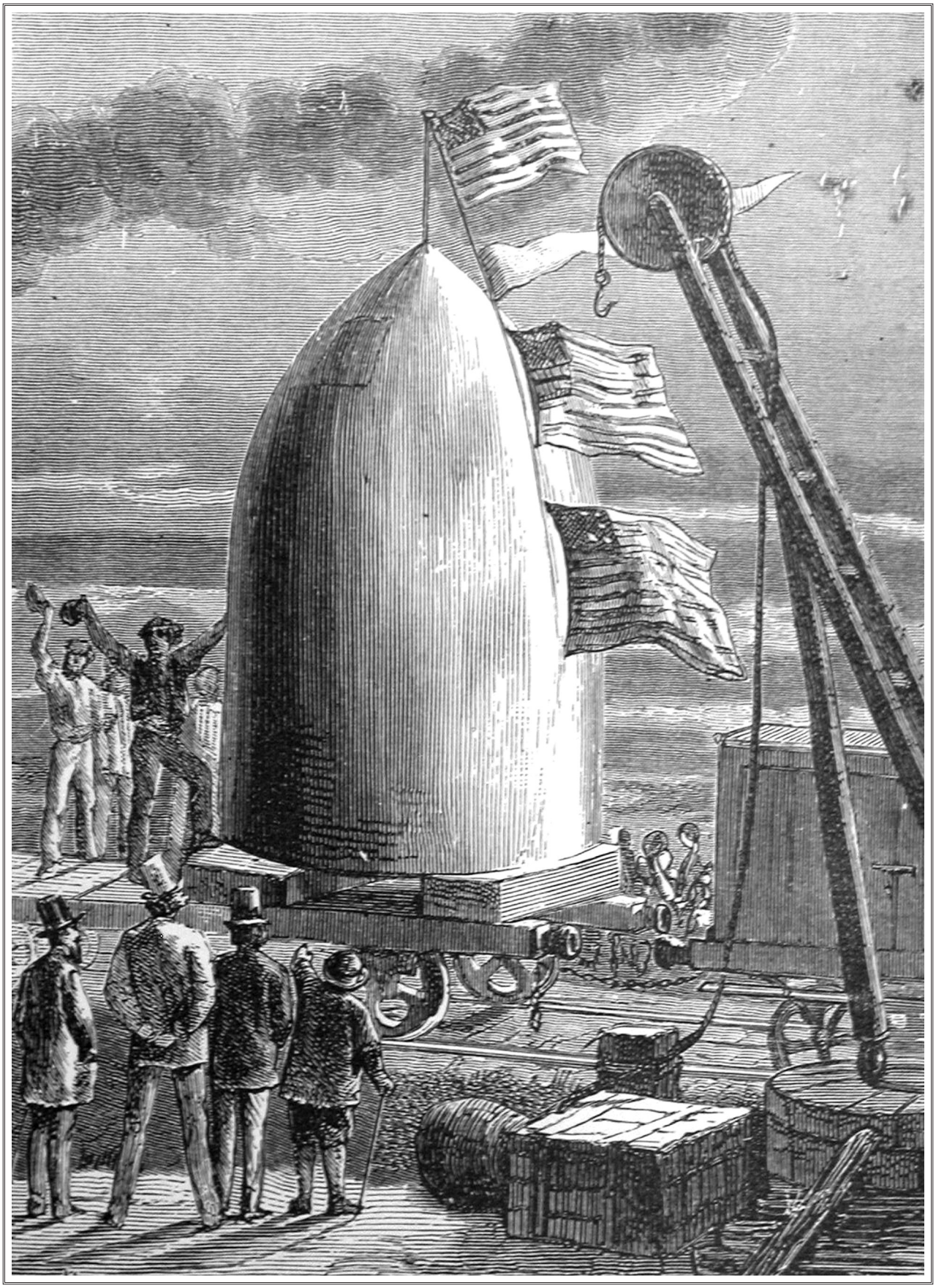


Fig. 13 ~ **The Arrival of the Projectile at Stone's Hill** *from Jules Verne's* **From the Earth to the Moon** *(1886 - Illustrated Edition).*

worldwide" in 1693[11]. Though the endeavor faced many setbacks and delays, Halley managed to generate the first ever mappings of the Earth's magnetic field variances at its surface[12]. Whatever difficulties and losses these voyages may have experienced, the hardships endured gave way to many 'firsts' in exploration and discovery, spiraling through history to become stories of inspiration.

The spirit of adventure and the appetite for new knowledge still has the power to motivate in the modern age of discovery and science. One of the most significant discoveries of the twentieth century is, perhaps, not the most well known yet completely surrounds us. While obtaining spectral data from a large collection of galaxies, Vesto Slipher, a colleague of Edwin Hubble, observed that almost all emission and absorption lines in the spectra of the galaxies observed were shifted to longer wavelengths[13]. In his review of this astrophysical phenomenon, Hubble interpreted this data as Doppler Shifts. A Doppler Shift measures the color variance of light coming from distant celestial objects and determines their speed and direction of movement: if the light is Blue Shifted – a shorter wavelength – it is moving towards us; is the light is Red Shifted – a longer wavelength – the object is moving away[14]. Some measurements had been taken previously and it was expected, according to current universal models, that things being relatively evenly distributed throughout the universe, there would be similar number of Red Shifted objects as there were Blue. However, Hubble concluded that in fact, it appears that almost all bodies are moving away from our galaxy, and from each other. Stephen Hawking stated that "the discovery that the universe is expanding was one of the great intellectual revolutions of the twentieth century"[15]. This discovery, not unlike Aristotle's theory of Earth's true geometry, effectively changed the way we understand our universe and its deep history. Our ventures into exploration and discovery have also changed the way we see ourselves within a finite yet boundary-less system, one that continues to expand in our minds, our collective imagination, and physically as time passes.

Jules Verne's *From the Earth to the Moon*, or *De la Terra à la Lune* (*fig. 13*) and H.G. Wells' *The First Men in the Moon* (1901) inspired generations to consider the possibilities of flight beyond our atmosphere and travelling through space to places like the Moon and Mars. Originally considered to be fantasy, the writings, drawings, and films of science fiction have repeatedly become a reality. The Space Age, brought forth by the Soviet launch of *Sputnik* in 1957, has defined exploration for the modern era. From the outset, space exploration has featured the classic ingredients of danger, adventure, and a steep challenge to our human and technological limitations. Through our endless curiosity and willingness to go beyond limitations and boundaries; the progression of technology has grown exponentially allowing explorers to travel either by satellite or by spacecraft to new and increasingly distant objectives. The Moon landing marked another incredible moment in the history of exploration. On its rough, pebbled landscape stood two men, gazing out to the ominously close horizon, who had traveled further from home than any person had before. But, in the words of Aldrin, "there are more people watching us than anybody else has ever watched two people in history"[16], referring to the televised event. They were alone, yet not alone. Today we aspire to venture even further into the solar system with our eyes fixed on

Mars and beyond. Science fiction writer Ray Bradbury states that Mars is, "a way station on our journey to our greater selves and our possible immortality"[17] and asks poignantly if this is where we stop or only the beginning of the eternally-spreading phenomena of the human race[18].

The stories read in preparation for this thesis are numerous and diverse in topic and narrative. They are visions of alien civilizations with histories as long and colorful as our own; there are stories from our near future painted in explicit detail with scientific research frighteningly based on current theory and potential scenarios. They are windows for the imagination, rich universes of ideas each springing off the other into webs of possibilities. Western lit-

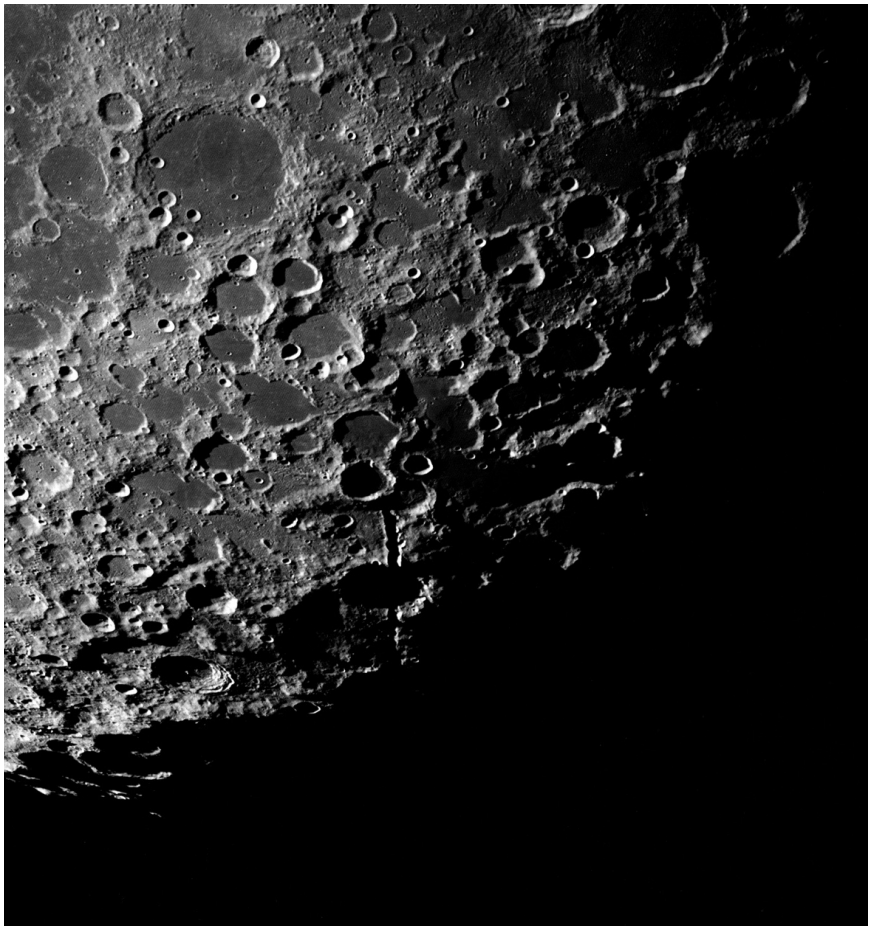


Fig. 14 ~ **Heading for Earth** *from NASA - Apollo 15 (1971).*

> *The disappearing of the horizon - it is distinct. There's no haze, no nothing obscuring it, and that makes distant objects appear clear, very clear. And then there's the rock, and then there's nothing.*[19]
>
> *~ Buzz Aldrin*

erature and film have produced a wide range of possible worlds that remind us that the only boundary to our potential is the barricade of an unimaginative mind.

That people could come into the world in a place they could not at first even name and had never known before; and that out of a nameless and unknown place they could grow and move around in it until its name they knew and called with love, and call it HOME, and put roots there and love others there; so that whenever they left this place they would sing homesick songs about it and write poems yearning for it, like a lover; remembering the groupings of old trees, the fall of slopes and hills, the lay of fields and the running of rivers; of animals there, and of objects lived with; of faces, and names, all of love and belonging, and forever be returning to it or leaving it again! [20]

~ *William Goyen*

We are born with the innate ability to explore, probe, move, observe, analyze, and search for meaning, and this thesis asks, "what if we could go on forever?" What if we built a ship to travel beyond all the known stars in an effort to know everything? How might such a mission support itself? Would such an exploration turn into an aimless voyage through space and time with no end goal and no grounded place to call home? What might keep such a mission from going adrift? What can architecture do to address the issues in the design of such a ship?

As the possibility of an infinite realm of exploration stretches out before us, our own scale, by comparison, becomes incomprehensibly small. In breaking the horizon, architecture connects humanity to the known universe through the formation of symbol, meaning, place, and ritual. A relationship between the *very big* and the *very small* is created. These aspects of design are necessary to shatter the monotony of eternal time, making a connective link to the past, present, and future of the journey and to create place within the void of the unknown.

Can the human need to explore ever be satiated or exhausted? The question is: have we ever gone far enough to find out?

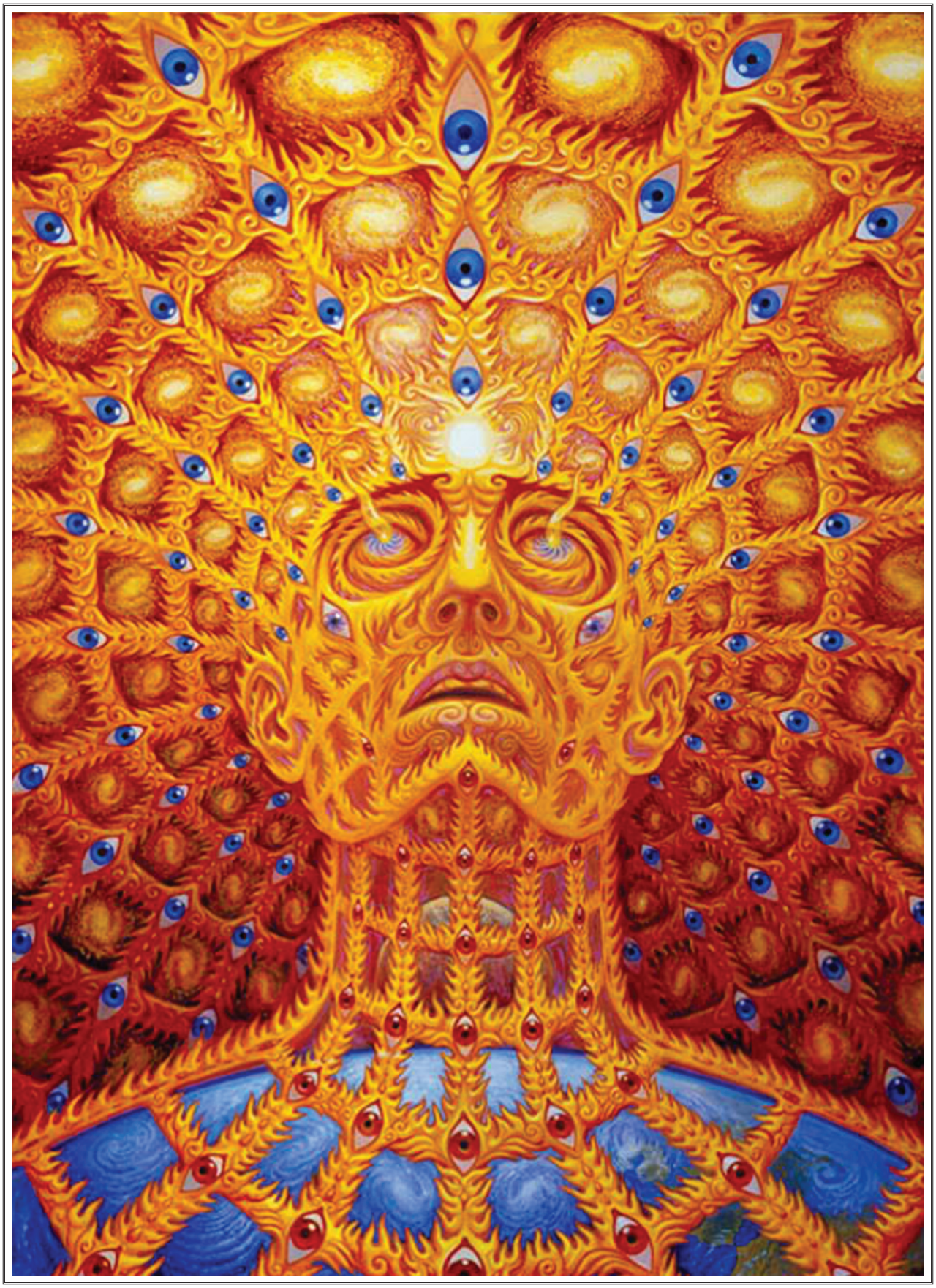


Fig. 15 ~ **Oversoul** - *Oil on Linen by Alex Grey (1998-99).*

PLACES OF DISCOVERY 2

Le seul véritable voyage ... ce ne serait pas d'aller vers de nouveaux paysages, mais d'avoir d'autres yeux, de voir l'univers avec les yeux d'un autre, de cent autres, de voir les cent univers que chacun d'eux voit …

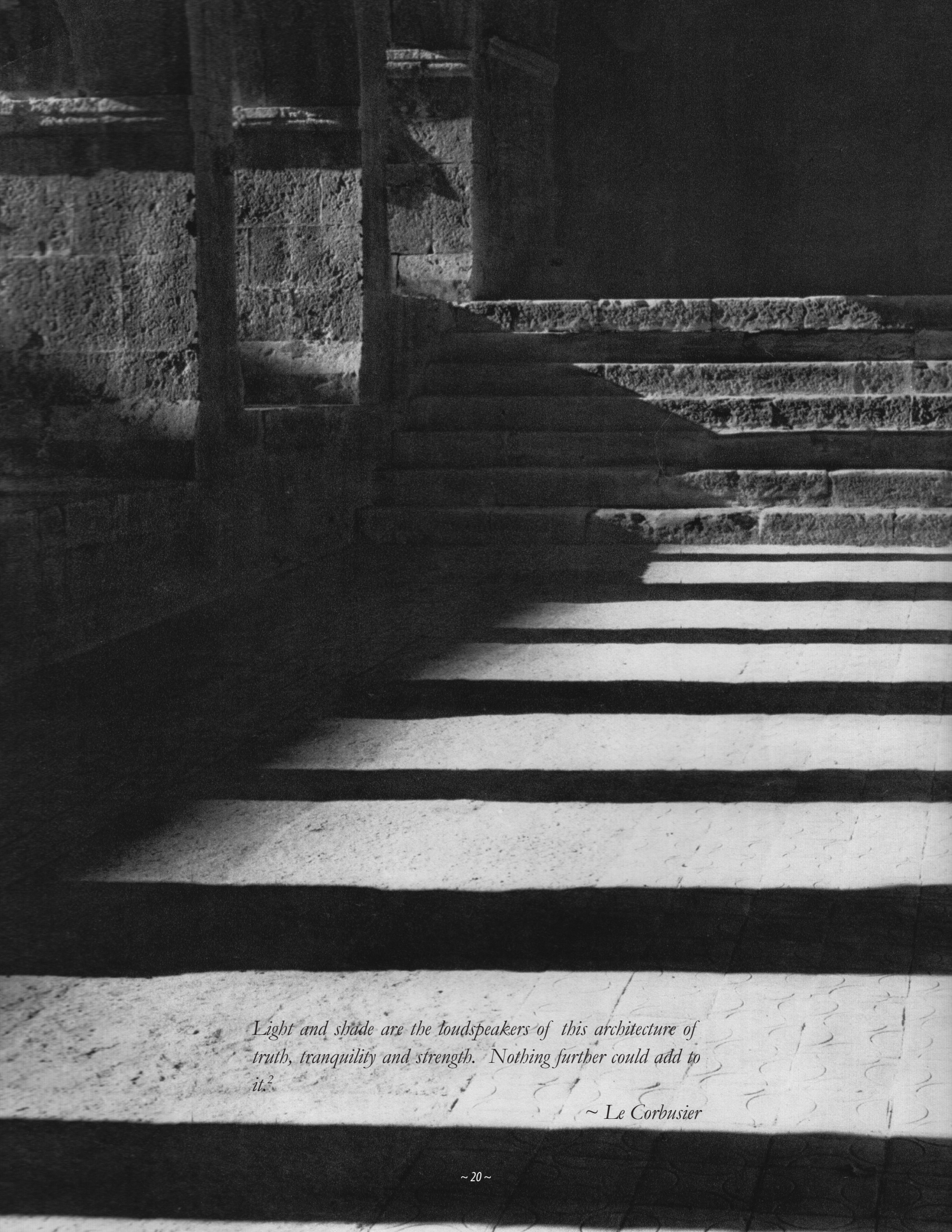
The only true voyage of discovery … would be not to visit new landscapes, but to possess other eyes, to see the universe through the eyes of another, of a hundred others, to see the hundred universes that each of them sees …[1]

~ Marcel Proust

IN all cases of design, it is important to study the work of others in order to better understand the conditions and cultures for which the designs are being produced. Precedents are also important to the designer as a source of inspiration for future creations.

The following case studies may not fall into any particular grouping or traditional sense of precedent. This thesis presents a design whose narrative is planted in the far future and therefore must draw from many sources to create grounding in our history, culture, and society. The precedents vary in: typology, cultural significance, landscape and built environment, architectural style, materiality, ritual, and occupation. They have been selected for their contributions to specific characteristics and not necessarily for the entire project design or philosophy. At times, the narrative that takes place within the confines of the case study is the most significant aspect, shedding light on how a similar condition might be handled within the design scheme of *Horizon*. Many of the case studies are in fact, fictional; some from film, some from literature. Though the projects described through fiction have never been constructed, they have been a part of our culture for decades and have given vision to a field of exploration in which few people have experience.

Each case study shall therefore inform the final design of Horizon, providing insight on issues of time, space, memory, social concerns, and exploration, among other things. Important points will be stressed in each case study through a visual conclusion, comprised of imagery and text depicted in a graphic style as a precursor to the final narrative of this thesis. Within each project and work of fiction, there are similarities and there are differences. No single design solution is complete or ideal. Some could be considered insensitive or even hostile. However, it is the blend of their characteristics that has provided a healthy guide to the production of a concept imbued with the value and spirit of the human desire to survive and explore. It is a concept that is not only interesting in terms of design, but one that is also culturally significant.



Light and shade are the loudspeakers of this architecture of truth, tranquility and strength. Nothing further could add to it.[2]

~ *Le Corbusier*

THE MONASTIC LIFE OF THE ~ CARTHUSIANS AND CISTERCIANS ~

2.1

The approach is not by a physical progression, but by flashes of succeeding light, and these are not corporal but spiritual....

The soul must seek light by following the light.[3]

~ St Bernard of Clairvaux

MOST people spend their lives inundated by a continuous bombardment of various sensory stimuli. From a constant stream of music playing through headphones, to light dinner conversation, to the color of paint chosen in the decoration of a living room, there is no shortage of audio, visual, and social stimuli to occupy the mind with wandering thoughts, dreams, and distractions. To choose solitude and isolation from the rest of society, a place away from distraction, is not an easy decision to make for such a social animal. A life bound within the confines of a space ship faces this difficulty directly; it is a lifestyle that offers endless discovery but also constant confinement. However, many people throughout history have imposed isolation upon themselves as the only way to live, not to escape society but as a means of attaining a contemplative lifestyle. It is a lifestyle of stability, unencumbered by the distraction of everyday life that hinders the interiorized quest for spirituality.

Saint Anthony of Egypt, one of the most famed instigators and practitioners of Monasticism, was inspired by a passage of the Gospel of Saint Matthew which said that if he wished to be perfect he must donate all his possessions to the poor; only then would he find treasure in Heaven[4]. Finding his ascetic hermitage in the desert of Egypt, Saint Anthony spent his life exploring his individualistic spirituality, remaining as disconnected as possible from the rest of civilization. Though the search for a state of contemplation and oneness with God is an internal and rewarding one, to choose an existence of complete isolation without human contact or sense of community is not an ideal lifestyle for all. Driven to hermitage by his disgust for the paganism of Rome, Benedict of Nursia spent three years in the isolation of a cave before his renown as a religious man brought him his own following and led to the foundation of several monasteries[5]. The Rule of Saint Benedict, written around 530, sets a simple guide to an alternative way of life that removes temptation through dwelling in isolation. According to St. Benedict, when this vocation is followed with obedience, humility, and contemplation it leads to the deepest connection with God and His Word. It is a world of outer stability, where each monk remains integrated within his community leaving only when called on official religious business. The heart of monasticism rests within the Opus Dei, the "Work of God,"[6] and requires a monk or nun's complete devotion. Consisting primarily of prayer, liturgy, and labor, the Opus Dei is a ritualistic pathway to daily life, internal contemplation, reflection, and personal communion with God.

Fig. 16 (Opposite) ~ **Cloister - The Cistercian Abbey of Le Thoronnet** *by Lucien Hervé.*

The Carthusian and Cistercian monastic orders share similarities in their belief, the isolated locations of their houses, and the ascetic nature of their way of life. Yet, the differences that exist between the two austere, alternative lifestyles, though subtle, are evidenced in their respective architectures and rituals of daily life. The utter solitude of the Carthusians emphasizes their inner journey to a life of contemplation where the Cistercians focus their rituals more on the benefits of manual labor. In either case, the dedication to their beliefs is unquestionable.

In his search for a more reclusive place to serve his faith in God, Saint Bruno departed his place of monastic apprenticeship at Molesmes in 1084, and was directed by Saint Hugh in Grenoble toward his destiny; the mountain wilderness of *La Chartreuse*, France[7]. There, he and his small following laid the first foundations of an Order of monastic Catholicism that would carry down through over nine centuries of devotion by realizing "the ideal life set forth by St Paul in his Second Epistle to the Corinthians: 'Let us show ourselves as the ministers of God in much patience, in labours, in watchings, in fastings, in chastity, in knowledge – sorrowful yet always rejoicing, having nothing yet possessing all things.'"[8]. The monasteries of the Chartreux order were established far from other habitations; in mountains and deserts. The Carthusians, as they were called, favored the life led by the desert Fathers before them; solitary, ascetic, and wholly dedicated to prayer; they believed that this allowed them to become as close to God as humanly possible[9].

Following a strict schedule of worship governed by the *Consuetudines Cartusiae*, a guideline to the order developed from recorded discussions with Saint Bruno[10], the Carthusians observe approximately 14 hours of prayer daily; either individually in silence, in personal study, or within the chapel. The rest of the day is given over to the consumption of two small meals and some labor, all taken in silence (*see Appendix A*). The rigorous schedule does alter on festive occasions and Sundays however, where meals may be taken in common and when the Fathers of the community take their exercise together and are allowed to share their thoughts. But, the Carthusians remain a community that is dependent on isolation to fulfill their devotion; "It is only the 'Law' of the desert which has maintained the purity of our vocation with its permanent cell"[11]. The architecture of the Carthusians is what facilitates this isolation. *La Chartreuse de Clermont* (*refer to figures 17 and 18*) exemplifies the rigidity of Carthusian ritual, designed to focus the attention of the monks on solitude and reflection. Surrounding the cloister are the houses or cells of the Fathers; individual enclaves of solitude where much of the day was spent in prayer, liturgical studies, meditation, and silence. Each cell, often built over two levels, was equipped with a small wood stove, a place for sleeping, prayer, study, storage for wood and the practice of carpentry, and a small garden to tend, completely invisible to any other Father or Brother. A lay Brother or novice would bring each Father his pittance or meal, accessed through a small chute from the gallery of the main cloister, hiding the novice from visibility and ensuring the monks utmost concentration, his solitude crucial to his devotion[12].

Filmed in the French Alps at *La Grande Chartreuse*, the founding Charterhouse of the Carthusian Order, *Into Great Silence*[13] depicts, through unobtrusive observation and documentation, the daily rituals of the ordained Fathers and lay Brothers in the serenity of their communal mountain hermitage. It is

significant that the most powerful moments of the film were not in an epically composed soundtrack or sweeping visual effects but rather they were in the unquiet spaces left open by the silent mouths and the serene, untroubled faces of the monks.

This powerful silence stands in marked contrast to a Western, secular world in an age where every opinion and thought, must be heard immediately by everyone. Our ears and eyes suffer from an unquenchable addiction to stimulation that manages to fill every spare moment. And so, when suddenly deprived of that stimulation, distraction, or temptation, by the walls of a monastery or the hull of a space ship, we are left open to receive the world around us that, newly discovered within our silence, is overflowing with the sounds and visions of beckoning spirituality[14]. Even from the point of view of an audience, twice removed from the event by its passage through the lens and its projection onto a screen, the intensity of each image becomes all the

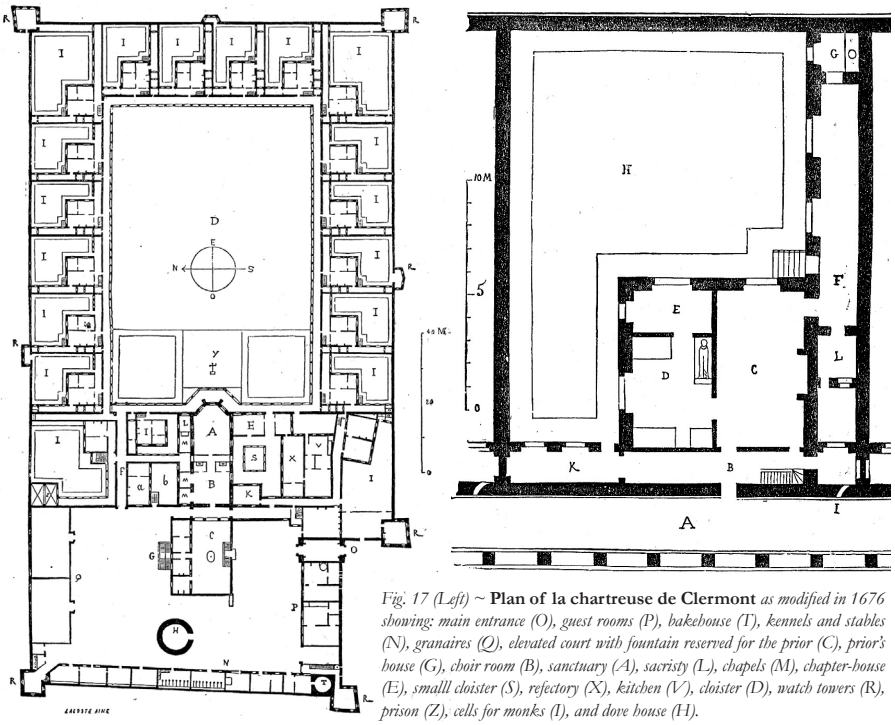


Fig. 17 (Left) ~ **Plan of la chartreuse de Clermont** *as modified in 1676 showing: main entrance (O), guest rooms (P), bakehouse (T), kennels and stables (N), granaires (Q), elevated court with fountain reserved for the prior (C), prior's house (G), choir room (B), sanctuary (A), sacristy (L), chapels (M), chapter-house (E), smalll cloister (S), refectory (X), kitchen (V), cloister (D), watch towers (R), prison (Z), cells for monks (I), and dove house (H).*

Fig. 18 (Right) ~ **Cell Plan** *showing: cloister gallery (A), sound isolating corridor (B), warming room (C), bedroom with book shelves and desk (D), oratory (E), covered walkway (F), w/c (G), garden (H), passage for food (I), porch for prior (K), and storage room (L).*

more powerful by the vocal silence, its importance punctuated by the chirping of a distant bird, the light tapping of rain, or the sharp snipping of a pair of shears through a future tunic's coarse fabric.

The motto of the Carthusians, "*Non sanctos patefacere sed multos santos facere*' or, 'To make many saints but not to publicize them'[15] is mirrored not only in the architecture of each Chartreuse through the hermetical isolation that essentially removes these men and women from our world, but also in the final departure of each monk and nun into death. Each grave is marked with a simple cross that lacks any description or definition; the identity of each man and woman who has so completely devoted themselves to their one true love, the love of God, remains known only to Him, preserved in his eternal solitude.

Not long after its foundation, the Benedictine Abbey of Molesme in Burgundy achieved great success both in following and in wealth. However, its founder, Saint Robert, grew frustrated with the "lukewarm and negligent" observance of the *Rule of Saint Benedict* there and proposed to the archbishop of Lyon that he be allowed to found a new monastery, one that followed the *Rule* with the utmost vigilance and austerity[16]. The order and monastery of Cîteaux (*Cistercium* in Latin) was founded in 1098 in the Saône valley, just south of Dijon, and from it, the Cistercian monks spread to quickly establish the daughter monasteries of La Ferté, Pontigny, Clairvaux, and Morimond[17].

The Cistercians, a reformed version of the Benedictine order, aimed "to restore the Benedictines to their early simplicity"[18]. And so, by adhering to the strict *Rule of Saint Benedict*, the Cistercian day was regimented and gov-

Fig. 19 ~ **The Cistercian Abbey of Le Thoronnet** *by Lucien Hervé.*

erned by the *horarium* that divided each day into periods of prayer, labor, study, and rest (*see Appendix B*). While the main focus of the *Opus Dei* remained a monk's relationship with God through his labors to sustain himself and his brothers, and the celebration of the seven Canonical Hours including an additional night office, Vigils; the studies of each Cistercian monk or nun were completed with equally ritualistic passion. A typical day consists of: up to 7 hours of manual labor working in the fields, the gardens, or mills to produce food[19] and 6 to 7 hours of prayer, divided throughout the day and night. For the lay Brothers who worked to serve the monasteries functional needs, prayer was performed intermittently while laboring in the fields, 3 to 5 hours were dedicated to study and pious lectures, and the remainder was

left to eating and sleeping[20]. *Lectio divina*, or study, was more than just reading; it was the process of fully understanding and integrating the purpose of Scripture deep within the Cistercian's soul. The words were lifted from the page and read aloud acoustically; they were "chewed, digested and absorbed as food is chewed digested and absorbed; and just as physical food is metabolized and transformed into the material of one's own body, so in *lectio divina* the spiritual food of the sacred texts is metabolized and transformed into the substance of one's own soul"[21]. Like the Carthusian life based in prayer, the Cistercian's were as determined ritualistically, allowing every task performed to bring them closer to God.

Where the architecture in the Carthusian monastery emphasizes isolation and internal focus within the hermetical cells of the Fathers', the ar-

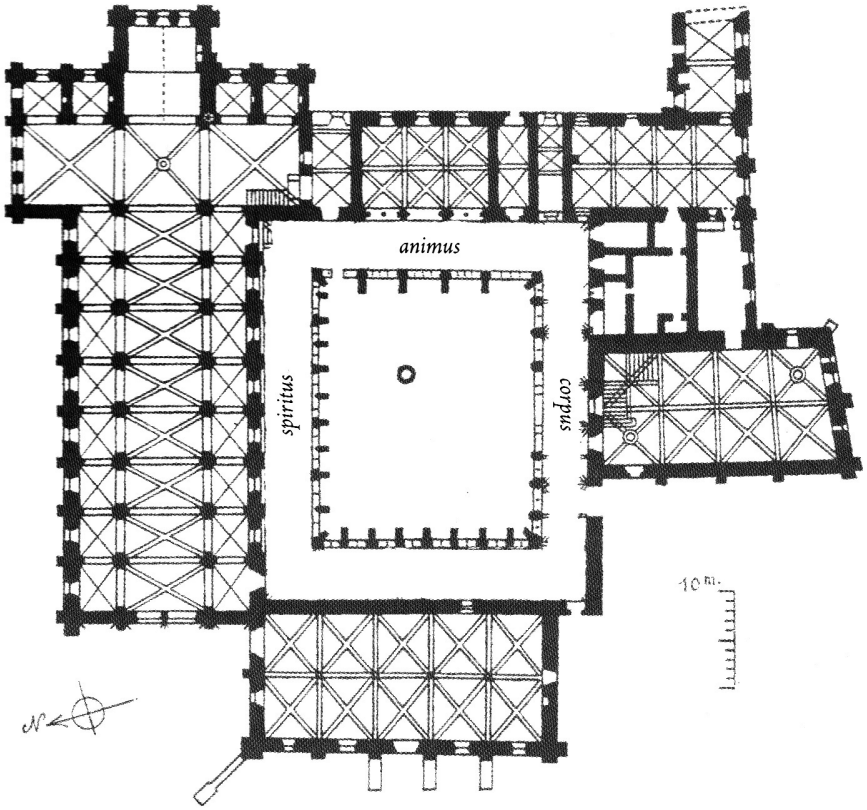


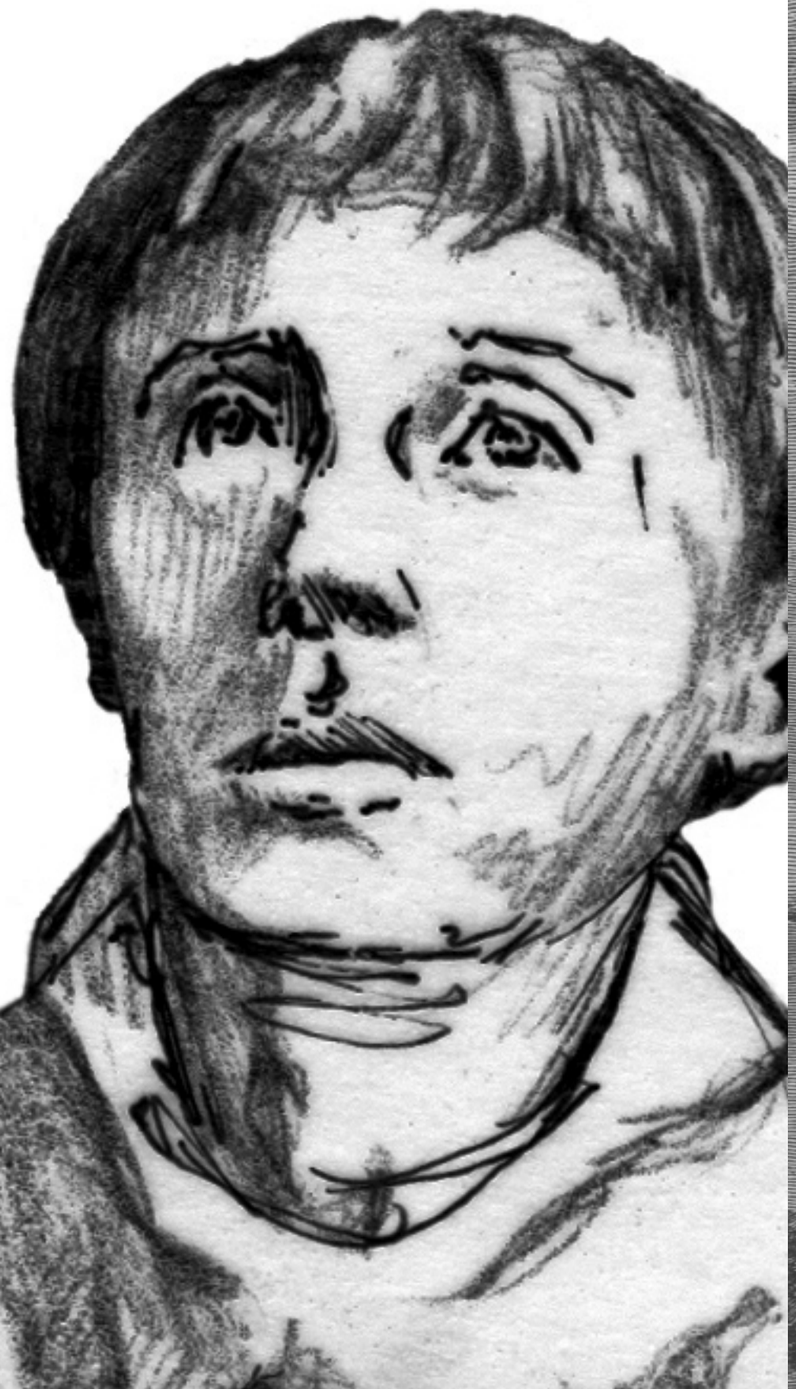
Fig. 20 ~ **Plan of the Cistercian monastery of Noirlac** *(France, Cher) showing the metaphorical divisions of the cloister.*

chitecture of the Cistercian monastery emphasizes ritualistic spaces that are shared silently by its members. The Cistercian practice is determined to make religion integral to the entirety of being, and may have been considered in the basic layout of each monastery. The galleries of the central cloister are bordered on all sides by various programs and could be divided metaphorically into the spaces of the body (*corpus*), the mind (*animus*), and the spirit (*spiritus*)[22] (*fig. 20*). The church stands on either the North or South side of the cloister, its gallery, the "collation cloister", is dedicated to the spiritual gathering of the monks at various times to listen to readings prior to the day's end or to participate in the *mandatum*, the ritual washing of feet. A fountain often served as a counterpoint to the church on the opposite side of the cloister.

It was representative of renewal and also sustained the rituals of the body in its watering and cleanliness; it contained the kitchen and the refectory. The East gallery, representative of the mind, was a confluence of movement and information exchange; containing access to the dormitory, sacristy, chapter room, and parlor as well as the entrance to the church. The East gallery was a busy place filled with the quiet movement of monks and their shadows. Yet, it was also used to communicate with the community through the sonorous drumming of the *tabula lignea*, a slab of wood struck to summon the monks or nuns to moments of meeting or ritual[23]. The West gallery remained as the final connective tissue between the refectory and the collation cloister and also allowed for possible communication between the lay Brother quarters and the rest of the monastic community.

> *It is sunlight that animates the building by day, outlining every protuberance and recession, giving full value to architectural detail. When trying to understand light in an abbey, the role of silence needs to be underlined, for speaking draws attention away from visual subtleties. In order to experience fully the movement of light and shadow in a Cistercian church, one needs to be present throughout the day from morning until evening, in winter and in summer, at dawn, when it is raining, and in the reflected light of snow. The evolving luminous effect is most apparent when one is sitting in the same stall, the very slowness of the moving light providing a perfect backdrop to contemplative life. Then the subtlety of the architecture and its detail may gradually reveal itself to those who have grown aware and can see it.*[24]
>
> ~ *Terryl N. Kinder*

Whether to be a Carthusian or a Cistercian, to choose the alternate life that is monasticism is not an easy decision to make. The monastery remains a persistent form, not solely Eastern or Western, in the human quest for a transformational vessel that can turn a simple, aimless creature into one of deep contemplation and ritual. Reliant on devotion, asceticism, and an urge to return to the desert in order to leave no room for anything but the love of God, the life of a monk or nun abandons all that is secular and all that will distract them from their greater purpose. The architecture of Carthusian and Cistercian monasteries is built to sustain that ideal of an unadorned, stable, and contemplative life. Can this contemplative, spiritual awareness of body, soul, and mind continue beyond Earth, in a place not necessarily devoted to God, or any other deity for that matter? Whether the pathway to salvation is lined by a play of sun and shadow cast by the columns of a cloister or is found in the gentle whispers of love and prayer that emanate from the cell of a Father, remains, to me, uncertain; but nothing could be more sure to those who live each day of their lives in service and devotion to their faith. The strength of belief and ritual, it seems, is the key to their inner peace.



20,000 LEAGUES UNDER THE SEA ~ THE NAUTILUS ~

2.2

Jules Verne - 1870

WHETHER fictitious or based on real events, stories of exploration and adventure have inspired and excited readers to vicariously fulfill his or her own journey, but also to question a world that is filled with unknowns, be they of the external environment or of themselves. Jules Verne's *20,000 Leagues Under the Sea* is a story of loneliness, strife, adventure, and discovery. Filled with mystery, the story delves into the darkness of the Earth's oceans.

Taking place between November 1867 and June 1868, *20,000 Leagues Under the Sea* recounts the journey of three captives held by the mysterious Captain Nemo aboard his powerful submarine, the *Nautilus*. Nemo is a man of unparalleled skill, ingenuity, and compassion for his crew. Yet he is consumed by his mysterious past, he fights eternally for freedom from the rules of society and from the rest of humanity[25]. What could drive a man to leave all of civilization behind – to leave it and despise it completely for all it embodies? The answer is never revealed but remains important as it is the cause for the crew of the *Nautilus* to choose isolation over integration with the rest of humanity. Despite his aversion to the life led by a surface dweller, Nemo brought much of his past with him on his eternal journey including his most prized possessions. The unbroken connection to his past permeated through the thick metal hull of the *Nautilus* creating a constant sense of nostalgia that, in spite of Nemo's vehement denials, must have remained important to him and his journey forward. The Library and the Saloon were the most prominent representations of his nostalgia and of his efforts to map, catalogue, and rule over his undersea domain.

A symbol of the accreted wealth of knowledge of Nemo and of human society, the library (*fig. 24*) stands as *the* centrally introspective place within the *Nautilus*. It is a hermetically sealed museum of the written word containing 12,000 volumes and periodicals. Nemo's last books were acquired just before the *Nautilus* first submerged; "the world came to an end for me on the day when my *Nautilus* dived beneath the waters for the first time… and since that time I should like to think that humanity has neither thought any more thoughts nor written any more books"[26]. Like a photograph, the library remained an unchanged memory from a world that no longer existed to Nemo,. The only additions to the library came from Nemo, his compatriots, and his captives, creating a heavily biased collection, but also providing an opportunity for self analysis and independent thought, similar to the contemplative lifestyle of a monastery. Nemo, free of influence from the multitudes of scientists and scholars of his time, through his self imposed isolation, could observe, hypothesize, and judge the world for himself. His hedonistic and isolated dedication to the accretion of knowledge in his library and catalogues allowed the crew of the *Nautilus* to become the sole the authority of the ocean depths, of a new realm never before explored by human eyes. It was acceptable then that this library no longer received new arrivals from the surface as it would never again be engaged with the

Pull-out: Fig. 21 (page 27) ~ **Light & Shadow | Faith & Doubt** *by Author; Fig. 22 (page 28 left) ~* **LS | FD Preview** *by Author; Fig. 23 (page 28 right) ~* **"Le capitaine Nemo gravit un roc."** *from 20,000 Leagues Under the Sea Original Plate (1870).*

issues of that world. The blanket of knowledge that encrusted the library's walls insulated itself from the land of its origin. The library provided a place of quiet order and familiarity within a vessel that traveled endlessly through unknown territories; it was a place where new discoveries were ritualistically recorded and catalogued for posterity, preserving the story of the *Nautilus*. The library remained introverted and concentrated on the discovery of the unknown within while documenting the watery world beyond the submarine's substantial skin.

When Nemo stated that his books were his only ties to the surface world, he omitted his fine collection of masterpieces displayed within his luxurious saloon. Part music room, lounge, and museum, Nemo's collection of fine art is the visual representation of what remaining respect he had for humanity. If the library of the *Nautilus* represented the analytical and logical mind of the vessel's archive, then the saloon (*fig. 25*) was the inlet and projection of the external realm; facilitating observation, creativity, and dedicated to viewing the expanse of ocean surrounding the *Nautilus*. When the exterior panels of the saloon slide away, the interior space becomes a part of the deep waters, the light blue and rippling, it appears to bring the life of the ocean into the saloon to be collected, observed, and remembered. The saloon's cabinets

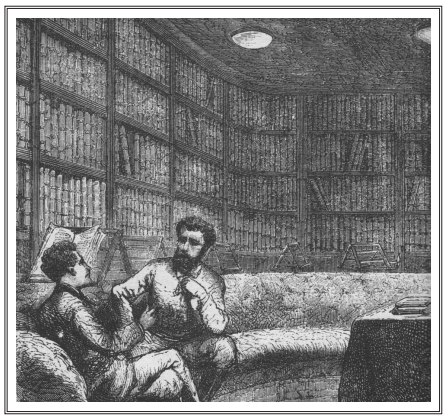


Fig. 24 ~ **Library** *from 20,000 Leagues Under the Sea Original Plate (1870).*

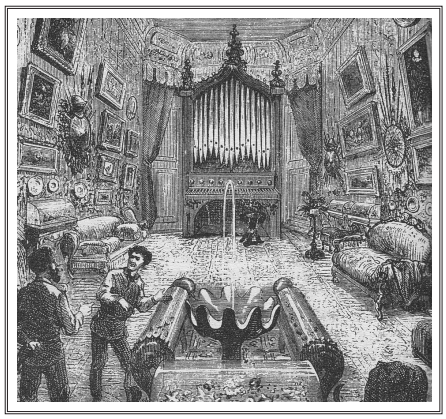
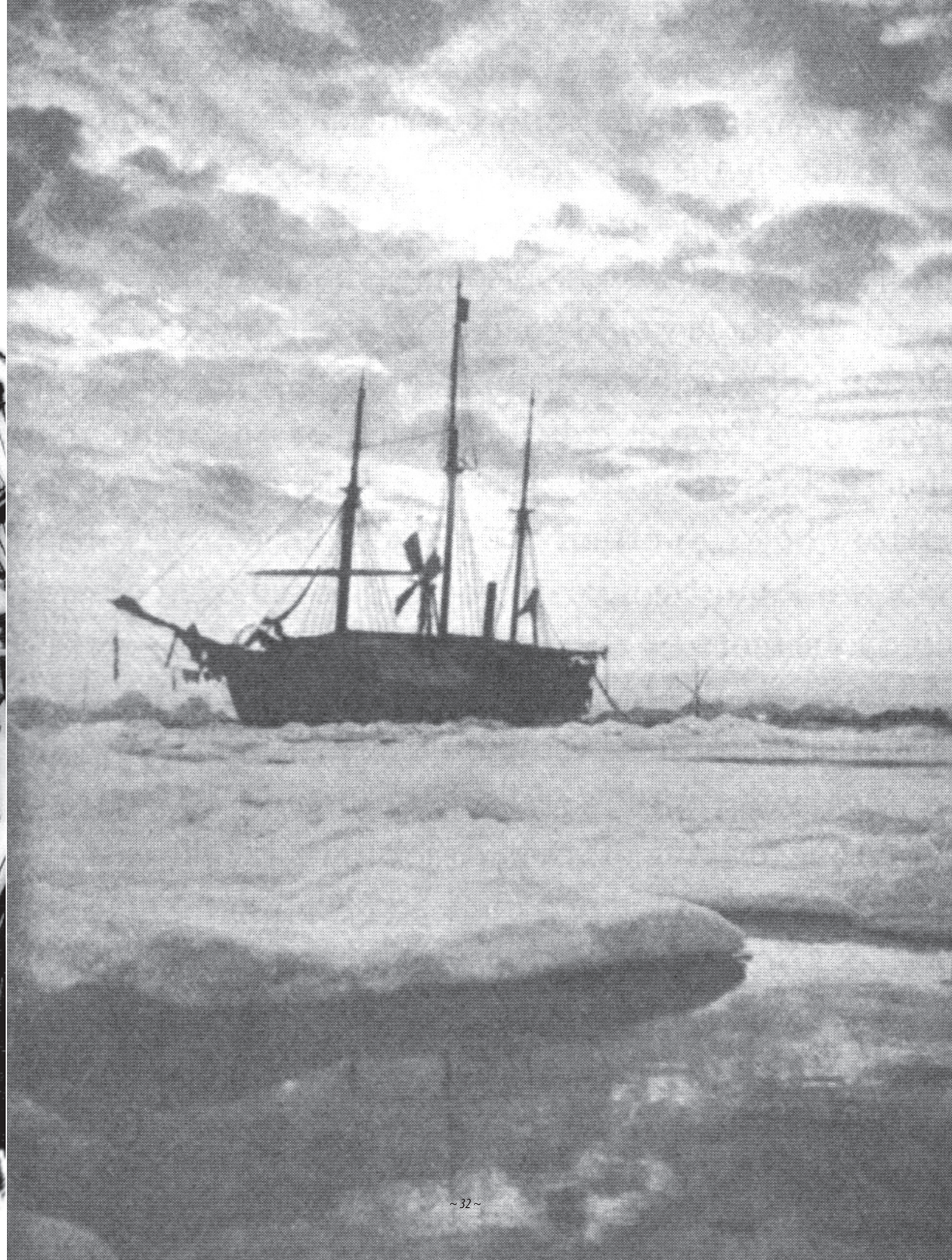


Fig. 25 ~ **Saloon** *from 20,000 Leagues Under the Sea Original Plate (1870).*

are filled with the products of the sea; anemones, shells, and huge pearls, all collected by Nemo in order to preserve his experiences and to display the results of his most cherished interest - the full exploration of ocean realm. The saloon is a processing station whose purpose is to organize and regulate the undersea world into a manageable collection of beautiful information. Perhaps it was a way for Nemo to mediate encounters with his enemies, past and present, by being immersed completely in an unknown environment; his new found knowledge giving him the upper hand, making him unreachable and unstoppable by any person, by anything but the force of nature.

The *Nautilus*, like the Atlantian continent it explored was made from the stuff of legends; of unconscious memories, of voids, of stories, and of pain. And through Nemo's refusal to accept the norms of society, the places within the *Nautilus* were formed; the remains of civilization that were deemed valid. The purposes for which Nemo existed were as reduced in nature as the places he kept for himself on the *Nautilus*. Despite his condemnation of society, Nemo remained like every human being, he was a creature driven by his internal urges to explore, to remember, and to selectively forget.



~ THE FRAM ~ 2.3

THERE are many locations on the Earth deemed to be inhospitable in nature. Though each location varies in type and extreme of condition, some of the most difficult regions to explore are at the most northern and southern extremes of the planet, the North and South Poles. Though other case study structures within this thesis are situated in the extreme conditions of the Arctic and Antarctic, one expedition from over a century ago exemplifies the importance of design functionality and its contribution to a successful and comfortable environment to inhabit, and also how it creates a pleasurable experience for those who occupy its spaces. The Fram, led by Fridtjof Nansen, first set sail on June 24th, 1893, and was intended to be the first manned expedition to reach the North Pole[27].

Designed to survive an expedition of exploration, research, and conquest of the most northern point of the planet; the *Fram* was specifically engineered to cope with extreme low temperatures, violent pressures imposed

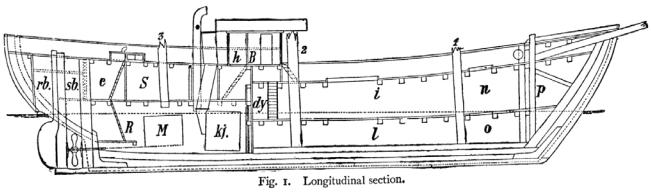


Fig. 1. Longitudinal section.

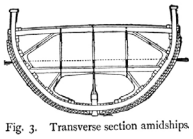


Fig. 3. Transverse section amidships.

Scale.

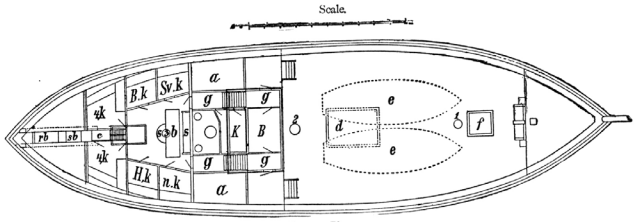


Fig. 2. Plan.

Fig. 4. Transverse section at the engine-room.

Fig. 29 ~ **Designs for the "Fram"** *showing: rudder-well (ib), propeller-well (sb), saloon (S), saloon sofas (s), saloon table (b), Sverdrup's cabin (Svk), Blessing's cabin (Bk), four-berth cabins (4k), Scott-Hansen's cabin (Hk), Nansen's cabin (nk), engine-room stair (c), engine-room (R), engine (M), boiler (kj), saloon corridors (g), cook's galley (K), chart-room (B), work-room (h), location for dynamo (dy), main hatch (d), long boats (e), main-hold (i), under-hold (l), fore-hatch (f), fore-hold (n), under fore-hold (o), pawl-bit (p), foremast (1), mainmast (2), and mizzenmast (3).*

by shifting ice, and to comfortably house a crew of 13 men for an unspecified duration. The compact and adaptable design of the *Fram* placed high importance on the wellbeing and safety of its crew. Nansen had described how many expeditions to the far north had set sail ill equipped for such unpredictable journeys and with vessels never intended to withstand the crushing pressures of ice[28]. The *Fram*'s size and shape, kept small in order to increase its strength in proportion to its mass, was planned precisely so that should the ice pressure on the hull become too great that "the whole craft should be able to slip like an eel out of the embraces of the ice", thereby saving it from being crushed[29]. And though personal cabin space was at a premium with the crew sharing two 4-berth cabins (*fig. 29*), the schooner's common area was comfortably furnished, warm, and well lit either by skylight in summer or by electric lights powered by the *Fram*'s dynamo or wind mill at night and during the winter. The main common area within the *Fram* was the ship's saloon that

Pull-out: Fig. 26 (page 31) ~ **Memory|Archive|Nostalgia** *by Author; Fig. 27 (page 32 left) ~* **M|A|N Preview** *by Author; Fig. 28 (page 32 right) ~* **A Summer Evening** *from a photograph (July 14th, 1894).*

functioned as dining area and drawing room[30]. The saloon's central role as a gathering place for the crew; one of comfort, warmth, and safety, was arguably one of the greatest contributing factors to the moral, comfort, and sanity of the crew that being overlooked, could have caused rifts between those who rely heavily on each other for ship maintenance, performing difficult tasks, and for protection during crises. Positioned at the vessel's center, the saloon was protected from harsh exterior elements by the surrounding crew quarters and galley. Along with the ship's careful design and construction, this kept the room warm and dry as well as highly accessible to all on board. It was simply furnished, containing a table and benches (*fig. 29*) to allow for a variety of functions including dining, relaxation, study, and festivities.

Over the course of the expedition, moral was maintained on board by the continuation of traditions and festivities held at home. The celebration of birthdays, religious holidays, and milestones in the expedition created a narrative of events in time, marking it as it passed and changed. Even with a

Fig. 30 ~ **Musical Entertainment in the Saloon** *from a photograph.*

crew as small as that of the *Fram*, celebratory occasions occurred often and were a welcome diversion from the monotony of regimented crew activities and barren sheets of ice. Parties on board were an extravagance that would have seemed out of place on the polar landscape. They consisted of specialized menus including desserts and aperitifs, music, stories, songs played and sometimes written by the crew, and lively games of cards (*fig. 30*). The saloon of the *Fram* was the heart and hearth of its small community; a protected place that was more than a shelter to its crew, the saloon provided a place where culture and experience could be built upon thereby strengthening the bonds of communication and trust.

Where the *Fram*'s design took special care to insulate its inhabitants from the harsh exterior environment while providing a stimulating place of discussion, center, and hearth; the initial preparation for the expedition and the

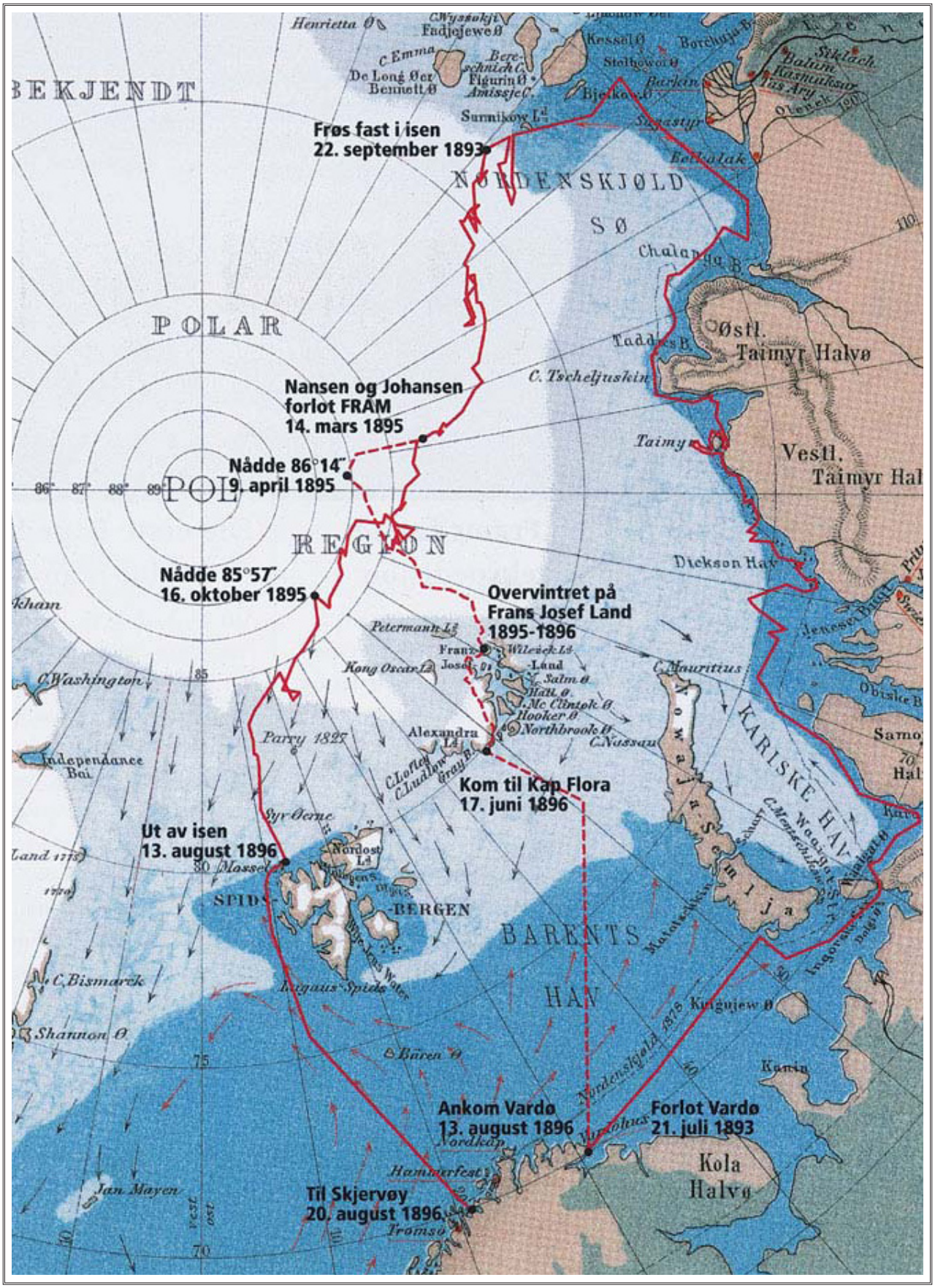


Fig. 31 ~ **North Pole Map** *showing: path taken by The Fram (continuous line) and the path of Fridtjof Nansen and Frederik Hjalmar Johansen (dashed line) after their departure from The Fram. They took with them six sledges and the intent to reach the pole by foot.*

selection of the crew also set this mission apart from previous failures. Each crew member had specific skills that made him indispensible both to the success of the expedition and to the survival of every person. Most carried years of experience in the navy or working on the seas while others were experts in the field of engineering, medicine, and science[31]. And like the ship's adaptable nature, able to fare both sea and ice with robustness and reliability, so too were the crew able to fill multiple roles as stokers and research assistants, sailors and hunters. Carefully selecting this particular crew, among the hundreds of applicants, created a powerful environment of dependability and resourcefulness.

Successfully returning without casualties after three years of planned drifting in the Arctic ice, Nansen's North Pole expedition became an instant legend. Though the intended goal of drifting with the currents and wind across the North Pole was not accomplished, the crew and Nansen returned alive having been the expedition closest to approaching to 0° latitude and

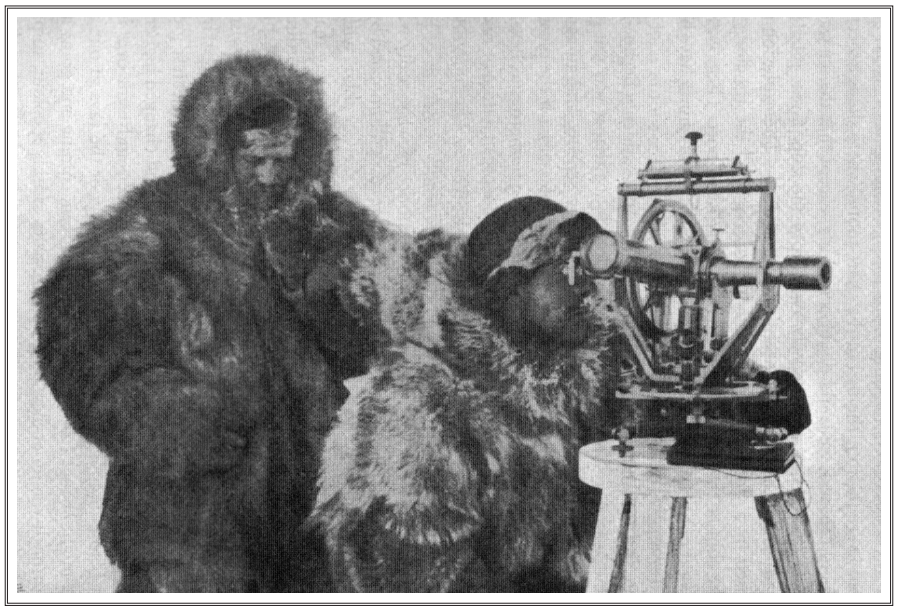
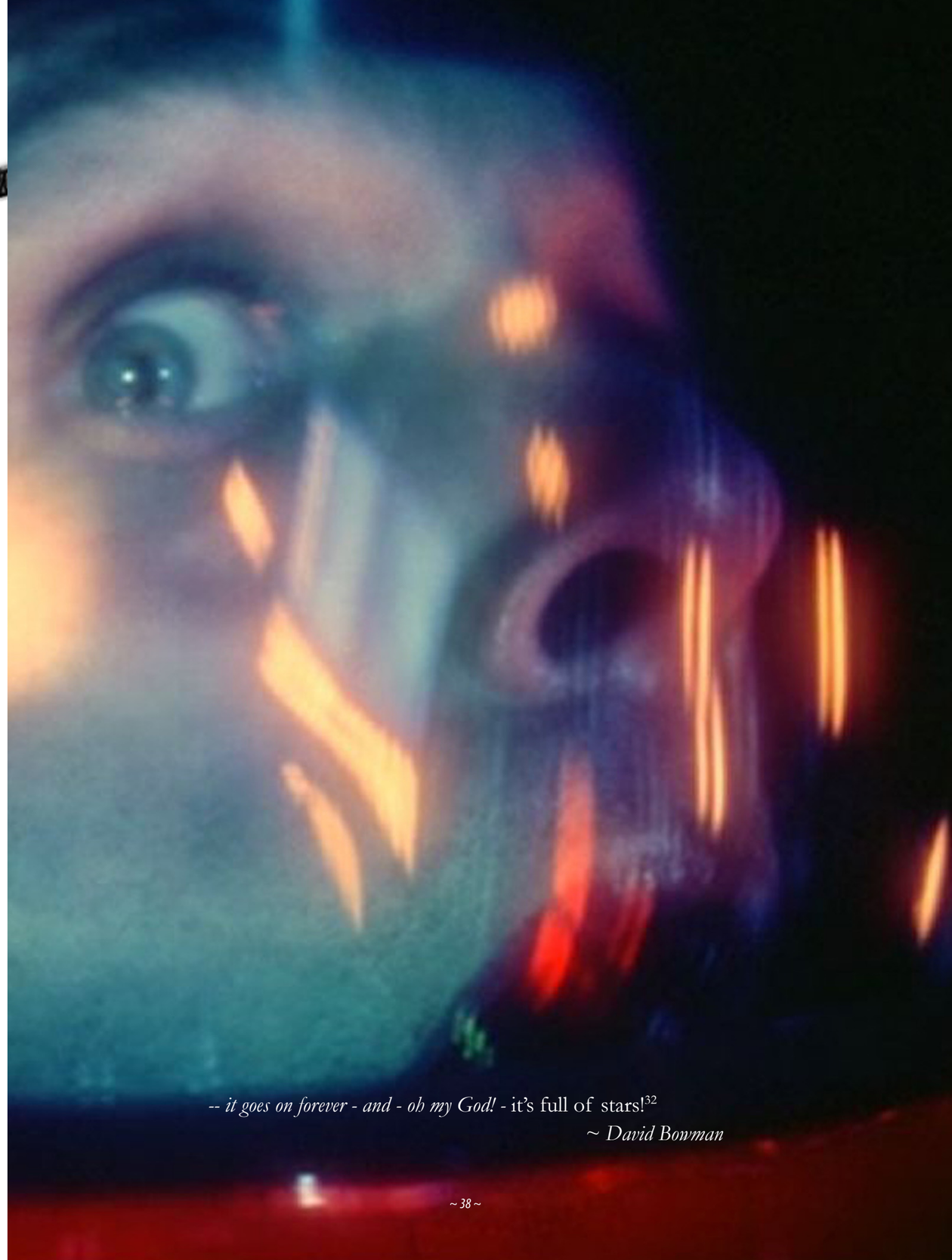


Fig. 32 ~ **A Chronometer-Observation with the Theodolite** *from a photograph.*

longitude in human history. This success was a result of many factors; the careful design and construction of the *Fram*, the availability of a place within to feel safe and comfortable, and the resourcefulness of a crew and leader that made a journey to the then unattainable northern extreme of the planet just that much more possible.



-- it goes on forever - and - oh my God! - it's full of stars![32]

~ David Bowman

2001: A SPACE ODYSSEY
~ DISCOVERY ~

2.4

DIRECTED by STANLEY KUBRICK - 1968

The robot body, like the flesh-and-blood one, would be no more than a stepping-stone to something which, long ago, men had called 'spirit.'

And if there was anything beyond that, *its name could only be God.*[33]
~ Arthur C. Clarke

Fig. 36 ~ **"Open the pod bay doors, Hal."** *Still taken from* **2001: A Space Odyssey** *(1968).*

PREMIERING just prior to the Apollo 11 Moon landing, *2001: A Space Odyssey* created an optimistic yet believable view of a future where interplanetary travel was within the grasp of humanity by the end of the twentieth century. Filmed in collaboration with the author, Arthur C. Clarke, *2001* is startlingly detailed, scientifically well researched, and told in a cold simplicity complimented by a score that elegantly, yet hauntingly fills the vacuous space. Carrying five crewmembers, two conscious and three in hibernation, *Discovery* was on a mission beyond exploration, endeavoring to find the source of a signal that emanated from the Jupiter system (Saturn in the novel), the hidden objective of *Discovery* was to make first contact with alien life[34].

Discovery was designed to incorporate habitable sections of artificially induced gravity containing living and work stations, and zero gravity; containing the bridge and shuttle pod bay, for the crew of five astronauts, three of

Pull-out: Fig. 33 (page 37) ~ **Hearth|Center|Resourcefulness** *by Author; Fig. 34 (page 38 left) ~* **H|C|R Preview** *by Author; Fig. 35 (page 38 right) ~* **Beyond the Infinite,** *still taken from* **2001: A Space Odyssey** *(1968).*

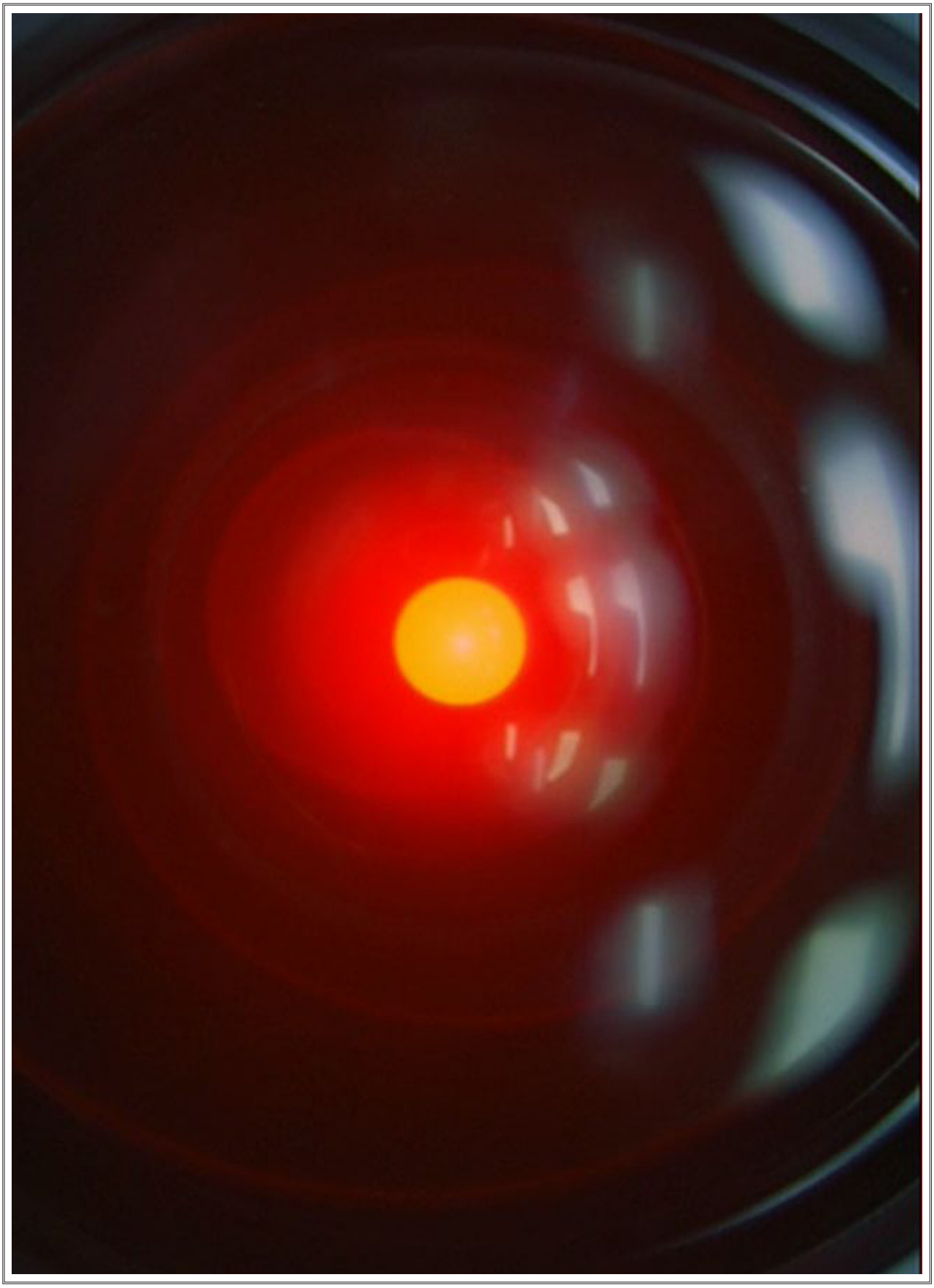


Fig. 37 ~ **HAL 9000,** *still taken from* **2001: A Space Odyssey** *(1968).*

which were in hibernation. Despite this, the vessel was almost completely monitored and controlled by *Discovery*'s "electronic-brain", HAL 9000 (*fig. 37*). Hal (as abbreviated within the novel), meaning **H**euristically programmed **AL**gorithmic Computer, was said to be infallible and completely dedicated to both the mission and the safety of the crew. However, upon its eventual malfunction, the importance of interface and communication between intelligences, human, artificial and alien, came excruciatingly to the surface.

The *Discovery*'s equatorial carousel revolved at 6 rpm, maintaining a Moon-like level of artificial gravity that benefited the physiologies of the crew[35] (*fig. 38*). David Bowman and Frank Poole, were left to go about their daily routines on a 12 hour rotating schedule. Their communications link, like an invisible umbilical cord, was tethered back to Earth via satellite connection, monitored by Hal. Carrying a constant stream of information and instructions back and forth between the two bubbles of humanity, this con-

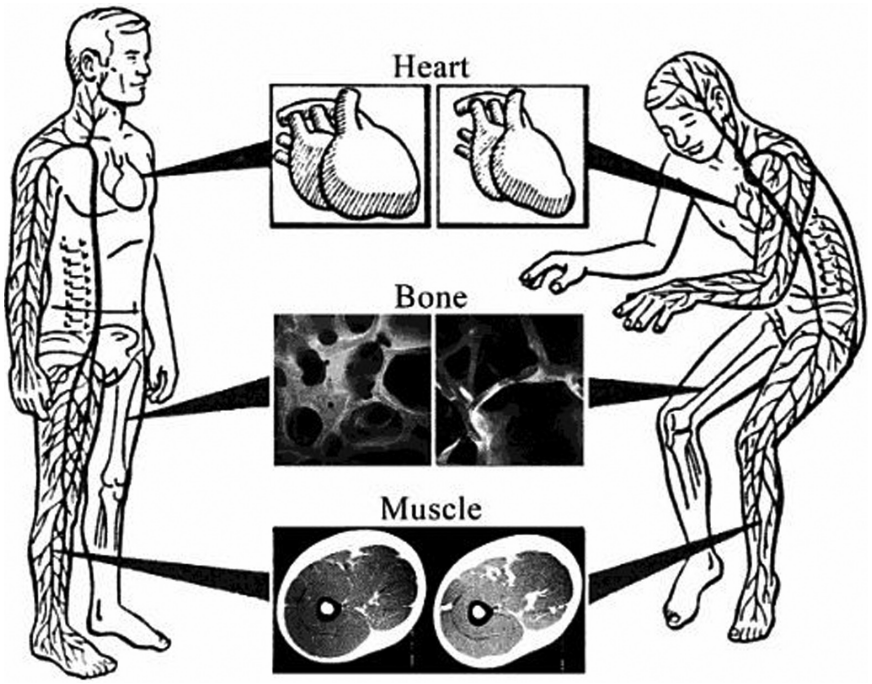


Fig. 38 ~ The known adverse affects on human beings of long-term stays in microgravity include bone demineralization, muscle atrophy, and reduction in heart size and plasma volume.

nection was not only important for the management of the mission objectives but also important to the crew's sanity. They relied on its connectivity to avoid the sense of abandonment that was caused by the millions of kilometers of separation.

The design of the habitation was kept clean and minimal, hiding all clutter and mechanical systems behind paneling and integrating all elements of control and life activities within the edge of the centrifuge. In comparison to the contemporary designs of the International Space Station and other analogue habitations, *Discovery* is a modernist's dream of the future. But the key components of *Discovery* are in the eyes and voice of Hal. Providing practically unlimited amusements in their spare time through games and stimulat-

ing conversation, warding off boredom and monotony, Hal was as much a companion to Dave and Frank as any other crew member could have been through the long months en route to Jupiter. As an artificial semblance of social interaction, companionship, and dedication, Hal seemed to interface seamlessly between man, technology, and space.

This seamless interface makes it all the more disturbing and painful when Hal turns on his crew, questioning their commitment to the mission, and killing everyone except Dave. The apparent guilt driven malice in Hal's behavior caused by the fault in his system[36] disrupted the connection between *Discovery* and Earth leaving the crew vulnerable to the attack of the panicked artificial intelligence that once guarded them from danger. His artificial intelligence and imitated humanity was both a blessing and a curse to the *Discovery* crew. The interface of words, visuals, understanding, and trust that originally connected the two entity types was permanently broken – amplified by the terrifying silence that remained in its stead.

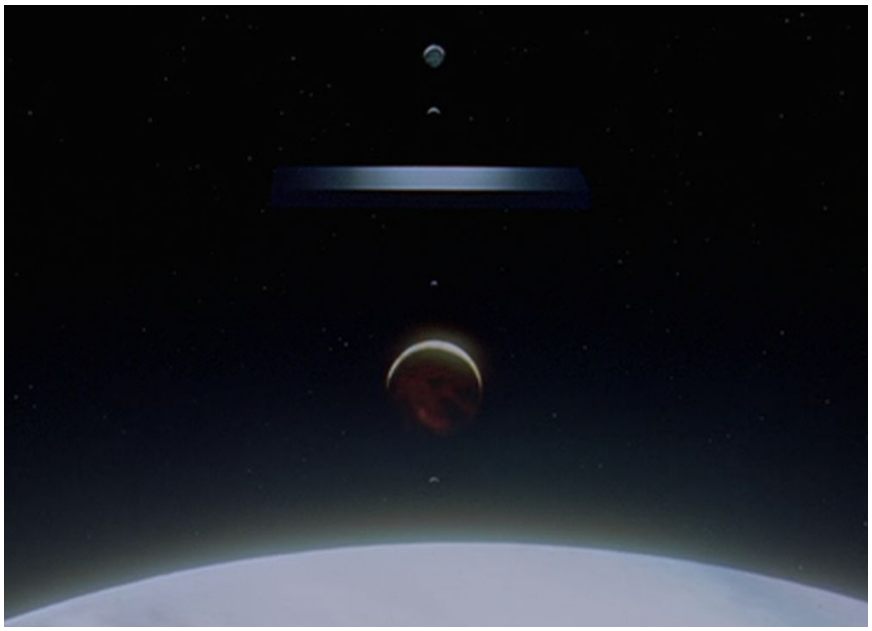


Fig. 39 ~ **Jupiter and Beyond,** *still taken from* **2001: A Space Odyssey** *(1968).*

It is more than a story of betrayal, of technology, or even of first contact with an alien race. *2001* confronts the destiny of the human race in space and time by allowing us to glimpse our transcendence into the possibilities of eternity, and the ultimate experience, be it in panic, terror, or grace, of traveling into the unknown.

ANALOG RESEARCH STATIONS ~ FMARS | MDRS | AMUNDSEN-SCOTT ~ SOUTH POLE STATION

2.5

IN an attempt to prepare ourselves for potential travel off-world and a life without the resources of an entire planet, several research stations have been established in various inhospitable locations around the world. The climates in which these stations are situated are predominantly desert regions, both hot and cold, though many are located in Antarctica where temperatures at the most southern point plummet below -80° C. These locations are remote, isolated, dangerous and possibly the most inhospitable places on Earth. But it is because of these hostile and comparable characteristics that locations in the Antarctic and other desert regions are so desirable when proposing analogue mission architectures for future habitations in space and on other planets. By looking at capsule typology habitats such as

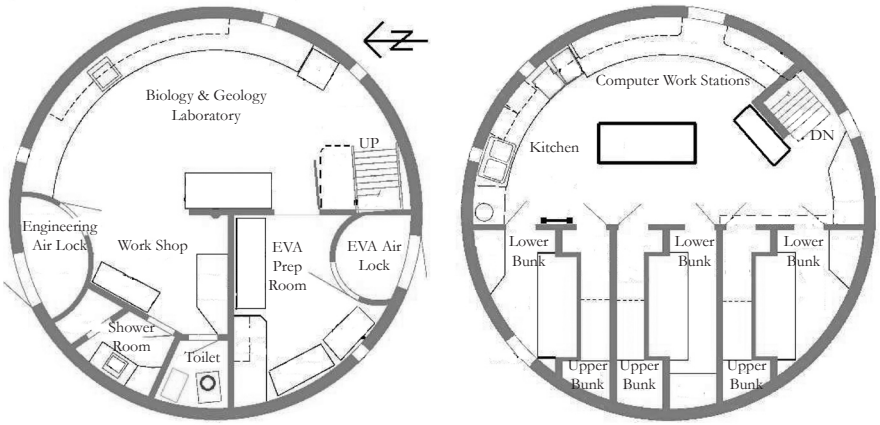


Fig. 43 ~ **MDRS Lower Deck (left) and Upper Deck (right) Plans**.

the Mars Desert Research Station (MDRS) and the Flashline Mars Arctic Research Station (FMARS); as well as the much larger Amundsen-Scott South Pole Station, a variety of important issues regarding the inhabitation of isolated and confined environments (ICEs) will be identified.

Many analogue habitats are capsules, highly condensed vessels designed to fit possible launch and resource constraints, containing working and living space, airlocks, storage for food and equipment, EVA (Extra Vehicular Activity) and life support systems. A very small percentage of area is allocated to private quarters or personal space. Personal area and many other aspects of design relating to what is known as *human factors*, "the study of the interface between humans and technology" (*see Appendix C*), are often lower in priority when preparing for missions to orbit when compared with the necessary design constraints implemented to protect the habitat occupants from hazardous environmental conditions. MDRS in the Utah Desert, USA, and FMARS located on Devon Island in Canada are both part of the Mars Analog Research Station Project. In each station, crews are numbered between

Pull-out: Fig. 40 (page 43) ~ **Interface** *by Author; Fig. 41 (page 44 left)* ~ **Interface Preview** *by Author; Fig. 42 (page 44 right)* ~ **"Moon Over Station"** *by Jonathan Berry (2002).*

6 and 7 persons; however, this number can double on crew change over. Mission durations vary between stations, MDRS missions are a standard two week rotation while FMARS lasts for four weeks in July; though, this has been extended to as many as 100 days in 2007 as part of the FMARS 11 Long Duration Mission[37].

In short duration missions, isolation and confinement is not a major concern. Though conditions are cramped and there is very little privacy, the beneficial experience of a Mars analogue sojourn far outweighs the negative connotations of isolation and confinement. The crew or researchers are heavily engaged in regulated activity; performing daily EVAs (Extravehicular Activies), collecting and analyzing data[38], and performing maintenance on the habitat and its systems. Missions, especially on MDRS, are kept short, making for intense experiences. Crews leave their mark within the station as well, they write their names or leave a mission patch on their crew cubby door (*fig. 44*). These small rituals are a part of the experience of an analog

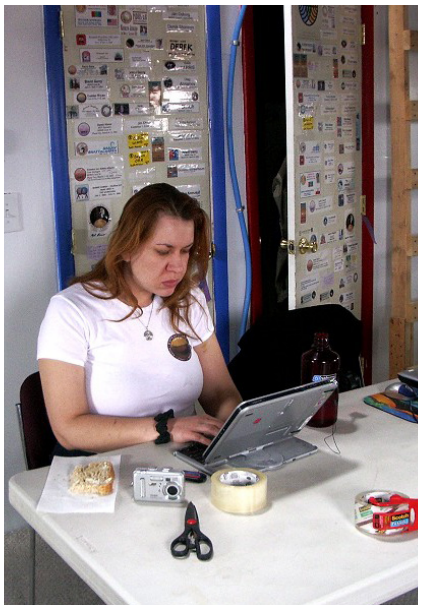


Fig. 44 ~ **Danielle Cormier - MDRS Crew 57** *(2007).*

Fig. 45 ~ **Chili Dinner - MDRS Crew 57/58** *(2007).*

mission; meals are prepared and eaten together, EVAs are a team effort, and there are also rites of passage performed during crew changeover where the habitat population doubles forcing an impromptu "slumber party" (*fig. 45*) that makes for a festive atmosphere encouraging discussion and camaraderie. This also allows for a period of knowledge transfer where crews can informally discuss daily procedures and share experiences.

Longer duration missions magnify the issues of isolation and confinement experienced in shorter missions in places like FMARS and MDRS. Feelings of loneliness and depression are experienced in a relatively low percentage of crew members but, "although these rates are lower than what might be experienced in the general population in the United States, they are noteworthy in that these men and women are required to undergo psychiatric screening prior to the austral winter"[39]. The Amundsen-Scott South Pole Sta-

tion (*overleaf fig. 47*), initially constructed in 1956, rebuilt in 1975 and had a further addition in 2003, stands at the geographical South Pole of Antarctica (*fig. 46*). Recorded temperatures have varied between -13.6° C and -82.8° C, there is an annual 20cm accumulation of snow with very low humidity[40], and access is completely limited to summer months between late October and the beginning of February. It has been described not only as "the harshest environment on Earth" but also paradoxically "the most benign", referring to the 6 months of dry, cold darkness it receives in winter, making the South Pole the most desirable place on Earth to observe the Cosmos; if you wanted better observation conditions, "they could only be found in space."[41] The South Pole Station is occupied throughout the year by up to 150 men and women. During the winter-over, the population drops to a few dozen people, 47 in February, 2010.[42]

So who would subject themselves to these kinds of conditions, no matter what the time of year? The station acts as a perfect host for those study-

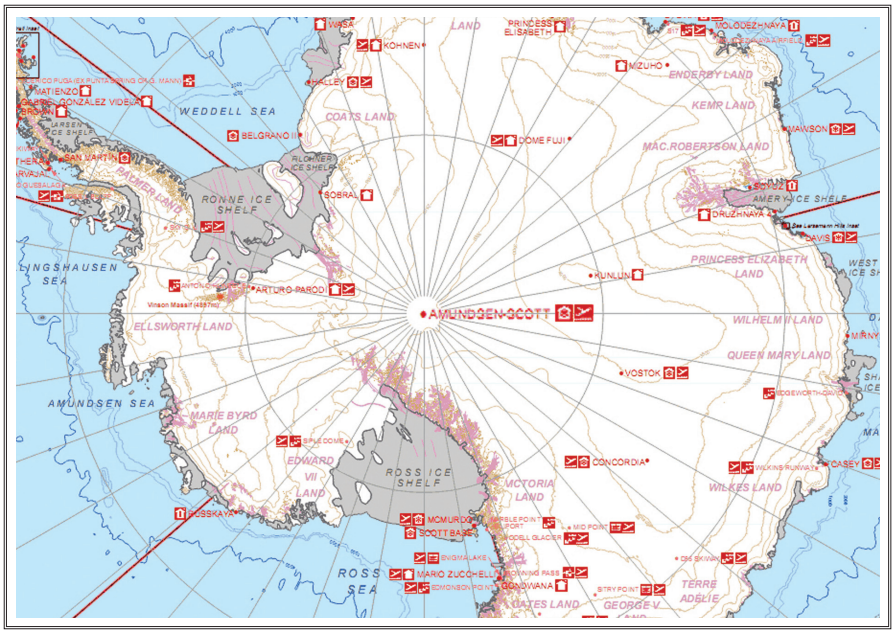


Fig. 46 ~ **Map of Antarctica Stations** *showing Amundsen-Scott South Pole Station at geographic South Pole.*

ing the Cosmos[43] but also to scientists interested in the study of our planet, including seismic and atmospheric studies. Perfect for science but painful to inhabit, the remoteness of South Pole demands a certain type of person, one who is able to cope with the isolation and difficulty of months of sunless skies. Common characteristics shared among polar expedition members, astronauts, and those best suited to cope with isolated and confined environments are: extraversion, a high degree of autonomy, social versatility, agreeableness, openness, a sense of humor, low measures of neuroses, and sensitivity and tolerance to others, especially with higher numbers of international crews[44]. Though there is a great deal of care taken in selecting crew members for all types of expeditions, there is no 100% perfect selection process; there will always be different reactions to every event, some positive, some negative.

The effects of occupying an ICE vary from person to person depending on how well the crew members are able to adapt to the environment, the duration of the mission, the type of habitation (capsule or otherwise), the lack of privacy, and inter-crew relationships, to name a few. Long term exposure to an ICE, space, or Antarctic environment can lead to many psychological, psychosocial, and physiological issues causing disturbances in: appetite, sleep, mood, thinking and cognitive abilities, and psychosomatics. It can also lead to substance abuse as a method of passing the long winter night[45]. There is a long list of possible stressors that can have varying impact on crew physiology and psychology. It remains an area of important study and continuing research (*see Appendix D*).

Despite the possible effects of inhabiting an isolated, hostile place like the Arctic, Antarctic, or the Utah desert for long periods of time, there remains the benefit discovering the unknown environment that surrounds, interacts with, and permeates each inhabitant. Marc Levesque, Logistics Coordinator at the South Pole Station during the 1981-82 winter-over, stated that during the year that he spent at South Pole Station, he often felt that it was the closest earthbound people could come to living on another planet[46]. This experience gave insight to so many on the limitations of people, how they work together in the worst of environments, and how they grow to appreciate even the smallest of conveniences, like a shower every three days if they are lucky. The experience enforces the importance of camaraderie among the crew, encouraging rituals that strengthen bonds between individuals and create an identity to what would be to an outside observer, a vast, inhospitable emptiness. But to those inhabiting these far removed stations, it is not emptiness; there is endless extremity. If not monitored, crew will often spend hours staring out at the unfamiliar beauty of the Polar night, its undisturbed starry sky, the ever-changing Aurora Australis, and the seemingly unending planes of ice. Researchers have stated though that "the environment has no direct impact on human beings. Rather, it is filtered through their psychological and physiological information-processing systems. In consequence, the crucial determinant of the response is not an environment, but an experience, this being defined as the environment *and* its meaning to the individual"[47].

Creating the experience and guiding it to be one that is cherished rather than remembered as a nightmare is as much a part of the place as it is the habitat. Every winter spent in the Antarctic, every two week stint in a tin can in a desert reaffirms the importance that needs to be placed on experience and living, just as much as on survival. It is interesting that some of the most hostile places on the planet are the only locations that can provide us with a window to the farthest reaches of the universe. The experiences gained there are difficult to attain and that, perhaps, is why they are so rich.

Previous Pages: Fig. 47 (pages 48-49) ~ **Auroras over the 10-meter telescope and BICEP (Background Imaging of Cosmic Extragalactic Polarization) at Amundsen-Scott South Pole Station** *by Keith Vanderlinde (June 25th, 2008).*

Remember the tests they gave us? They measured our tolerance to stress: confinement, prolonged isolation, chronic physical danger, that sort of thing. Remember what you said? About mountain-climbers, and free-fallers, and why people deliberately do dangerous things? … and do you know what thrill-seekers have in common? They all say that you haven't lived until you've nearly died. And a lot of the really compulsive ones, the ones who can't be happy unless they're on the edge, all the time – a lot of them got started early, Lenie. And you, I bet… you don't even like being touched –[48]

~ Ballard

STARFISH
~ BEEBE STATION ~

2.6

Peter Watts - 1999

A pressurized sphere tethered three thousand meters below the surface of the Pacific Ocean, *Beebe Station* is the habitation and work space for a crew of six individuals known as "*rifters*" (*fig. 50*), serving a one year contract to maintain the geothermal energy plants of the Channer Vents on the Juan de Fuca Ridge. In the near future when the world has resorted to collecting energy from the most remote locations on the planet, the story of *STARFISH*, written by Peter Watts, follows *Beebe*'s crew through their work and experiences living with three hundred atmospheres bearing down upon their mechanically modified bodies at the bottom of the Pacific[49]. In an environment as alien to us as another planet in the solar system, where animals phosphoresce both to attract a mate and their prey, can there be a place for humanity?

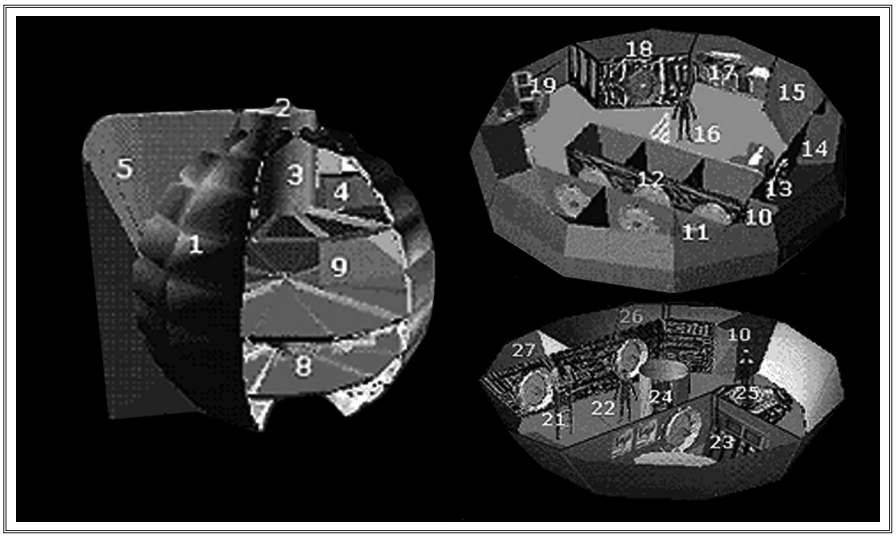


Fig. 51 ~ **Beebe Station: General Layout** *showing: double hull (1), docking hatch (2), top hall (3), ballast/organics stockpile (4), tool shed (5), wet deck (8), dry deck (9), toilet (10), shower (11), personnel cubbies (12), sewage recyclers (13), inorganic stores (14), organic stores (15), lounge (16), galley (17), communications cubby (18), library/entertainment pedestal (19), interdeck ladder (21), ready room (22), medical cubby (23), personal airlock (24), engineering airlock (25), life support/seawater electrolysis (26), and storage (27).*

Though its remoteness could be compared to an Antarctic research station, the crew chosen for the duties onboard *Beebe* were selected by opposing criteria. They are thrill seekers interested in pushing their limits, careless, rigid in personality, and unsympathetic to others[50]. It is revealed that all of the characters involved on *Beebe* are "disturbed" in some way; either victims of aggression or as the aggressors, the crew of *Beebe* have become predisposed to seek out isolating conditions. In their shared desire to be alone and escape from the pressures of society, the small station at the bottom of the ocean is perhaps the most desirable place to be on the planet.

The only purpose of the station's occupants is to maintain the geothermal generators of the under-sea power plants. Like dedicated machinery, the crew is provided with no more than is required for survival, making the habitat claustrophobic, cramped, and psychologically destabilizing. The omnipresent pressure of three thousand meters of water is felt even inside;

Pull-out: Fig. 48 (page 51) ~ **Endlessness** *by Author; Fig. 49 (page 52 left) ~* **Endlessness Preview** *by Author; Fig. 50 (page 52 right) ~* **Rifters** *by Scott Clarke (2004).*

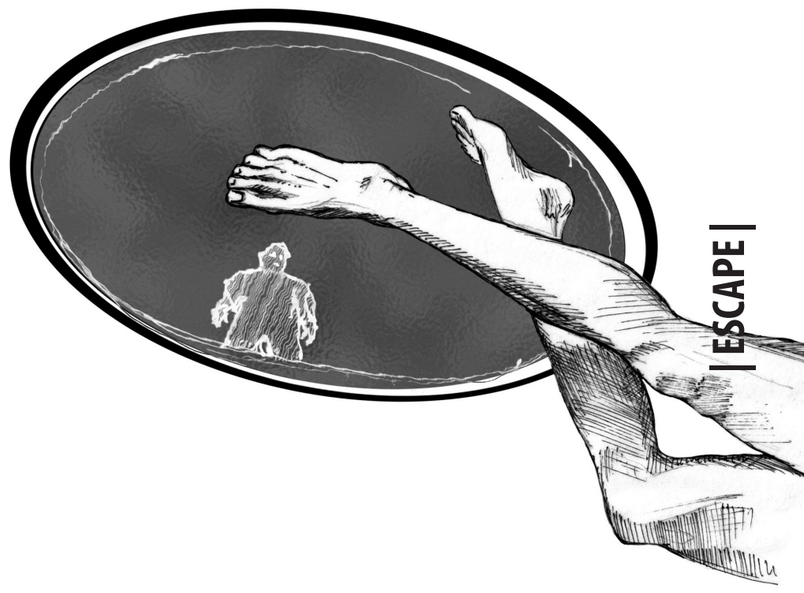
"when the lights go out on Beebe Station, you can hear the metal groan."[51]

Though, according to Watts, *Beebe* was designed to withstand five hundred atmospheres[52], the station provides little comfort or reassurance to its crew from its structural design or planning.

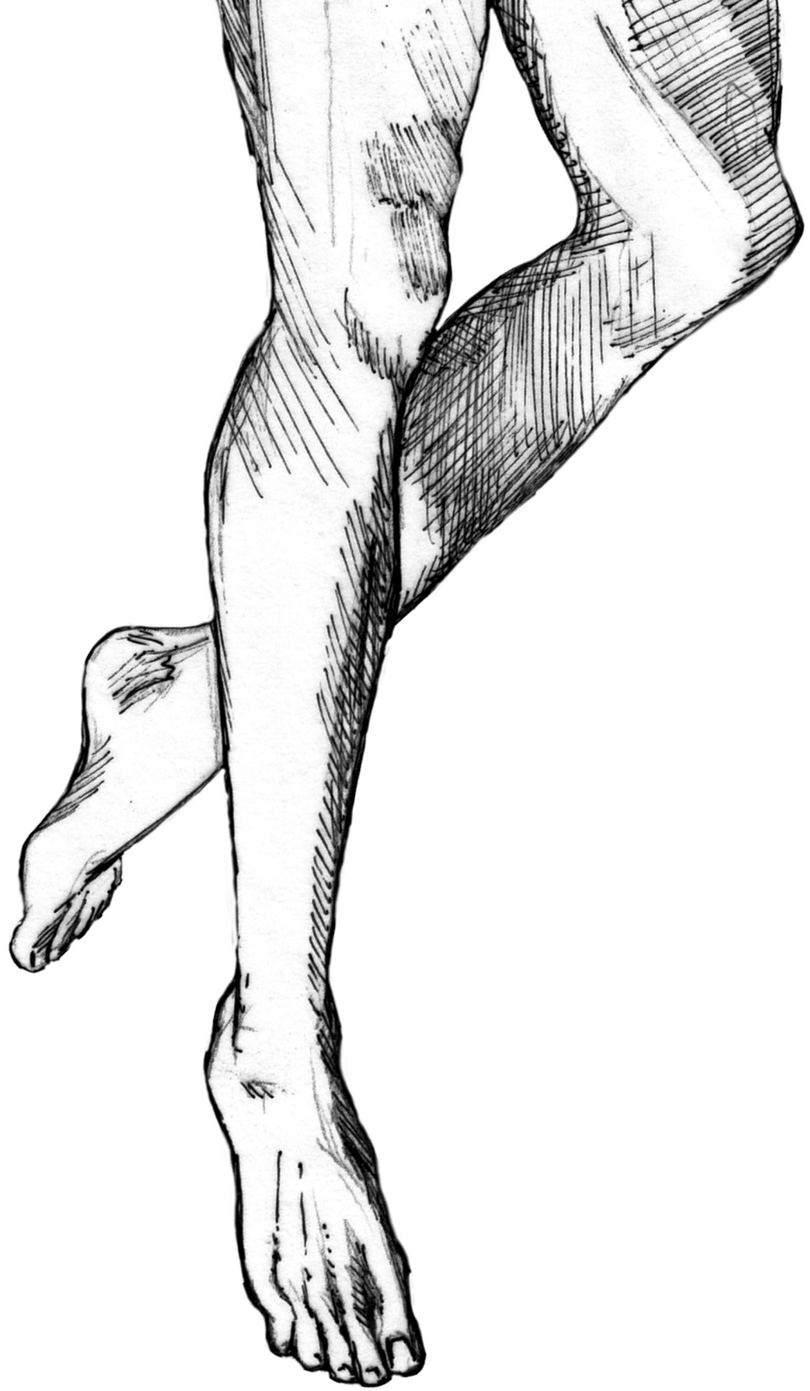
Beebe Station is divided into two main sections; Dry Deck, and Wet Deck. The Dry Deck, located at the top portion of the station (*fig. 51*) contains the crew quarters, a galley, small lounge, communications, library console, and sanitation. The lower, Wet Deck contains the air lock for extra vehicular activities (EVAs), ready room, medical bay, life support systems, and storage. All spaces are kept to a minimum area; personal quarters are only two square meters, the lounge, what most would consider an integral zone for any social environment, is a shapeless thoroughfare bordered by services, level changes, and a very small galley; the complete opposite compared to the place of gathering that was provided by the saloon of the *Fram* for its crew. The station is without character. Devoid of adornment beyond the mirrored bulkheads within the quarters, the crew of Beebe Station maintained an absolute personal disconnect between themselves, the station, and any relationships with other crew members. Intended for use only in the ocean to enhance vision in the darkness and protect the eyes, each *rifter* chose to wear his "eye caps" while on board Beebe Station, effectively placing a barrier between himself and everyone else. The masks they wore on the empty stage of Beebe provided each crew member with a place to call his or her own, something that the station could not provide.

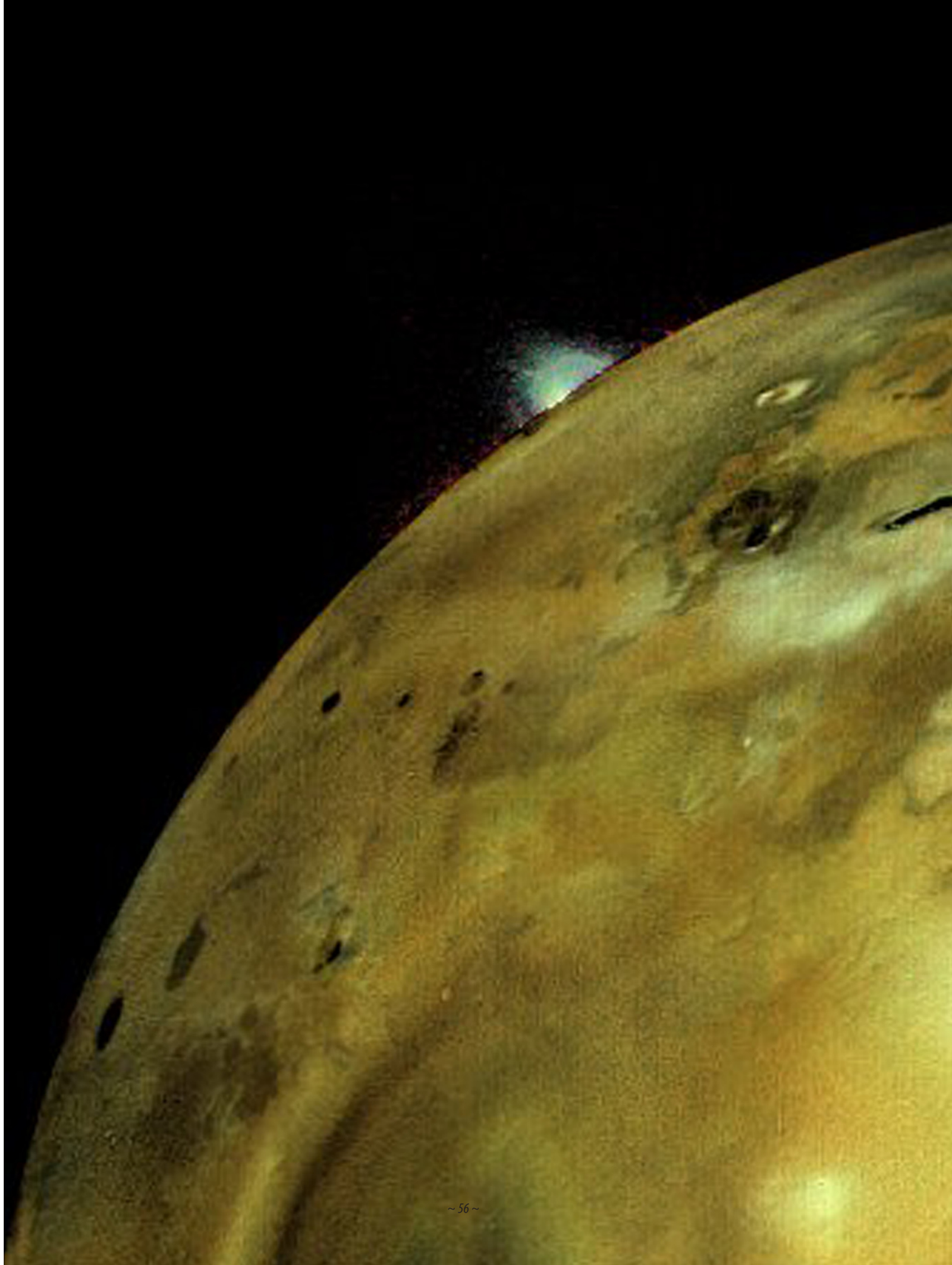
The term 'escapism' does not always have the most positive connotations; to habitually avoid reality by seeking solace in fantasies or distraction is often seen as a form of weakness, augmented by an inability to cope with the truth of one's existence. Aboard *Beebe Station*, instead of escaping into fantasy, the crew escapes into sensory deprivation - into the utter darkness of the ocean. There, time appears to move at a different rate; hours slip by unnoticed while the each crew member fulfills her duties, or while she explores the darkness of an underwater landscape known better to the *rifters* than their own cabins. Aboard *Beebe*, the tension between the crew is palpable. Each moment is spent in awkwardness and emotion, relationships are strained in the confinement; the next reason to escape outside into the silent waters cannot come soon enough (*fig. 50*). The dagger like teeth of the monstrous aquatic life, it seems, are less difficult to confront than the presence of another person.

Beebe Station is more a shell than it is a habitation. Its purpose is to protect its crew from the enormous pressure of the ocean and its hostile creatures, and to guard against the impact of being contracted to an ICE, or isolated and confined environment, however it achieves this only by the most basic standards, if at all. By creating an environment found to be inhospitable by the crew, the architecture of *Beebe Station* finds unintentional success in provided the escape from society her crew so desperately sought. It was said early in *STARFISH* that *Beebe Station* is "only dark when the lights are on"[53], as it repelled the voracious and strangely beautiful phosphorescing fish. Yet, the darkness appeared most prominently in the shadowed masks worn by the crew while inside *Beebe*; their true selves only rising to the surface when they swam away from their supposed home.



| ESCAPE |





OUTLAND
~ CON-AM 27 ~
DIRECTED by PETER HYAMS - 1981

2.7

WHEN contemplating the future of humankind in space, it is easy to be seduced by the idealized representations of sleek space ships, "transporter beams", and the perfectly functional utopian societies that are sprinkled liberally through science fiction. The upper-middle class aesthetic has been a part of design studies at NASA and in other venues since the 1950s. *Space Settlements: A Design Study*[54], published in 1977, depicts life on board a toroidal station in orbit of Earth, populated by 10,000 colonists, as an idyllic image of space-suburbia (*fig. 55*). Of course, the research gathered for this project is extensive and includes issues of construction, sociology, and the future prosperity of the colony. But where and how are the resources for these colonial paradises being procured? What about the dirty side of space colonies? The film *Outland* depicts aspects of daily life within a mining colony located on Io, Jupiter's inner most Galilean moon.

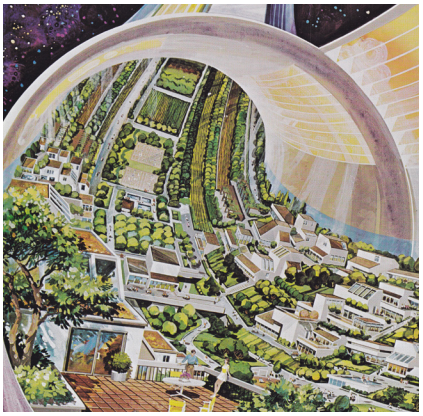


Fig. 55 ~ **Colony at Lagrangian Point L_5** *by Rick Guidice. Image courtesy of NASA (1977).*

Fig. 56 ~ **CON-AM 27,** *still taken from* **Outland** *(1981).*

The spaces within the colony are functional, industrial, and mechanical in appearance leaving us feeling cold, and drained by the ever present flicker and acrid tint of fluorescence lights. But there is life within these spaces, vibrant, impassioned, and brutal. But perhaps this is a more truthful vision of humanity's future in space than any one depicted on the Stanford Torus or in episodes of *Star Trek*.

Situated on the most geologically active object in the solar system[55], *CON-AM 27* is a titanium mining operation with a staff and labor force of 2144 people, each holding a one year contract (*fig. 56*). Upon contract completion, they are transferred and replaced by fresh employees. The colony is connected to Earth and a neighboring space station by a weekly shuttle and through regular communications. Despite the millions of kilometers that separate our planet and *CON-AM 27*, Earth is not far enough away for the colony's culture to evolve independently.

The working conditions depicted in *Outland*, dangerous and difficult, are not that different from those in a contemporary Earth bound mine, though

Pull-out: Fig. 52 (page 55) ~ **Escape** *by Author; Fig. 53 (page 56 left)* ~ **Escape Preview** *by Author; Fig. 54 (page 56 right)* ~ **Volcanic Explosion on Io** *taken by the spacecraft Voyager 1, credit NASA/JPL (1971).*

the actions of the miners depicted in the film are heavily exaggerated and perverse by comparison. The work day is long and intense. The payoffs, depending on the danger level of the job, are high. The living is simple. Where labor force barracks are stacked cages, similar to animal kennels (*fig. 57*), the officers' quarters are far more luxurious. For the miners, entertainment and relaxation begins to take an increasingly prominent role in sustaining a positive working attitude. There are squash courts, food halls, bars, and brothels. The spaces are not pristine, their materials are robust, they are well used, beaten up, and built to last. The entire base has the appearance of a tanker that was quickly transported to the site and dropped off ready for action. The rituals and routines kept to pass the time until contract's end are as rough as the work – the miners put in their time, get drunk, and enjoy casual sex either with partners or prostitutes. The bar, the main social gathering place in the colony, is gritty, dark, and loud. Abstractly illuminated and highlighted by circles of blue laser light, entertainers dance provocatively on the bar and tables, enticing the crowd to spend their hard earned cash on drinking themselves into oblivion. When evening's end draws near, the workers pair off and move to red lit private rooms to enjoy more carnal diversions. And if problems of behavior arise, a sobering night in a holding cell is always on offer. In the morning, the cycle of work and debauchery begins again. This

Fig. 57 ~ **Sleeping Quarters,** *still taken from* **Outland** *(1981).*

is no monastery. There is no hope for enlightenment or attaining a state of higher being. Their lifestyle is a mirror of the environment they inhabit; hard, industrial, and raw. There is, however, a paycheck, and with that comes hope for the future and the possibility of something better.

CON-AM 27 does not encourage the discovery of the unknown; there is no time for that, for observation, or for contemplation. *CON-AM 27* is about work, making money, and getting the job done. To complete a job like this with such a high level of risk, the miners resort to animalistic behavior, both as a form of recreation and in order to face their dangerous work with a clear mind and confidence.

Outland tells an honest story about a mining colony on a distant moon that omits the glamour usually associated with the future in science fiction. It depicts the dangers the miners of Io face daily, but also the animalism that appears when survival is at stake. We may try to deny our origins when designing high architecture, built to exemplify the power of the human spirit and our many lofty accomplishments, but all of us at one point or another must confront the fact that we are nothing more than intelligent members of a vast animal kingdom.

WALL•E
~ BUY n LARGE STARLINER AXIOM ~

DIRECTED by ANDREW STANTON - 2008

2.8

THIS thesis proposes to permanently remove a human population from Earth's solar system in order to continue our destiny as explorers to the ultimate extremes of our capabilities. In the abstract setting of unending space and time, the issue of duration and how humans cope with the concept of eternity in daily life begins to become problematic.

The 2008 Pixar™© animated film, *WALL•E* confronts this issue, among others, in a narrative in which the Earth's population must be "temporarily" evacuated in order to complete a planet wide clean-up project. However, the failure of the program left Earth's population out in space on board a convoy of BnL (Buy n Large Megacorporation) Starliners for seven hundred years. The BnL flagship, *Axiom*, was completely automated providing all inclusive service to its passengers, leaving them to relax and enjoy life to its fullest while away from home. But, when left with nothing to do for seven centuries, the people of Axiom progressively became fatter, lazier, and lost all comprehension of their origins and purpose in space.

Catering to every whim of the passengers, Axiom's design centers on the subservience of robots and use of technology to accomplish all tasks, no matter how basic, in order to leave the population to relax and do as they please. Whisked about the expansive vessel on a transit system of reclining chairs, the people of *Axiom* did not even have to walk from the bed to the toilet in the morning, and never even had to consider where their next meal would come from. The reliance on technology was pervasive, required even for two people to carry on a conversation, no matter the distance between them. These dependencies on technology in turn created complete disconnect within the population: disconnect within social interaction; disconnect between the person, the vessel, and their location in space; and disconnect between the person and the value and meaning of time. Having automated all tasks on board Axiom, the *BnL Starliner Fleet* effectively made an already indifferent population, one who knowingly destroyed their own planet's ecosystem, impossibly apathetic.

The automation of Axiom has taken the Western ideal of the all inclusive vacation and has expanded it to monstrous proportions - in area, population, and sheer timescale. The obvious purpose of a holiday resort is to provide a place to take a break from the everyday, the mundane, and the stresses that we face in daily life. Having ones needs catered to and indulged is a wonderful feeling – it is restful and rejuvenating and is sometimes required in order to perform better upon return to "real life". But what happens if this type of environment and lifestyle is prolonged indefinitely? When you have nothing to do, what do you do? With nothing pressing, no tasks to complete, no work to be done, the population of Axiom was left with nothing but "free time" on their hands – which brings a new literality to the term. When time comes at no cost, if there can be no valued accomplishment or thoughts associated with its passage, how can time have any value? It becomes abject, unimportant, impossible to waste, and unchangeable.

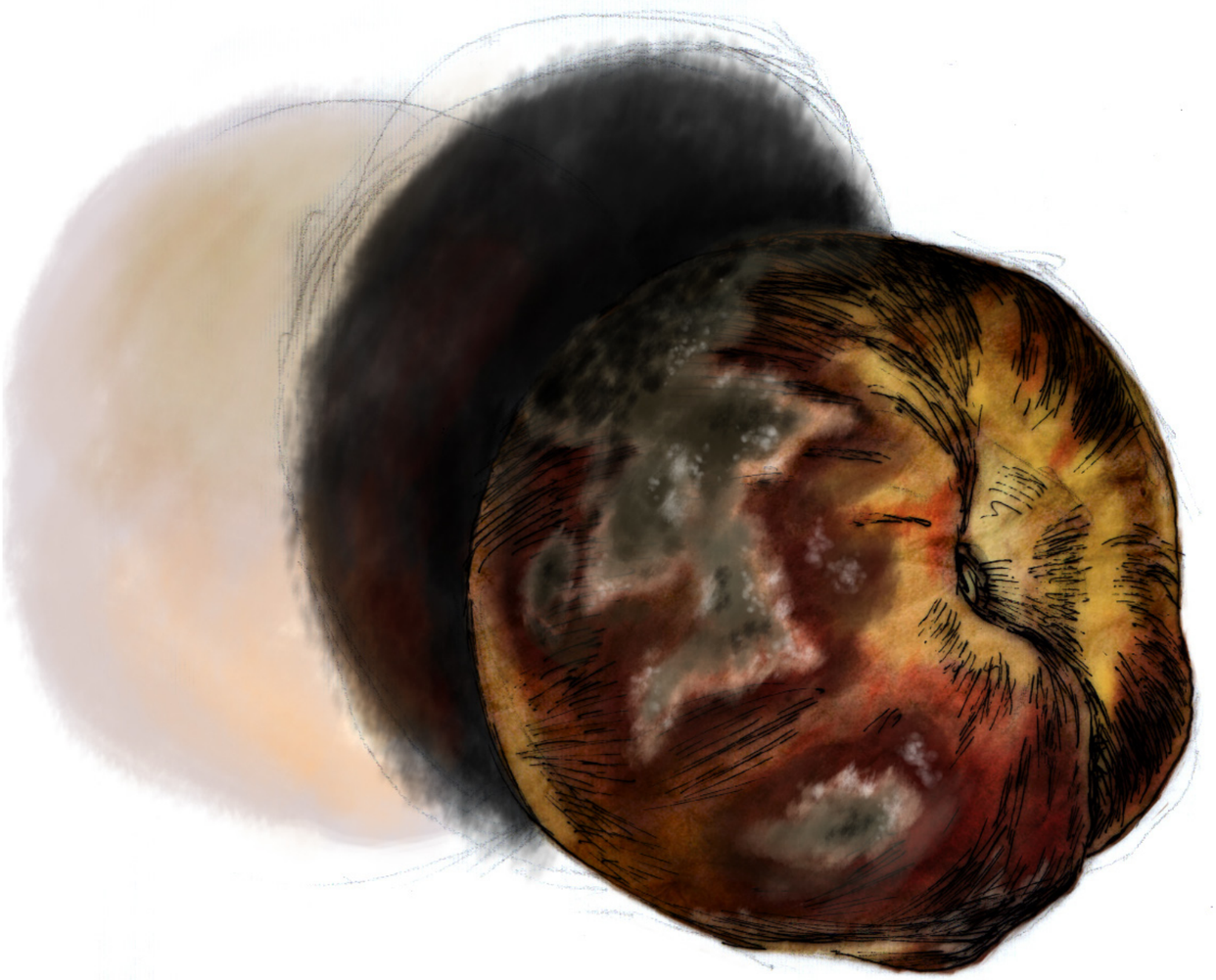
Pull-out: Fig. 58 (page 59) ~ **Animalism** *by Author; Fig. 59 (page 60 left) ~* **Animalism Preview** *by Author; Fig. 60 (page 60 right) ~* **Buy n Large Starliner Axiom,** *still taken from* **WALL•E** *(2008).*

Our perception of time and its passage is affected by many things: what we're doing, if we're wearing a watch, if the sun is out, the weather, the season, the people we're with… it is an unending list and it is highly individualized. All of these factors affect our emotions, our effectiveness at work, and whether or not we are able to fall asleep quickly or wake up in the morning. Circadian rhythms are special criteria to pay attention to when we travel great distances, changing time zones and sometimes crossing into places where the "normal" affecters are no longer present, upsetting our schedule and changing how we live. The hypothetical designers of Axiom implemented a circadian rhythm regulator, a cartoon image of the sun that tracks across the ceiling over the course of each Earth day that passes (*fig. 61*). It is interesting because it raises more questions about how we represent and understand the passage of time than it solves by simply projecting an image of the sun into a false sky. Though it is an element of consistency throughout the day, it is also one of monotony; one that always "shines" brightly and, along with the other ship systems, maintains a perfectly comfortable temperature and pressure. It lacks the change that is craved by every person. Where are the rainy days that change our mood, make us stay in and read a book, call on a friend and relate to one another on a level and in a situation we could never have without water falling out of the sky? Where are the changes in season that

Fig. 61 ~ **Sun Control,** *still taken from* **WALL•E** *(2008).*

everyone looks forward to? Change: it is an operative element in the defeat of monotony. It is that *thing* in the future that we all look forward to, that we wake up for in the morning, and that we dream about at night. It gives meaning to the impermanent and draws awareness to place and surroundings as things both grow and decay.

There are many interesting and important social issues presented in *WALL•E*: planetary conservation, over indulgence, disassociation, and apathy to name a few; all of which seem to be surrounded and augmented by an overabundance of technology and the disengagement with its operation. Yet, the film also manages to ask important philosophical questions in the background of a very exciting and entertaining storyline. We have all, perhaps, asked ourselves these questions at one time or another. What gives life meaning? How are we connected to space, place, and time? Does what I do matter? Our vices and guilty pleasures have been exploited by this film to make important commentaries on the issues our society faces today and will face far into the future. What is important is that these issues do not go on being ignored and that we are never afraid, or too indifferent, to go on searching for meaning in everything that we do.




VALLEY FORGE
AA

SILENT RUNNING
~ VALLEY FORGE ~

2.9

DIRECTED by DOUGLAS TRUMBULL - 1972

IN the near-future scenario presented in *Silent Running*, Earth's climate has changed so drastically that its vegetation could no longer sustain itself. In an effort to preserve the remains of Earth's flora and fauna, a fleet of American Airline Space Freighters act as a veritable "Noah's Ark", housing and maintaining individual planetary ecologies within their respective eco-domes, were locked in orbit around Saturn, waiting for the call home.

Valley Forge, one of the American Airline Freighters, bore its precious cargo of plants, trees, and small animals in a series of six geodesic domes along with a warehouse style structure staked with crates of seeds and DNA samples. Charged with the maintenance of the *Valley Forge* facilities was Freeman Lowell, the ships ecologist. To Lowell, the gardens are his home, much more than any other part of the ship. While his coworkers amuse themselves by racing about in small Argos, he walks peacefully through the expansive domes, maintaining the health of the system and taking advantage of their openness, quiet, and queer juxtaposition to the vacuum of space. Containing a wide variety of foliage varying in height and density the domes offer a diverse landscape spotted intermittently with bubbling fountains and bouncing rabbits. The delicate structure of the geodesic domes compliments the attempt to provide an apparently endless vista. Comparable to NASA's *Space Settlements* design study that provides approximately 50 meters as an optimal height to provide openness[56], just beyond the tree tops, the thin, triangular structure of the dome is visible with the stars and Saturn brilliant beyond. Even with the Sun shining through the glass, on this vessel, in this forest, there will always be stars in the sky. But, like Noah's Ark, *Valley Forge* and its ecological archive remains an island of the living floating through a sea of eternal nothingness.

Lowell's dedication to the preservation of Earth's natural resources becomes increasingly pronounced throughout the course of the film. Lowell takes pride in the work he puts into the gardens, the soil he tills, and into the food that he cultivates. And in his desire to maintain its natural beauty, he takes ownership over the domes and the life they house, taking pride in his efforts and offence in the casual carelessness of the crew. It is a heartfelt ritual that turns him spiteful against those who refuse to understand his beliefs. While taking their meal in the mess hall, the crew and Lowell debate the value of his efforts to grow his own nourishment versus ingesting synthetics:

> *"You don't see the difference? The difference is that I grew it. That's what the difference is. That I picked it and fixed it, and that it has a taste and it has some color and it has a smell…"* [57]

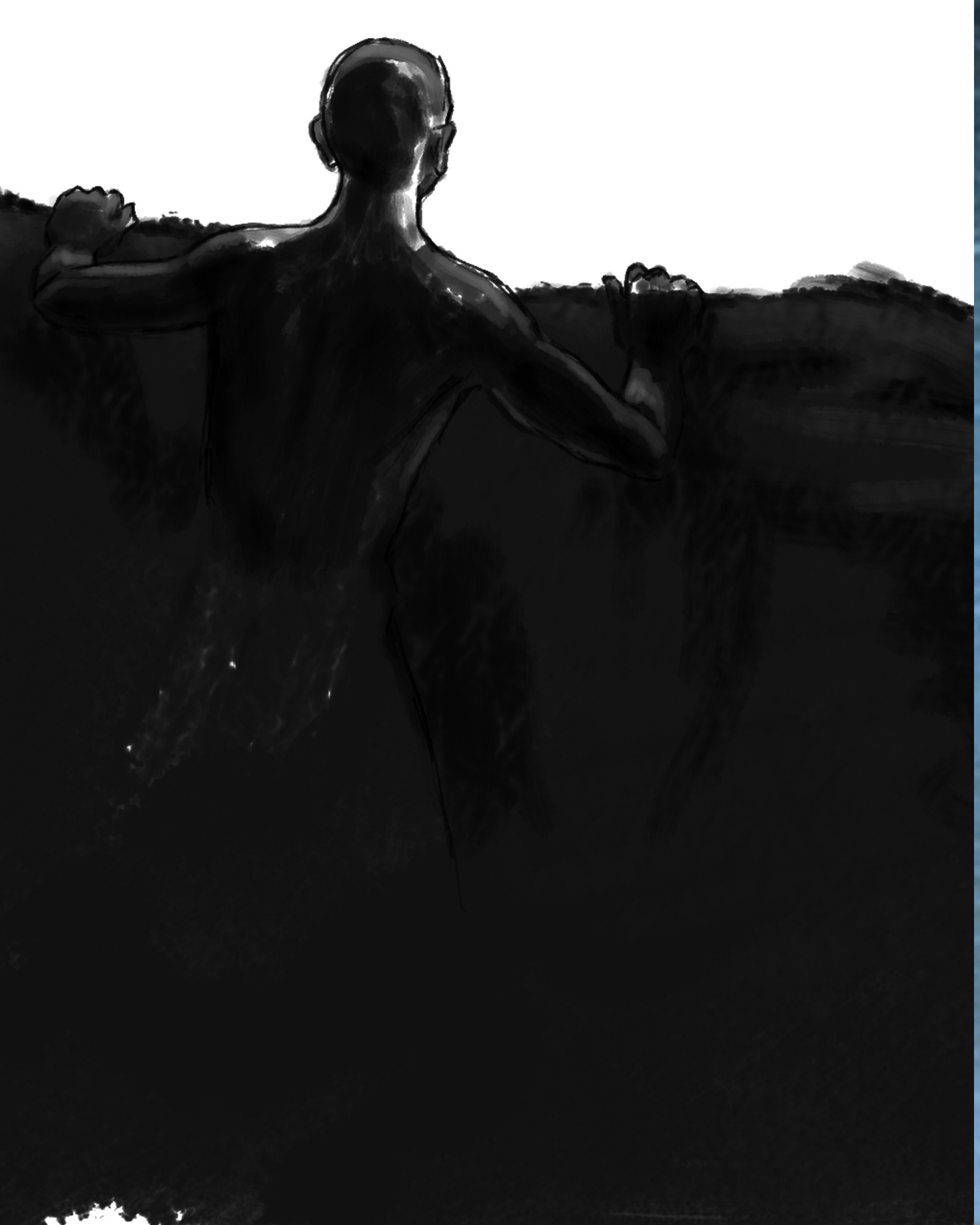
It is through his individual attachment to each living creature he cares for that makes his daily rituals so important to him. And though his beliefs and practices help to pass the time and find purpose while waiting for the call

Pull-out: Fig. 62 (page 63) ~ **Time & Change** *by Author; Fig. 63 (page 64 left)* ~ **Time & Change Preview** *by Author; Fig. 64 (page 64 right)* ~ **Silent Running,** *movie poster by Joseph Smith (1972).*

back to Earth, the depth of his conviction leads to Lowell's violent defense of the ship and its cargo when the crew is ordered to destroy the eco-domes. In killing the rest of the crew and setting a course into deep space, Lowell had both saved the last remnants of Earth's ecology and obliterated his connection to humanity, condemning himself to a solitary end.

The use of the domes as a design choice in the film, go beyond their purpose to preserve and protect their endangered cargo. They offer a place on board a featureless vessel to experience the wonder of space and its unfathomable depths by opening its walls and offering a vista of intense, contrasting pairs; verdant forests against the vacuum of space, matter against nothingness, futurist architecture housing a naturalistic environment, peace rivaling hostility, and life fighting against ever approaching death.

It is a monumental task, having power over the fate of all known life; how can anyone be successful when the issue is so overwhelming that it can be hardly understood? *Silent Running* pinpointed the frailty of life by containing it within a thin membrane of glass and steel and facing it toward the cold of space; the ironic struggle of man to preserve the natural world, for whose destruction he was responsible, within a completely man made environment. In providing a vista within the warehouse like qualities of the *Valley Forge Space Freighter*, the domes also offered a place of reflection and self examination where Freeman Lowell could be alone and gaze upon eternity. Yet, when confronted with the terrific task of caring for the last of Earth's natural biology, Freeman Lowell had to become integrated as a part of the greater system, and in doing so, lost a part of himself.



SOLARIS
~ PROMETHEUS ~

2.10

DIRECTED by ANDREI TARKOVSKY - 1972

SINCE the 1957 launch of Sputnik, humanity has sent literally thousands of satellites into orbit around Earth[58] and has deployed well over a hundred other missions within, and beyond our solar system (*see Appendix F*), in a supreme effort to better understand the environs in which we are surrounded.

From Stanislaw Lem's novel and directed by Andrei Tarkovsky, *Solaris* told the story of a space station in orbit of the planet Solaris – an ocean-planet suspected of being sentient. The station in orbit, *Prometheus*, was a platform for observation and possible interaction with the entity. Its aim was

Fig. 68 ~ **Library in Zero Gravity,** *still taken from* **Solaris** *(1972).*

to determine the life form's purpose or intentions and to make first contact. In response to *Prometheus*' probing, the entity created and sent "visitors" to the station as reconstructions of its crew's memories, thoughts, dreams, and loved ones. Whether created to offer companionship to the small crew in a lonely environment or to be used to gather information is not known, however, they set about a cycle of events that made time and place aboard *Prometheus* impossible to distinguish from fantasy.

Prometheus is described as, "a haunted house in space,"[59] seemingly devoid of activity or life upon the arrival of Kris Kelvin, a psychiatrist sent from Earth to counsel its disturbed crew. Far from being the typical representation of a sparklingly clean future, *Prometheus* is tired and dingy with exposed wires shorting out, and equipment strewn about the passageways. Most places on board feel spent and time worn, its wear evidence of its past and untold stories. *Prometheus*, though inanimate, speaks volumes of the years of orbit and observation, of experiments and failures. Amid the mess of ducts and equip-

Pull-out: Fig. 65 (page 67) ~ **Vista** *by Author; Fig. 66 (page 68 left)* ~ **Vista Preview** *by Author; Fig. 67 (page 68 right)* ~ **Prometheus,** *still taken from* **Solaris** *(1972).*

ment, Kris' quarters are a sharp contrast; white and clean, appearing freshly made up despite his sudden arrival. It is a fresh stage, its purity unmarked by past traumas that affected the rest of the station. It presents a future that ties Kris to Solaris with his own "visitor", a replication of deceased wife, Hari. The future waits to be played out by these characters who are, it seems, the audience of their own production.

Different in character again from the rest of *Prometheus* is the library (*fig. 68*). Painted a deep green and decorated with classical statues and crystal chandeliers, the library is representative of history and the past of Kris and his wife. Painted winter scenes hang on the wall depicting snapshots of villagers hunting and skating. The images seem to come to life, overlapping memories of Kris's home and childhood and weave an ever more complicated tapestry of events that manipulate whatever is left of his reality. The library of *Solaris*, like that of the *Nautilus*, is an archive of the past yet, the memories and dreams it retains are given the power of tangibility through the manipulation of *Solaris*.

Kris' quarters and the library do share a commonality with the rest of the station; the station's plan, rings of corridors around a central launch bay, its windows, mirrors, and tables – everything on *Prometheus* is circular… and cyclical. Reflections upon reflections, replications of lives lost, found, and lost again; its repetitions and endless cycles confusing reality, memories, and dreams. The characters wake and sleep, the sun rises and sets, but everything remains the same. In a place where people and memory are constantly replaced instead of being remembered or forgotten; can time have any meaning? If memories can become a disturbing reality, where the present and past blur through the manipulative actions of visitors and the architecture of an orbiting station, is it possible to find solace?

The narrative of *Solaris* underlined the importance of meaning within space and time; that experiences and memories must be created and moved beyond in order for histories, mythologies and stories to be formed. The past was represented in the library; the future was in the white purity of Kris' freshly made bed, a blank canvas. The cycle of it all surrounded Kris in the ringed passageways and the oculi that looked out onto a churning oceanentity. The spaces and architecture of *Prometheus* were as confusing as a house of mirrors; each reflection becoming another replication, each replication becoming another superimposed reality in an ever-changing, uncertain series of events. And it was through this confusion of cycles and repetitions that the stage was set to tell a story of ongoing loss, of a world that existed without memory and that could only offer the artificial consolation of a copy to its human neighbors, denying them any true sense of time.

Fig. 71 ~ **Synosius** *by Theodoros Pelecanos (1478).*

The Ouroboros, depicted as a serpent or dragon, can be interpreted in many ways. The circular arrangement caused by the creatures self-consumption is a symbol of motion, continuity, self-fertilization, eternal homecoming, and a closed cycle of development.[x] *Also a depiction of celestial perfection, a meaning imbued within the circle itself, the image of the serpent biting its own tail denotes a marked change in its own existence, one that extends to the realm of the spiritual.*[x]

FRAMING THE INFINITE 3

IN architecture, the response to and choice of a site for a building is as important to the final success of the project as the building design itself. Yet, for *Horizon*, the task of design is complicated by a complete inversion of site, or, its lack thereof. No longer provided with a place to build on, *Horizon* must be many things: site, building, environment, and world – to the greatest extent of the word. Bound by apparent infinity, the scenery of the celestial highway it travels will, depending on velocity, appear unmoving to the naked eye for decades, centuries, or even thousands of years.

Horizon is a finite organism travelling through a borderless and unobstructed ocean of everything.

When I first conceived the premise for this thesis, I envisioned that its conclusion would be the refined massing, layout, and sectional design of a space faring vessel capable of supporting, caring for, and enriching the lives of 2000 inhabitants while travelling far into their unknown destinies. It was not until I started my research and began conceptualizing a variety of spaces that I realized that a design with such finality, with such defined resolutions to an abstract problem, would be misleading in its claim to conclusiveness. The fully realized vessel would be incapable of embracing the beauty of the undefined universe through which it traveled by ineffectively reconciling the sea of questions that still continues to wash over me even as I conclude this thesis. Most importantly, it would ignore the many voices of the persons carried within its community.

> *From the start of humankind, we have been trying to understand the world around us. In our search for reasons behind behavior, we try to theorize things. Our well-developed brains are not fulfilled by just thinking about essential life actions like eating and breeding. We have many questions, and with questions answers have to follow. The answers become stories; many stories told us how to act and how to look and what to see… The world around us can enthuse us; the art is to see that.*[3]
>
> ~ *Jurgen Bey*

A story was the only solution. Like exploration, it is a part of our nature. We make stories in order to share information, to understand and relate to the experiences of others, and to build the legends and myths that rest at the core of continually evolving human culture. Spoken, written, or depicted graphically and symbolically, stories increase widespread understanding and permanence within culture and collective memory. This in turn can extend the grasp of a story deeply into society by capturing the gaze of onlookers, drawing them into the depths and complexities of its many messages. Or, alternatively, a visualization or symbol has the ability to focus its message so precisely that its importance is recognized within the milliseconds of a glance.

Pull-out: Fig. 69 (page 71) ~ **Watching & Being Watched** *by Author; Fig. 70 (page 72 left)* ~ **Watching & Being Watched Preview** *by Author.*

Fig. 72 ~ **Diomede I** *by Brodsky & Utkin (1989/90).*

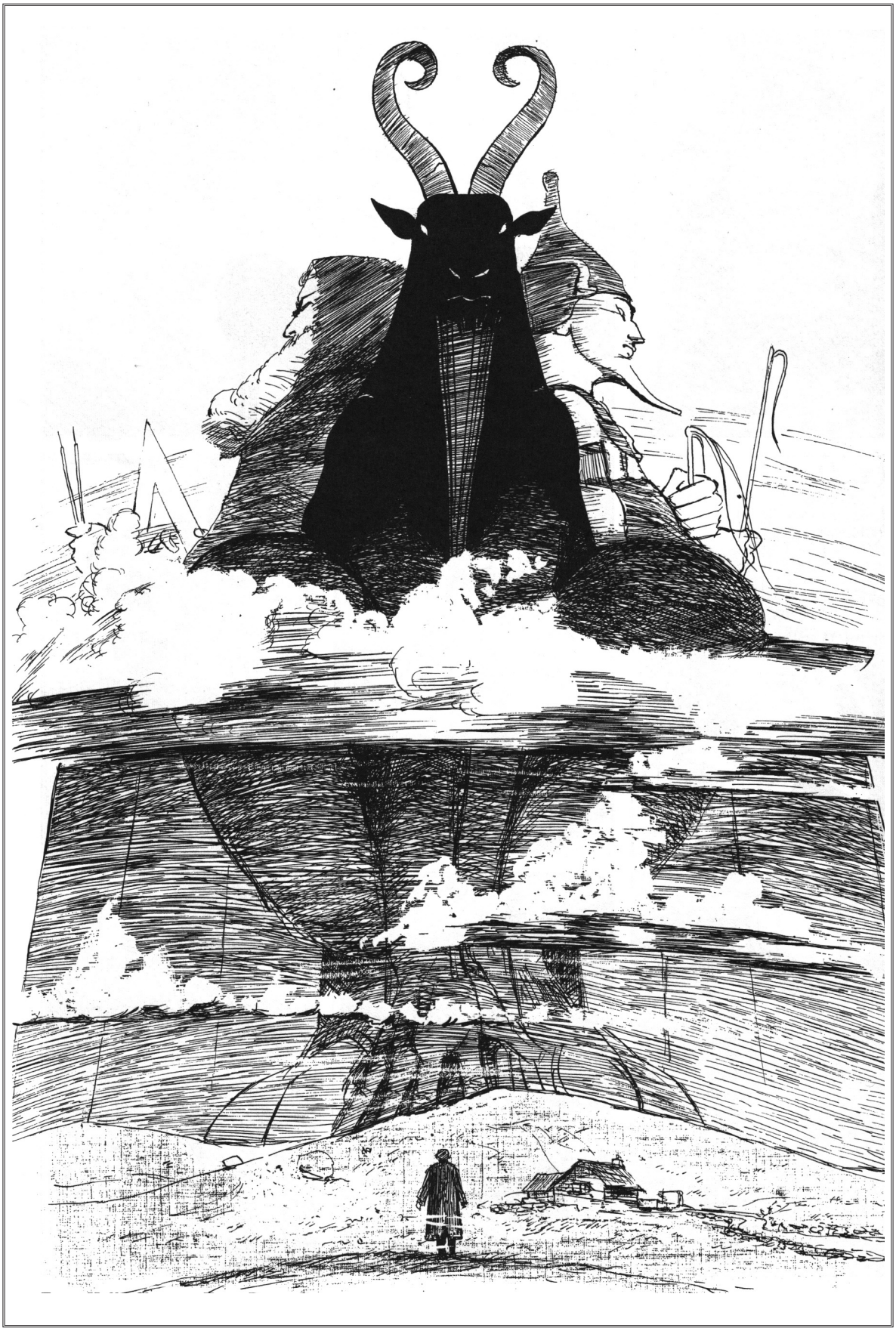


Fig. 73 ~ **Jahbulon** *by Eddie Campbell (1989).*

Presenting the final conclusions as an illustrated narrative immediately draws attention to the most important aspect of the thesis: by severing its physical and communicative bonds with Earth, *Horizon* and her people are wholly alone in the void of space. This is exemplified by the paradox that is created by rendering the endlessness of space within the confines of an 8 ½ x 11 inch piece of paper. This framework has the ability to take the many abstract concepts of space and time and places them, quite literally, within the grasp of the reader. *Horizon*, like the paper on which it is drawn, is the container for its own universe, filled with the same innumerable possibilities as that of a blank page.

An illustrated narrative is highly descriptive, conveying a great deal of information through words but augmented by condensed imagery. Yet, by choosing this format to selectively omit specifics in structure, layout, vessel organization, details of crew selection, and certain political structure, the reader is given the freedom to overlay his or her own experience and imagination, identifying with the characters and their individual stories, and creating a far more inclusive and thought provoking series of solutions for a problem with no definite answer.

As was stated in the introduction to *Part 2 - Places of Discovery*, each case study holds particular significance within the final narrative. Created to act as instructional concepts, providing a different perspective to similar issues of isolation, confinement, and existence in harsh environments, each case study directly informs either the architectural sense of place within *Horizon*, an event within its history, or an overarching concept or theme within the story. To specifically divulge the implications of each concept or its placement within the narrative could spoil the enjoyment of reading the story uninterrupted. It shall be up to the reader to interpret the story, keeping in mind the contributions of not only the preceding case studies, but of the thousands of years of exploration, endured and relished by those who have come before - those people who were willing to take a risk in the name of discovery, in order to find the unknown.

BUT Ransom, as time wore on, became aware of another and more spiritual cause for his progressive lightening and exultation of heart. A nightmare, long engendered in the modern mind by the mythology that follows in the wake of science, was falling off him. He had read of "Space': at the back of his thinking for years had lurked the dismal fancy of the black, cold vacuity, the utter deadness, which was supposed to separate the worlds. He had not known how much it affected him till now – now that the very name "Space" seemed a blasphemous libel for this empyrean ocean of radiance in which they swam. He could not call it "dead'; he felt life pouring into him from it every moment. How indeed should it be otherwise, since out of this ocean the worlds and their life had come? He had thought it barren: he saw now that it was the womb of worlds, whose blazing and innumerable offspring looked down nightly even upon the earth with so many eyes – and here, with how many more! No: space was the wrong name. Older thinkers had been wiser when they named it simply the heavens – the heavens which declared the glory – the

"happy climes that ly
Where day never shuts his eye
Up in the broad fields of the sky."

He quoted Milton's words to himself lovingly, at this time and often.[4]

Out of the Silent Planet
~ C.S. Lewis

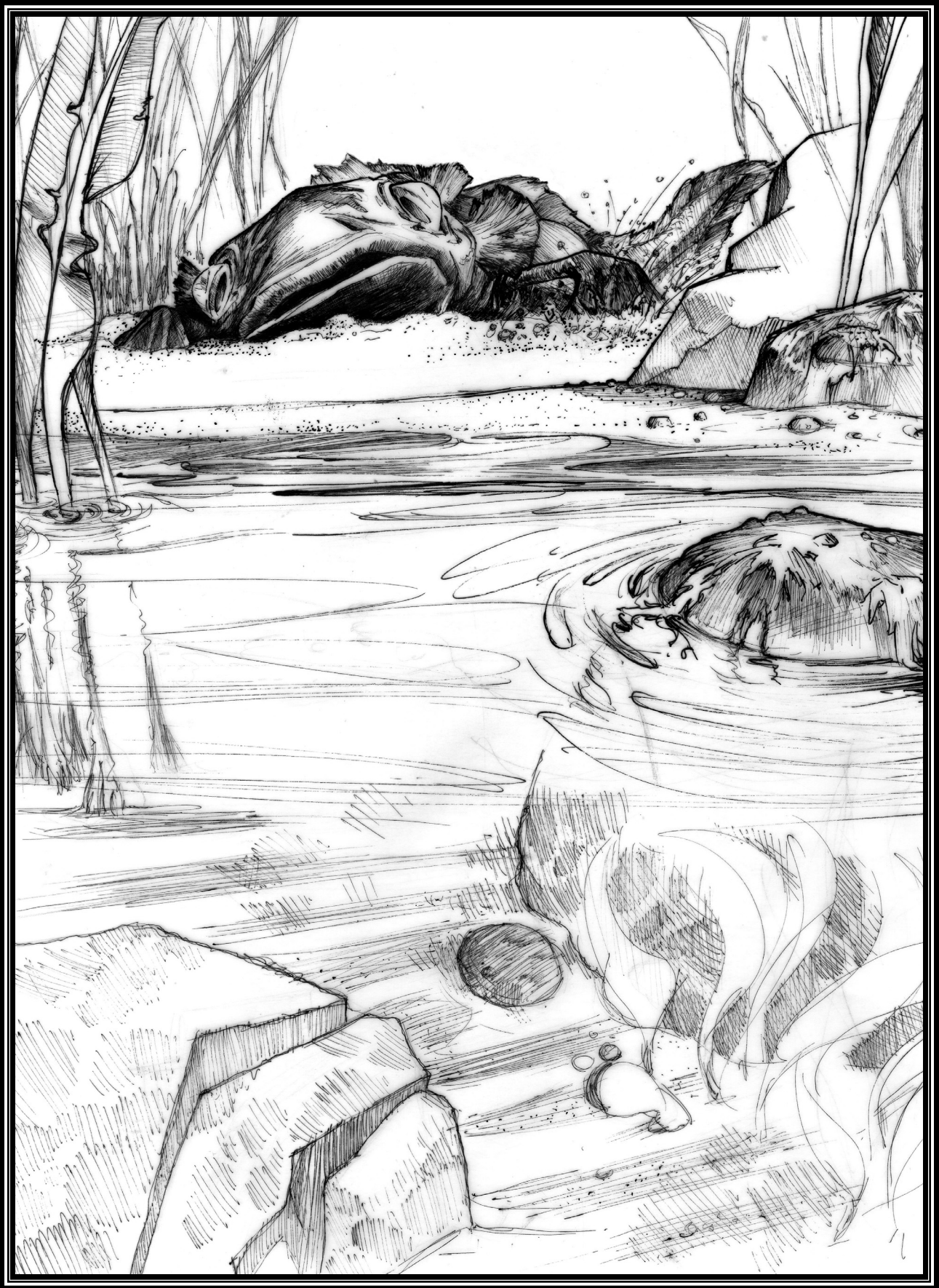
IT was a voyage unlike any other, unprecedented and unfathomable in its purpose, the departure from the solar system was just beginning. Two thousand people, the population of a small town, have been selected to embark on a journey of discovery to explore the farthest reaches of space and of our imagination.

So vast and unknown are the dimensions of space that this mission is not expected to ever return to earth.

With them, they've taken few material possessions, only the most vital… the most precious; but in their minds, their culture, and their customs, they embody the story of all humankind. On an endless venture of exploration through the cosmos, the interstellar vessel *Horizon* moves with the determined conviction of a marathon runner. Yet, with no plan of return, the path forward remains uncertain.

Face to the **HORIZON**

~ THE FIRST MIGRATION ~



Struggle

~ THE HUNT ~

SHE was not a fish. Yet the warm water embraced her as she swam, flicking her finned tail back forth. Darting between her companions with quick elegance; she used her small, webbed appendages to maneuver. She was an air breather, one of the few. Breaking the surface tension of the undulating ceiling, her nostrils flared, expelling stale, oxygen depleted gas into the rich and heady atmosphere. It was only a split second before she had refilled her lungs, closing her nostrils and the nictitating membranes over her bulbous eyes, she submerged, set for several more minutes of swimming.

She was on a mission, a hunt, but not for food - that would have to wait. She was hunting for something far more important, for a place where her still unfertilized egg-bound young would be safe until they matured to grow into her legacy. It was becoming more difficult as each mating cycle passed to find the perfect hiding place where the eggs would not only be concealed, but a place that would also have the proper incubational characteristics. She would know instantly when she found it; she could sense the perfect temperature through her smooth, receptive skin; her large, observant eyes could pick out the most protective locations. She didn't have to think; she was all instinct, just as it was with her need to hunt, and to release her eggs at precisely this time each year.

Even though this was her spawning ground, her search for what her instincts dictated remained unfulfilled. The waters were teeming with competition, searching for the same type of place she needed. The rivalry for a place to nest was becoming ferocious, and if it came to attacking her own kind in order to lay her claim, she would not hesitate, she couldn't even think about it. The quest pushed her closer in to the shore; the water becoming progressively shallower, its mirrored surface reflecting the sand, stones, and grasses – it was confusing, had she entered a cave? She pressed on with urgency.

Again, she surfaced to breathe. She was now so close to the shore that she could see, through blurred and strained eyes that were unaccustomed to long air exposure, several large objects, stones scattered at the water's edge. Beyond the sandy gaps that separated the stones, shallow, calm pools reflected the blue sky. From where she rested, her full belly pressing into the sand, she couldn't understand what she saw, and in her short memory, she only saw conflict behind her.

Her tail propelled her forward through the last few centimeters of water while her tiny limbs scrambled to help lift her dragging abdomen. Her buoyancy gone, she moved in awkward, painful bursts, needing to rest after every action. So heavy, so dry – a totally new sensation, and a horribly painful

one; she caught glimpses of the welcoming waters she was achingly leaving behind every time she stumbled.

Turn around

Even the ground beneath her was beginning to dry, cutting excruciatingly into her skin with the sharpness of a million tiny teeth.

TURN AROUND

No. Though all she knew was the pain she felt piercing through her desiccating body, she had come too far. Forward or backward made no difference now, but stopping would lead to only one outcome. Writhing, she fell to one side, and then the other, each movement bringing her closer to the blue flatness that lay before her. The sand becoming moist once more, her thirsty flesh drank the water in, quickly rehydrating. She began to slide more easily but it took everything in her power to resist the temptation to rest, in her instinct to survive, her need to return to the water was critical.

With none of the elegance she displayed swimming earlier among the others of her species, she flipped over once more, making a small splash and ripple across the pond as she landed. Relishing the wetness that once more surrounded her, the water lifted the burden of weight off of her heavily swollen abdomen and limbs. She floated quietly for a moment, holding still to avoid drawing more attention to herself, cautiously observing her new surroundings to see if there were predators laying in wait of plump prey. Grasses swayed gently, pushed magically from above by an invisible breath of wind, they appeared to be the only thing moving beyond her roving gaze. She began to move again through the water, continuing her ever pressing hunt for a place to lay her eggs.

There. Her receptive tissues, activated by changes in temperature, water currents, and chemical composition, pulsated excitedly, sending signals coursing through her primitive nervous system to her central node located within her thin skull. This was the place. The unassuming, sheltered, rocky outcropping would provide the perfect surface to adhere her eggs, holding them tightly and maintaining their temperature until they were ready to hatch and populate this uninhabited oasis, that is, if they were ever fertilized. She was faced with a difficult task, not a choice – an instinct: in order for these eggs to ever have a chance at life, she would have to go back to the big pool, leaving a hormonal trail behind her for a male of her kind to find and follow.

The likelihood that another creature could endure the same journey she had just completed in order to fertilize her eggs, was slim. Slimmer yet were the odds of even a dozen offspring surviving to adulthood of the thousands of eggs she had laid. But, that wasn't her decision; it was beyond her control and understanding. Governed by the overwhelming instinct to reproduce, she became the first creature to crawl from the sea and drag herself across a narrow, meter wide swatch of land by her own power and sheer will. With no one to hail her as the most important pioneer in the history of the planet, she swam off into the murky waters in search of her next meal, barely able to recall the events of the past few hours.

It seems our leap into space, the second great migration of Earth, was initiated by the unlikely survival of one species. The actions of one female, whose instincts to reproduce were even stronger than those of self-preservation, forever altered the course of history on our planet.

The lives of countless billions were brought into existence not by choice, but by chance. And though the decision to move our species into space was one made with great awareness and intention, it is no less of a gamble than that of one creature dragging her pregnant belly across the sand.

~ MONSTER ~

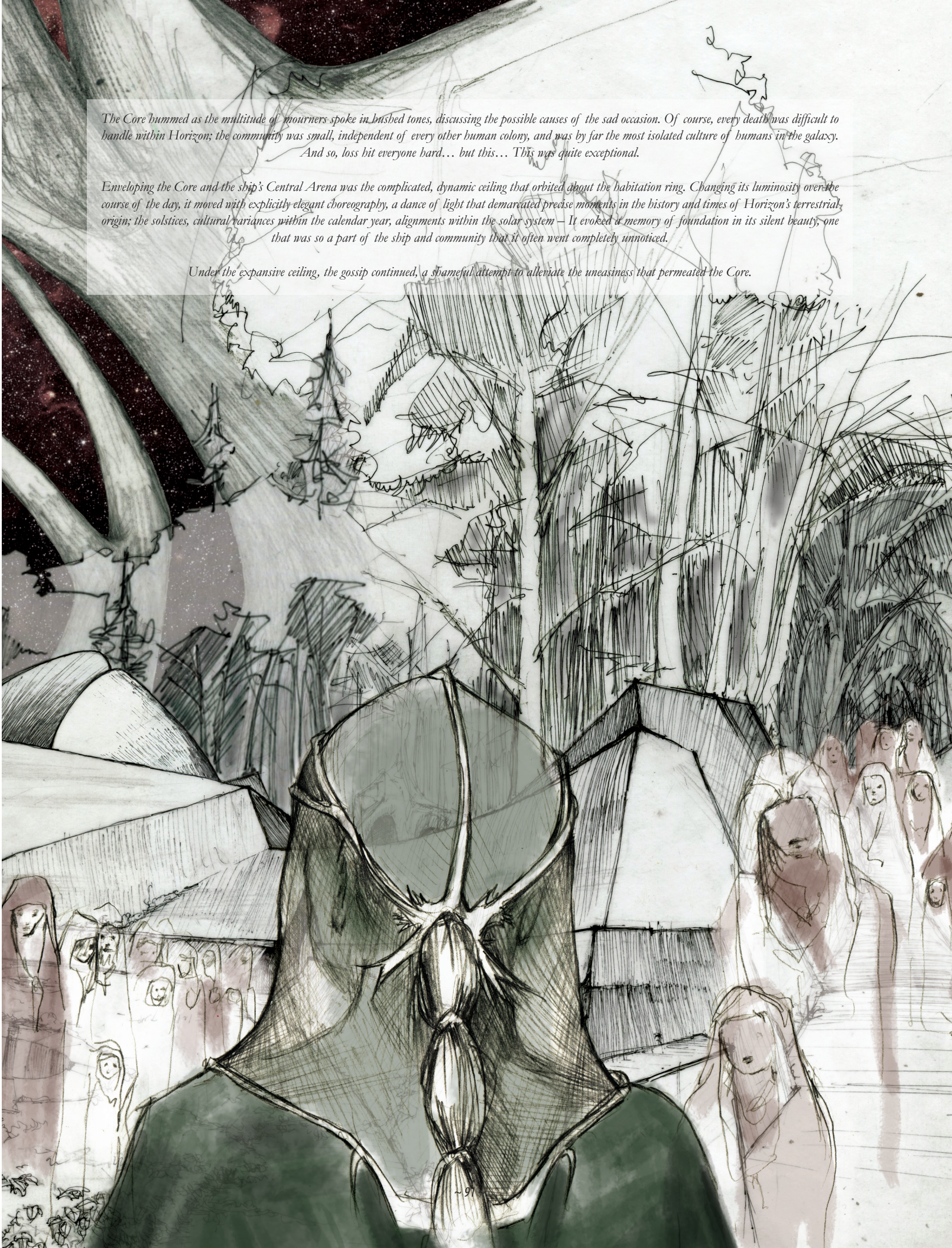
~ INTERMENT ~

WHEN morning came, it wasn't easy for Emisia to pull herself from the confusion of her dreams. Dark shapes moved in and out of focus, darting through her field of view in an intensely complex, and choreographed dance of passion. She too, was one of these mysterious bodies, locked in the smooth, aqueous maneuverings of mindless ritual. But as the sonic tendrils of her alarm drew her from the watery ballet, she gasped for air until the warm glow of the gardens shining through her cabin walls brought her sharply back to reality. It was then, in the security of her warm pallet, that she remembered why she had wanted to remain asleep today; the memorial for her father would take place before morning's end.

She recovered from her abrupt awakening by eating a light breakfast and stretching in the ambient garden light. It was this quiet, personal time that she so thoroughly enjoyed in her daily routine. Without it she felt unbalanced for the rest of the day. Her mornings were never complete without meditation, time she spent before the window wall looking out upon the wheeling star-scape. Bathing in the spinning brightness of the stars cast her into deep trances that, unmonitored, could last for hours. Her solitude was insular and protective for her, given the almost constant social interaction that was life on Horizon, her space bound home. It was especially important before a day like today.

After pulling her formal robes over her svelte, elongated frame, Emisia made her way through the vast decks of hydroponics where her quarters were situated, down to the base level of *Horizon*'s rotating, wheel shaped pressurized habitation. There, emerging from beyond the delicate tree trunks of one of the ship's many forested zones stood the Core; a place of deep thought, ritual, emotion, and where *Horizon*'s deceased were interred and reintegrated into her systems. Emisia was among the last to arrive and walked to the podium as the crowds parted for her, heads bowed out of respect for her loss. The eulogy had been something she had been dreading from the moment she heard of her father's sudden death. "It was a terrible accident," she was told, "a fall that no one had time to stop before it was too late." Oh, but even before his body was cold the rumors had begun to fly, and at greater speeds than the fall that killed him.

Her words were brief and tinted with the expected cadence of bereavement from the daughter of the deceased, but Emisia knew they were hollow. As the procession of close friends and family moved together through the sanctuary, and passing among the jubilantly colored plants in its garden, Emisia's heart filled with sickening trepidation at the thought of the pain these final few formalities would impose; stealing from her the last few moments alone with her father.



The Core hummed as the multitude of mourners spoke in hushed tones, discussing the possible causes of the sad occasion. Of course, every death was difficult to handle within Horizon; the community was small, independent of every other human colony, and was by far the most isolated culture of humans in the galaxy. And so, loss hit everyone hard… but this… This was quite exceptional.

Enveloping the Core and the ship's Central Arena was the complicated, dynamic ceiling that orbited about the habitation ring. Changing its luminosity over the course of the day, it moved with explicitly elegant choreography, a dance of light that demarcated precise moments in the history and times of Horizon's terrestrial origin; the solstices, cultural variances within the calendar year, alignments within the solar system – It evoked a memory of foundation in its silent beauty, one that was so a part of the ship and community that it often went completely unnoticed.

Under the expansive ceiling, the gossip continued, a shameful attempt to alleviate the uneasiness that permeated the Core.

The Garden

At the rear of the garden, a pristine curving stairwell descended before the party. Its mirrored surfaces were gleaming white and cleared of any debris, as always, by the Caretaker; a woman in her late sixties so dedicated to her work that she might have thought every life on *Horizon* hinged on its cleanliness. The smooth walls of the staircase, echoing metallically with their footfalls, gave way to the humid darkness of the cavern; the Core's hallowed foundation. Entering the Core's heart was a shock to the system. Before her eyes could adjust to the change in light level, Emisia found herself splashing through the deepening waters of the subterranean lake that lapped at the foot of the stairs. But as she waded through the tepid pool, her father's body floating silently at her finger tips, she found the space illuminated by soft beams of light cast in the moist air from openings in the cavern's ceiling. From below, a rippled floor of stars shone through the water, dancing over her somber glance and animating the otherwise featureless walls. "*Walking on stars to turn back into stardust*," she thought to herself. Coming to the space's center, her father was gently slid onto a raised platform that would eventually lower into the bowels of *Horizon*. The corpse would be literally digested. Every part of his body would be reused; every milliliter of fluid purified into the water they drank and poured onto the gardens, every bone would be pulverized into fertilizer. It was a temporal and cyclical world she lived in where, in order to maintain balance, eventually every living thing would meet the same fate.

Once each friend and family member had said his or her goodbyes to Emisia's father and had wished her well, the ceremony reached its end. Now alone, wet and cold, she thought back to her early morning dream. As it faded from her mind, she bleakly felt that the life of her father was also a fading memory. Not even a corpse was left behind to decay. It was as if he had never existed. She was disgusted: by her horrible thoughts, by this "harvesting process", and especially by the obviously fabricated explanations she had received about his "accidental" death. All made to preserve public moral, no doubt. "*Well, fuck the public morale!*" she said louder than she'd meant, her words reverberating back at her off of the barren walls. Her father had never lied to anyone, least of all Emisia, so the last thing she could allow was a filthy lie to tarnish his memory.

~ THE MEMORY FIELDS ~

MOVING with determination through the thickets and trees that tugged sharply at her still dripping robes, Emisia made her way from the echoing hollowness of the Core towards one of her favorite places, the only place on *Horizon* she would be able to find the answers she was looking for; the Memory Fields. Like the Core, the Memory Fields were hidden within a wilderness of trees and bramble. This outcrop of vegetation being far denser, it was able to insulate the gigantic structure from the rest of *Horizon*.

The robust exterior of the Memory Fields soared upward like an immense tree, piercing the ceiling of the habitation's pressurized volume to continue onward through empty space, finally connecting at the central hub with two other spoke structures. Though it was a major structural component within *Horizon*, it was constructed to act independently. In a way, it was a "cultural lifeboat", built to survive even if the rest of the ship was compromised. Its smooth face was marred by only a single slice, beginning at its base and extending part way up, it traversed through the building and cut through the opposing wall, thus creating entrances on both sides. Emisia climbed the shallow stairs that separated the Fields from the ever-encroaching wood. She pushed through the heavy, vaulted doors of the entrance; the musty scent of age and dust bathed her in memories of past visits, intangible and fleeting. She walked swiftly past objects and displays that she had seen dozens of times before, sometimes with her family, sometimes alone, all originating from an almost forgotten planet. Like a fingerprint on a clean piece of glass, the Memory Fields carries a record of everything that it encounters – in every sense. It preserves the physical; sculptures, paintings, books; and it preserves the ephemeral; important moments in audio and imagery; the transitory memories of the departed. Records were kept of only what was chosen to be shared prior to death; it was a voluntary and pleasurable process, not a rape.

Moving upward through the Archive and approaching the central hub, the grip of centrifugal force loosened on Emisia – her quickened steps becoming leaps and bounds, and finally, she took flight, rolling over the long axis of her body and leaving the spiraling ground plane behind. Spinning, Emisia saw the place she was looking for. The Memory Fields' center held its Human/*Horizon* interface; the Archive Seed. Revolving independently from any other surface, it sensed her approach, slowing its rotation and altering its orientation to receive her – both body and mind. She quivered slightly as if chilled; she always found its autonomy to be a bit creepy, no matter how many times she was enveloped within its welcoming shell. But the more she used it, the more sensitive to her body it became – it was like entering a warm bath;

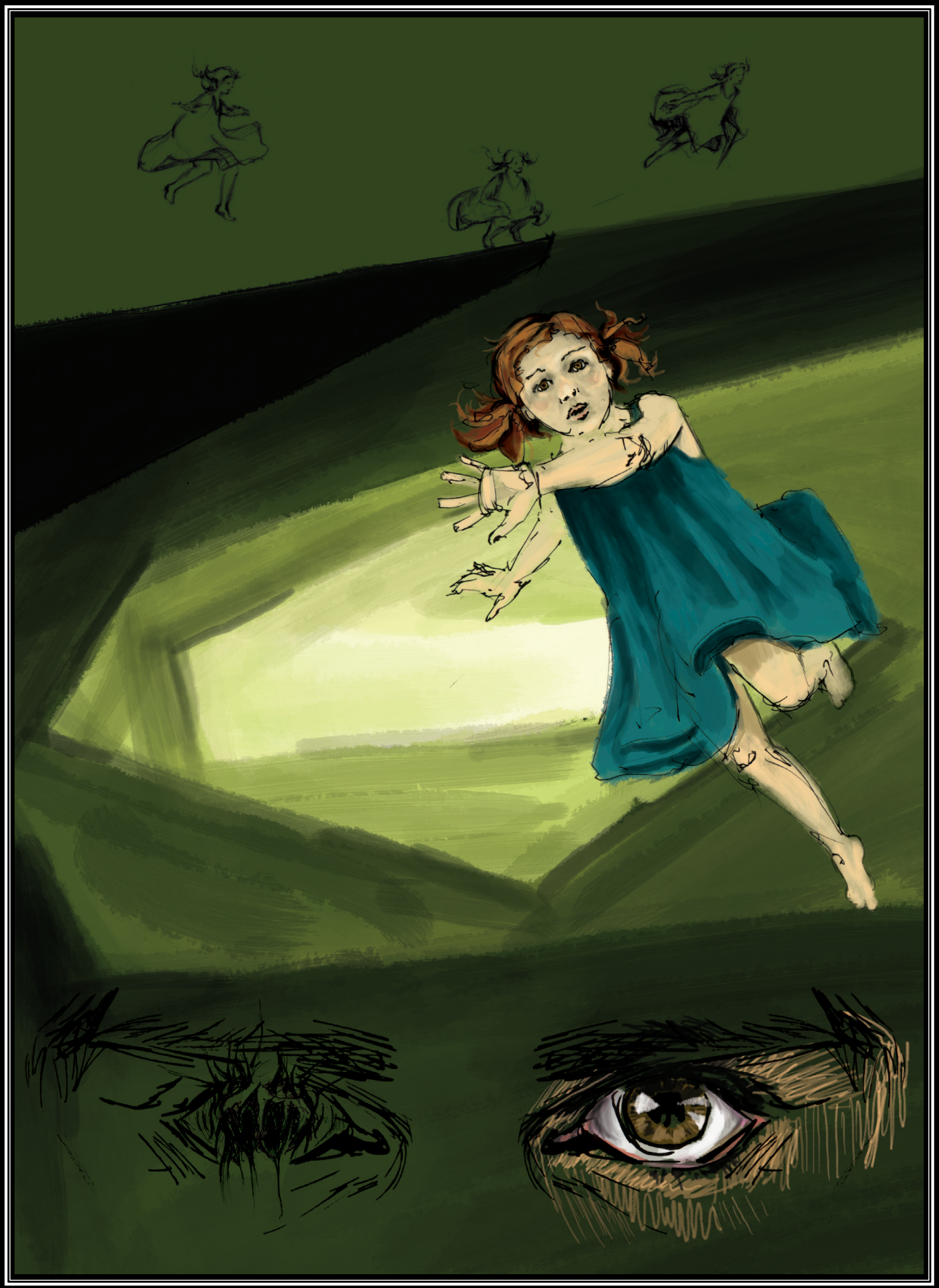
The Memory Fields

one that cared for and understood her. She was happy to see that it wasn't already occupied by some teenage girl sharing memories of her first kiss, still fresh on her lips – "*no one else cares, honey*," she thought to herself, slightly embittered by her own somber task. She landed gently, the Seed absorbing her excess velocity. Removing her robes, she immersed herself, the plasma within the Seed slowly crept over her bare flesh; warm but without the sense of being wet. It was a combination of "living energy" and the essential parts of human grey matter, capable of storing, projecting, and even understanding both conscious and unconscious thoughts. It was, perhaps, repulsive to think of the technicalities; to be smothered by a slurry of brain and plasma. The ethics of the matter was another story all together but the Seed was a marvel to say the least. Whether it was contented, a creature satisfied with its existence or, whether it was even aware of its own existence remained unclear. The shell closed over her. It was dark at first but as her eyes adjusted there arose a soft, flesh-toned light that emanated from all directions and surfaces, even from her own body. As the final mechanisms came into position, there came a flash of light that entered her eyes, despite her instinctive reaction to squeeze them shut against the brightness.

ACCESSING… ACCESSING…

The Seed probed through her mind, faster than she could think, as fast as light – she would not have to say or even think of what she was in search of, or like those young girls, what they wanted to tell. The Seed would find out for itself faster than she could articulate a request. An immense flash of light coursed across Emisia's mind, beyond her eyes.

The Seed took her back to of one of her earliest memories, one that coincided with something that had happened to her father – in this very place. She saw herself as a little girl, maybe five, skipping jauntily through the Memory Fields, taking in the sights and absorbing the stories of her ancestors. Her path followed almost precisely the one she had taken just moments ago. However, when she arrived at the Seed, it was her father who was about to interface with the Archive system. Landing softly beside him, the young Emisia, her voice so small and bright compared to the one she had used today at the wake, asked what he was doing. Looking up slowly, his gaze looking past even the walls of the ship, he said in a distant voice, "I need to get rid of… rid of… something." Then he looked at her, giving a small shake to his head, he continued in a more level quality, "I'll be home soon, Misi. Why don't you go on ahead? I heard Mummy is making your favorite tonight!" He



smiled lightly, but there was something quavering about his expression. As he turned his back on his young daughter, the memory playing in Emisia's mind began to fade and was suddenly cast into a speeding side drift, as if forcefully struck by a mallet.

FLASH

The archive had vanished and was replaced by the obscurely rotating glow of space. Emisia didn't know where she was until the edge of *Horizon* came rising into view. Attached to the ship's hull by *Horizon*'s tentacle-like restraints was her father, repairing micrometeorite damage with a laser welder and fusion pads. The vision, Emisia realized, was a compilation of views; almost omniscient in character, built from the memories of her father and any other information *Horizon* and the Seed had acquired and could extrapolate upon. Various "camera" views gave her the freedom to see things from all directions, individually or all at once – it was confusing and yet provided hyper-clarity.

What happened next occurred quite suddenly and shocked both Emisia, watching, and her father who had experienced the event. While concentrating on his work, his safety tentacle somehow became entangled causing him to slip with the welder and sever his connection to the ship. Emisia watched aghast as her father peeled away from the ship's hull, his limbs flailing in alarm as his gyratory momentum carried him off in a chaotic role. Helplessly watching the event unfold, Emisia ached to hear her father's panicked respirations, deafening in the quiet of space.

Breaking through the tension, a crackling of static exploded from his intercom. The calming voice on the other end was assuring him of his imminent rescue; "We're on our way, don't worry. Just try to relax and enjoy the view!"

Immediately his movements and breathing began to calm, "thanks guys! Take your time!" he said, quite relieved.

Emisia's vision was wholly confined now within the eyes of her father. She could see the readouts within his helmet; temperature, pressure, food, water, and oxygen reserves, all nominal. He continued to drift through the vacuum, farther than he'd ever been from *Horizon* in his entire life; the ship shrank in size, looking like a child's toy hanging, fragile, amid endless points of light. "Don't look at it… look at the stars… *look at the stars.*" His thoughts, also a part of her own mind, were laced with anxiety at being so far from home, from everything he had ever known. Looking at the stars now, he thought of how they were so very bright, how there were so many of them,

innumerable – infinite. How could seem they be brighter here than inside the ship? "*I'm imagining this*," he thought. "What is taking them so long?"

Staring – "*Twinkle twinkle*," the stars seemed to sing – they blurred in and out of focus, brightening and then diming in places. "*What's going on?*" Something… something in the stars… they were moving – shifting. Something was beginning to take shape in the eternal night. "*What the hell* is *that?!*"

A static burst came over the intercom again, startling him out of his trance, "Bet you thought we were going to leave you out here!" the pilot of the rescue pod joked as it approached his position.

"Huh?" he mumbled, twisting his body around to get a better view. "Oh. Oh, yeah. You sure took your sweet time," he said distantly, still lost in what he'd seen. Though, when he looked to the mission log displayed within his helmet, he found that only 4 minutes had elapsed since severing his connection. It was surprising how long it had seemed.

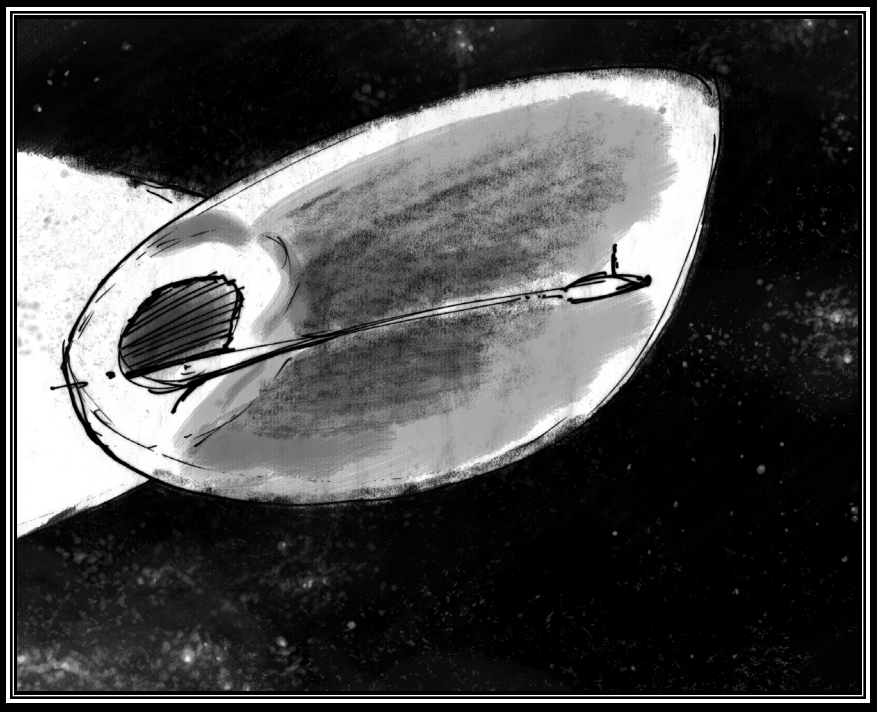
Inside the pod, the pilot spoke, looking over his shoulder to her father who was slumped in his seat, staring blankly at the wall, "So, we'll have to write up a report… you know, to keep things organized, figure out what happened, nothing serious. We've got time now, are you okay to answer some questions?"

"Yeah, umm… sure." He paused, rubbing his eyes with his fingers. "Actually, would you guys mind if we met back in an hour or so? I just feel like I need to take a bit of a breather after that whole thing… That's ok right? It's not like I'm going to run off or… or anything!… " After docking and removing his pressure suit, he immediately stalked off in the direction of the Memory Fields, toward the moment that Emisia had recently experienced. Only now did she realize just how disturbed he had been then, how pale, his skin glossed in a slick of cold sweat. As he stumbled down the passageway, the memory began to fade, and then… to slide…

FLASH

She was swept away. Her vision was a blurred mass of whirling shapes, faces, and light. And before her focus could return, a throbbing sickness began to permeate through her abdomen; one she could detect even through the semi-anaesthetized state The Seed had placed her under upon integration. Despite the jarring confusion and the accompanying pain being inflicted on her body, Emisia clung desperately to her need to preserve her father's name, and was carried by the surging current of his repressed anguish.

As fast as the preceding memory had been swept into a chaotic torrent, the next one coalesced; reassembled from a fractured past. Her father stood alone and resigned in one of *Horizon*'s balloon like observatories that projected out from the ship into space. Though his years were not excessively advanced, her father appeared to be stooped and frail, a mere shadow of the powerful man from the earlier projections. This was the man Emisia had buried. This would be her father's finale. Emisia only hoped that she could bear his stage exit. Standing on a platform that was suspended from wall, ceiling,



The Observatory

and floor, he stared out beyond the invisible barrier that separated atmosphere from vacuum. His eyes were not hollow, as his stance suggested; they were determined, piercing the infinite space with his gaze, searching the stars. Her viewpoint was roving again, casting impatiently about the observation gallery – she was seeing all of this through *Horizon*'s eyes, its cameras monitoring almost every crevice. It was apparent that no other memory from this moment existed within the archive. Her father's memory was gone, already dissolved into bits of energy, component salts, and enzymes.

Confusion. Chaos. She couldn't be sure of what she was seeing. Her father had clearly changed his stance, his body rigid and yet shaking. Rubbing his eyes in an apparent attempt to clear away the vision that confronted him, he uttered something so quietly that *Horizon*'s recorders almost didn't catch it. "No…" he breathed.

The point of view changed hectically, providing various views of his stance and facial reactions. She was provided with his vital signs; temperature variances, chemical and hormonal changes, increased respiration – Something *terrible* was happening to her father, as if what he saw was ripping him apart from the inside out. And then, the Seed did something unexpected – it began projecting extrapolations of the data it had collected and combined it with what it had recorded previously – from a past situation – from when her father had been left adrift in space for a mere 4 minutes. It was blurry, pixilated at first but the data progressively achieved higher clarity and resolution. Taking into account the motions of her father's eyes and head, the Seed had created something whose image left Emisia completely lost for words and whose reality within the mind of her father had shoved him completely passed the edge of sanity. The camera-frame edge extended outward in a smooth, computer generated motion and Emisia could see what her father saw. A Monster. A creature constructed from iridescently twinkling, sharp edged stars that defined a darkness of the utmost nothingness. It was the embodiment of fear - primal, animalistic fear - and it encompassed half of the heavens.

Her father, no longer capable of holding his ground or comprehending what it was that he saw, broke into a roaring sprint up the gangway that tied the observation platform to the gallery entrance. The cameras followed, bounding around him, all the while including the not-quite-fully-resolved Monster in pursuit at the edge of the frame. He was hysterical, crying out to anyone that crossed his path, "Run! RUN! It's coming… Don't you *see it?!?*… *RUN!!!*" Stumbling, scampering, he ran on leaving the observatory far behind. He seemed not to know or care which way he went. But, Emisia knew. And it was to her personal horror, even already knowing his fate, that she saw him running full tilt toward a precipice. The images were spreading out; there was nothing close enough to record him any longer. Emisia *pushed* forward with her mind – the image zoomed in and resolved. She saw him realize the situation, and he skidded to a stop, falling backward on his hands.

Puffing heavily from his run, he sat exhausted and sweating. But he stiffened once more, as if being spoken to by a voice that only he could hear, one that whispered of the chase - that it would never end and that he would never be able to stop running. Then, after a momentary pause, he said only

"I'd rather die." He stood, slowly stretching to his full, impressive height. His head was bowed slightly, as if saying a prayer. His eyes opened and without looking back, he once again began to run. Leaping from the structure's edge at full speed, he soared a great distance out into the open air before the rotational direction of the habitation wheel played its part. In his final airborne moments, he twisted his body to look back, either avoiding the view of the ground rushing to greet him or to get one last look at his mysterious pursuer. Whatever his reason for turning, he didn't have the time or capacity to say anything about it. But his eyes told the whole story.

The impact was awful and yet, spectacular. Half in and half out of the fountain that splashed festively in *Horizon*'s central meeting place, his body lay broken and unmoving. The cameras continued to automatically record the event: people running to see what had happened, the screams of horror at the sight of his mangled body, the water running red, the sheer shock of the situation. But no one had seen what had *really* happened. No one could have imagined the true circumstances of his demise – and no one wanted to… except for the Archive Seed… except for Emisia.

The chase finished, it appeared the Monster had won.

FLASH

The relationship between the occupant and the Archive Seed was one of mutual understanding. Without request or conscious urging, Emisia was released from the Seed's shell, the plasma gently retracting from her body. Donning her robes, she left the Memory Fields feeling dazed by the shocking imagery she'd experienced, and by the darkness in her father that she'd never known existed. Clearly, it had been no accident and it was obvious that nobody had bothered to investigate the matter. "Why bother," she thought to herself, "It wasn't murder… not by human hands anyway. So leave it alone; let people move on." But she had needed to know the truth. Now, with the truth lying plainly in her hands, what was she going to do with it? The Memory Fields had done so much for her, for her father; hiding his deepest fears all these years, carrying the burden so that he wouldn't have to, but it hadn't been enough. The horrors of her father's memories were stored eternally within the endlessly analytical framework of the Fields; its temperature readings, camera angles, and projections. But what about her father, his essence? What of *him*?

~ EFFIGY ~

THE answer came quickly and so did her actions. Storming back through the ship and gathering materials along the way; a hammer, a chisel, modeling clay… whatever she could lay her hands on. She found her way back to the Core. She spent many days working down in the cavern; her feet were cold, her skin was wrinkled, saturated by the water. Her hands were blistered and bleeding, inexperienced at what they were being told to do.

His image, the effigy of her father she had molded and carved from *Horizon*'s ground, was *like* him, but not just in appearance. It exuded all of his strongest characteristics: his courage, his strength of heart, his serenity, and the kindness in his face – the burden he'd carried for so long had been released, but not forgotten.

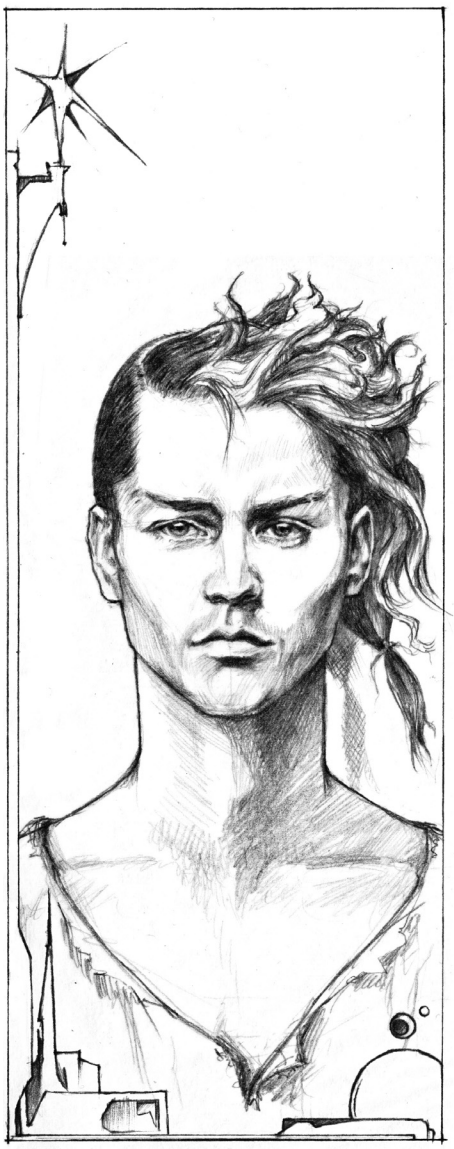
His eyes were closed now, in the peace of un-being. He faced out onto the starry lake, into its shadows and, somehow even without eyes, beyond them. He was the first. "How could it have taken this long?" she thought to herself – The Core had seen hundreds of bodies pass through its systems – bodies. That's all they had been at that point. Did it made things easier for the family, to think of the corpse of their loved ones as only the housing for the person they once were? But what beyond trace biological elements and cold, archival recordings were left behind? It was not enough. *Horizon* was as much its people as it was its hull, its plants, its systems, and its memories. "Without the truth, we are nothing," she said to herself.

This was only the beginning. Her father wouldn't stand alone in the darkness for long.

A Memory

~ MITOSIS ~

~ Baqer Varian ~



~ Nakia Kanan ~

~ Kabira Varian ~

~ JOURNAL ~

SEARCH: ARCHIVE - Personal Log Entries

POSITION: Head Caretaker - Sisterhood of the Path

NAME: Nakia Kanan

SUBJECT: CLASSIFIED

PASSWORD: **********

working…

working…

working…

ACCESS GRANTED - Entries unlocked. Partial entry view enabled. Only entries pertaining to detailed search criteria available.

****

It was an interesting time, the first time since the original construction that serious building has taken place out here in the darkness. It all started after we came across a rich mineral deposit, some twenty years ago now; the remains of some huge celestial body, torn apart either by a collision or by gravitational tidal forces. Whatever caused the debris field, it made it easy for us to pick up the pieces. The harvesting took some time but we were able to take our work with us, so to speak. We never actually had to stop or change course, our small fleet of external collectors was sent ahead, completely adept at traveling independently of *Horizon*.

Near the completion of construction, twins – a boy and a girl – were born. It was an interesting coincidence and interpreted as a good omen by some of the, shall we say, more *spiritual* of us in the community. The twins were hailed as a sign of the promising future of *Horizon*, as she doubled in volume, so the twins came to mark the occasion and were made part of the completion ceremony. In fact, their birth was the inspiration for the naming of the new construction: *Progeny*.

And now, here we are with the completed addition to *Horizon*. Never have we had so much excess: so much space, resources, and food. It is almost terrifying, the openness we're all now experiencing. I had to look up the feeling I was experiencing – agoraphobia; I find myself clinging to the walls for support or even avoiding some of the newer, expansive spaces all together. But, I'm sure I'll get used to it eventually. The only excess we seem to lack is time – we've been pushing hard for years now in an attempt to finish the construction so that we may return our focus to our rituals, to the lives we had before the find. All this change has been exciting though, especially for me. I've been privileged enough to play a role in this monumental transformation, the most significant alteration to the ship in its long history. I've been here to help maintain our views, our faith in ourselves and our beliefs during this shift, and as a reward, I've been appointed Head Caretaker within the Sisterhood; the youngest yet at only 40 years. Our previous Caretaker retired at the completion ceremony, exhausted by the extreme task and ready for a well deserved rest; after all, she is coming up on sixteen decades.

Perhaps the younger ones think this is a regular occurrence; something that happens every generation or so. They will learn though, how things really are out here… all alone.

This was an extraordinary circumstance, one that won't be repeated for many generations to come. It was a lucky circumstance, really. It will, I'm sure, have a much greater effect on our society than anyone can foresee.

****

It is the mission of the Sisterhood of the Path, and particularly myself as Head Caretaker, to maintain the physical and spiritual relationship between *Horizon* and ourselves. *Horizon* is so much more than just a ship; it is our home and the catalyst of our creation. But it was not always seen like this.

When it was first constructed in Earth orbit, she was considered an inanimate, empty vessel; one that would only become animated through its occupation by people. More than finding a way to survive in space, the Horizon project was about experiencing a truly happy and unique way of life, one that could not be found anywhere else. Infinite exploration – that had been the initial

draw; but it ended up being much more than that, the meaning of *infinite* changed and *Horizon*'s people were faced with an endlessness they couldn't comprehend. And as a result of the expanding distance between *Horizon* and Earth, our attachment and connection with our new home intensified in ways no one could have imagined. The depth of the symbiotic relationship was exemplified by the Seed, the keeper of our history. With every memory it absorbs and with every experience it shares, it becomes more a part of us, and we a part of the Seed. Its continuous growth as an independent entity, human in its quest for knowledge, has etched each of us into the soul of the ship. Eventually, we realized that after a few generations of births and deaths, *Horizon* and her people were essentially made from the same material; renewed and decaying in a constant cycle. *Horizon* grew as we grew, lived as we lived, died as we died. That was when the job of the Caretaker began to take shape as something more than a cleaner or maintenance worker, but as a nurturer; helping the ship to grow in order to assure the development of our own society in which the two were inseparable.

So it's funny – and that's why I'm recording this – that despite the importance of my all consuming daily rituals and duties, I always seem to find time to look in on the Varian twins, Kabira and Baqer; the "good omens" of the completion ceremony. No longer infants, voiceless symbols in a time of change, they are youth in the prime of experimentation, pushing every possible boundary. Born into a world with more space than any of us have ever known, they have taken full advantage, exploring all aspects of this world within *Horizon*'s walls. As I watch them grow, I see how they act toward their home; they seem less connected to the ship than most. They look outward, trying to understand how it took us this long to find such a rich stream of resources when we had an entire universe at our disposal. They perform their duties as all the other children, youths, and adults do; in fact they excel in every way but, their preference for the outer world is evident. While not everyone can be Caretaker, these two seem unwilling to accept the ways of the Sisterhood as a personal choice. Whenever they are to study our history, practices and beliefs, mild tolerance and knowing smiles are their usual response. I love them… but I feel like there is something more here than just two, intelligent children.

****

The Varian twins are young, but even at 25 years old their standing within *Horizon* is high and strong. They have been leaders in everything they've done, every aspect of ship life… and they've spearheaded a movement away from our old traditions, the foundations on which *Horizon* exist! They are not anarchists… no, they haven't gone that far. They still show tolerance to all, be they a part of the old ways or not. But I can see what's going on; people are being led astray by their new and exciting outlook, blinded by this "plentiful" world we've made for ourselves. Only those devoted to the Sisterhood, those old enough to know, seem to understand how hard we've all worked to get here, and how quickly all this could be lost.

Beyond the decadence that the people seem to be craving and associating with the aspirations of the twins, Kabira and Baqer only seek our expansion, our conquest of the surrounding space, and to project as far ahead as possible in an effort to find more resources; even to find and occupy another planet. They show no regard for deviation from our course: a course that was set so many generations before their birth, before even the original construction was complete. They want to change what they do not fully understand. Perhaps I am being over-cautious to be so suspicious of them; *Horizon*'s history has been peppered with difficulty, and in the end the people have always favored the side of reason *without fail*. This time of adjustment shall pass; marked in history but incapable of destroying who we are.

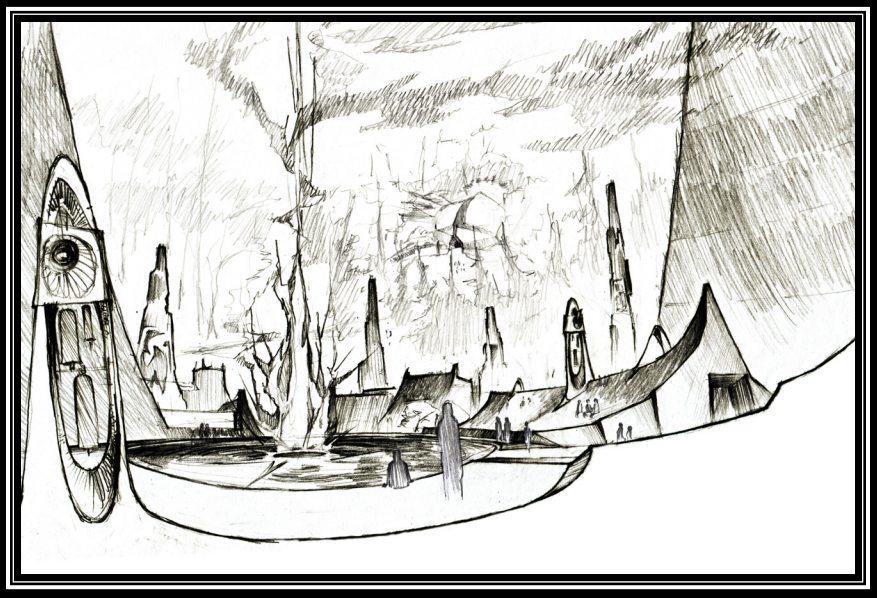
****

The differences between *Progeny* and *Horizon* are becoming more pronounced. As time passes, *Progeny* has come into her own, building character, especially as it has become inhabited. But it's not just families immigrating to one section of Horizon from the other, leaving behind old homes in favor of new. I'm not against this. There is space to be used and new life to bring into *Horizon*. But why must they turn their backs on everything they've ever known, in all we've worked for? They look constantly outward and never back at themselves. I worry that the beliefs of this popular new existence will soon cause painful disruption in all our lives.

Horizon has always functioned as a single minded, symbiotic unit that placed equal dependence on its people as it did on its own systems and structure.

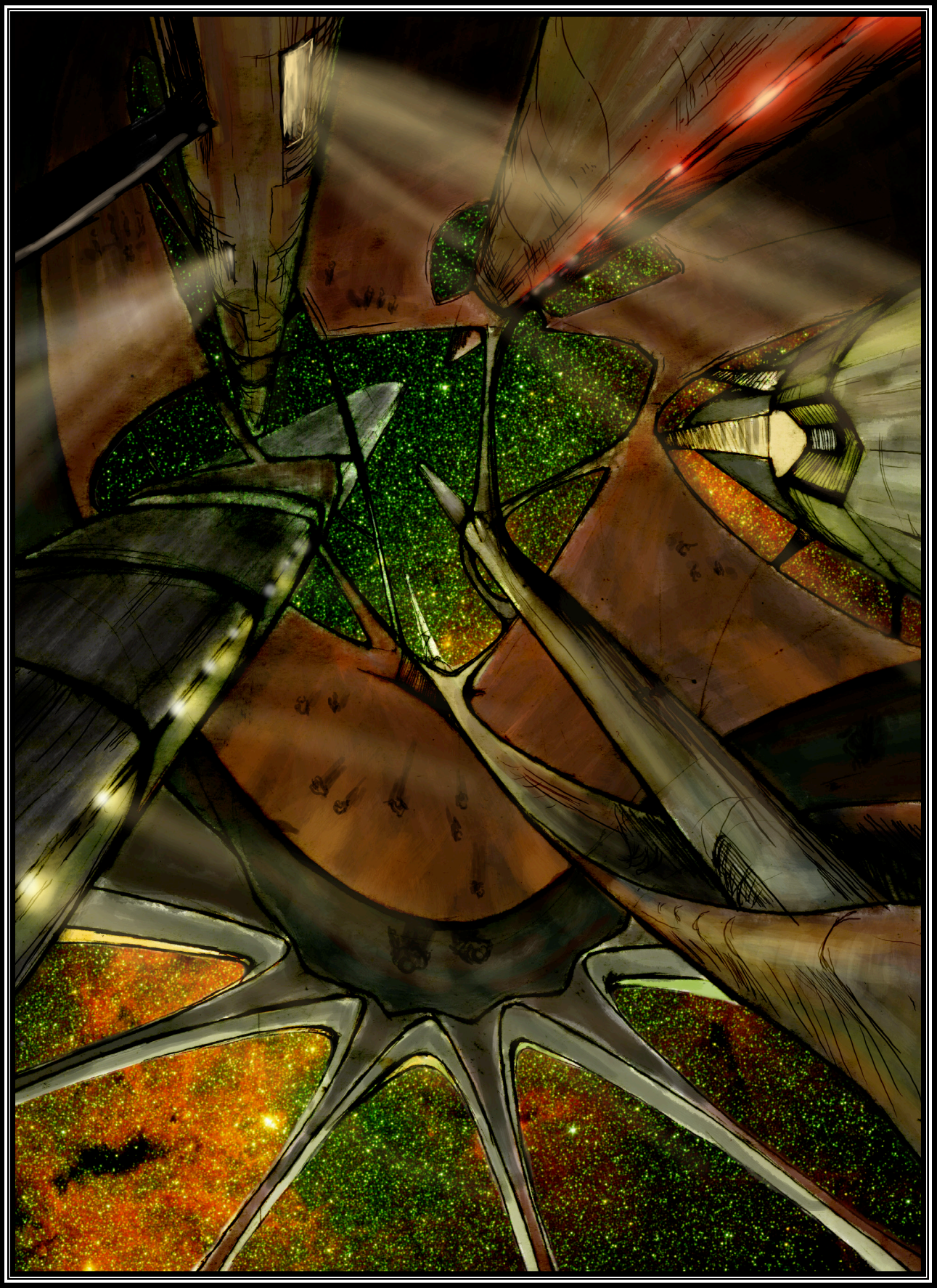
Decisions have been made through a highly inclusive democracy where everyone's voice could be heard. And the seat of decision making, debate, and discussion has *always* been within *Horizon*'s Central Arena; an energetic confluence of movement and dialogue that was surrounded and looked upon by as many places and people as possible. In ancient times, this would have been the piazza, the town hall, the hearth of the home, or even further back, the fire around which people sat, ate, created their own personal mythologies, and protected one another from the animal dangers that plagued the planet.

The Core faced the Central Arena in counter balance; one place steeped in the memory of past individuals, the other in the decisions and ideas that



The Central Arena

those people helped to form. As Caretaker of the Sisterhood, I stand to represent the united voice of *Horizon*. Now the twins have requested that that voice no longer resonate from the Central Arena, that it be moved to represent our future destiny from the new center of *Progeny – their* center – to what they call the Pulsar; a place that stares vacantly to the stars through soulless telescopes without thought for the culture of its people. Without them saying it, I can sense they are positioning themselves in a place of dominance over our people and our past. There is a rift forming within *Horizon*; in its rituals, in its beliefs, and in its people.



The Pulsar

****

It's happened! I thought it could be a possibility but, I never thought… not in my lifetime! The Varians have divided the population. I can't even fathom the backhanded treachery of it all but, they've managed to gather a majority vote in the matter deciding that individual leadership of each ship section would be a better option than the way we've been living for our entire history!!! It's ludicrous! And what's worse, those two demons intend to hold another referendum. They've suggested, no, demanded the unthinkable – they want to change course.

What is it they don't understand? The path has been set! We have no choice but to follow; to deviate would be to set ourselves to wander in aimlessness, moving from one resource to another as nomads, forgetting the way we've been for so many generations.

For the first time in my life, I feel so utterly alone. With no surety of what tomorrow will bring, I feel as though the entire ship is collapsing around me, that I'll be snuffed out of existence with no one to remember me, no one to mourn my loss, no one who cares. *They've taken everything from me and left me alone to fend for myself. They've… oh… oh dammit…* [crying]

RECORDING TERMINATED

****

I will not be idle in this… this situation we are ALL in together. As long as there are those still dedicated to the Sis… no, not dedicated. I am no queen. I will not have disciples. But, I will always be here for those who will honor our traditions, rituals that have been passed down for generations, rich with time and experience.

I'm still out of sorts. I did not think it was possible but, things are worse than before. There are mean spirits about – sabotage – no one's been hurt yet but

given enough time… How is it possible that we've come so far yet, in the moment that should be the most joyous, where our boundaries are allowed to slightly expand, we return to the savage nature of the ancient world? "This place is mine", "You are different so you must leave", "I am right and you are wrong." The discussions have all but ended. We are still moving but no longer as one, no longer in a *forward* direction. We are officially lost.

****

I feel like I'm falling to pieces. I will admit that I too have been neglectful to the needs of *Horizon*. Having been abandoned by so many people whom I've known and loved, some for their entire lives, has broken my heart. I've completely withdrawn and spoken to no one, save my own journal, for days. The grass has literally grown under my feet.

But something has pulled me free. And low, it was them, Kabira and Baqer. They've requested an audience… *how formal of them*. But, there is urgency in their tone so I won't let this sit. I've invited them to the Core Sanctuary. It is unconventional meeting outside the Center Arena but, these are unconventional times. And I believe that what's to come will be more unusual still.

****

ARCHIVE SEARCH CL0SED

****

~ THE CORE SANCTUARY ~

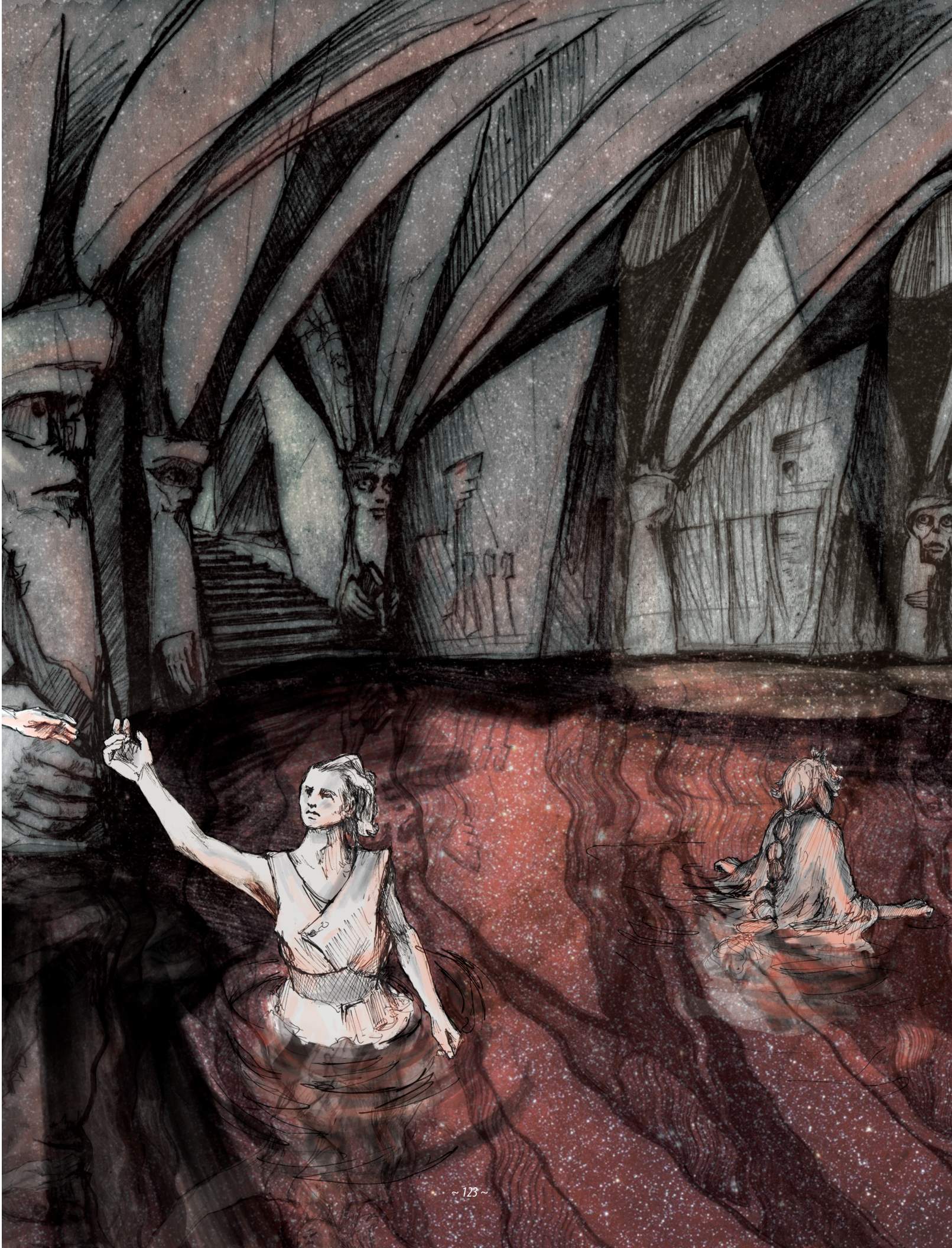
IN anticipation of her meeting with the Varians, Nakia thought it would be best if she meditated before hand in order to achieve as deep a calm as possible; their conversations tended to get heated. And so, in one of the dim and leafy chambers of the sanctuary, Nakia found some peace. Her muscles ached as she stretched, slow to remember those positions she used to practice so regularly; the stress of the situation had penetrated deeply into her body.

Balanced on her right foot with her arms extended upwards to the distant habitat ceiling, Nakia heard the heavy wooden door of the chapel be pushed open, its hinges singing. Resuming a standing posture and turning to face the entrance to her small chamber, she saw the twins almost pass by her; she had been standing so still. Meeting their gaze, Nakia waited, unwilling to be the first to break the silence.

Baqer finally spoke with attempted authority, "We're sorry to interrupt your meditation but, can you speak with us now?" His voice, though strong, was mingled with anxiety. It resonated through the chapel becoming less confident with each echo.

"Of course," she said tightly, "follow me, please." Brushing past, she led them to the rear of the sanctuary and through the back gardens, overgrown and pleading for attention. They came to an archway, scarred by centuries of overlapping carvings and messages; it was the gateway to the heart of the Core. The curving stairway that led down to the subterranean lake was nearly choked by the encroaching vines; creepers, gourds, and other vegetable hung somberly overhead, like festive lamps snuffed out after the party. But what should have been a very dark and shadowed place was spontaneously illuminated by the plethora of sculptures, carvings, effigies, offerings, and stories etched or set into the walls of the stairs. Some glowed intermittently, activated by their body signatures; others, carved from living organic tissue, continued to grow over time, changing and maturing just as a boy turns into a man. All of them told a tale of memory or loss. It was beautiful in its overwhelming clutter.

Nakia stepped gingerly into the water, hardly making a ripple across its starry surface while Baqer and Kabira followed, mesmerized by the thousands of faces that stared at them from the walls and columns. Every surface was so densely and completely articulated, it was a wonder there could be any room for more. This was a place that the Varians had never frequented; to them it exuded a repulsive aura of death, sadness, and pain. Among their friends, they told ghost stories about the Core and the spirits who haunted their own effigies… and the tomato plants they'd grown into! But being brought here by Nakia, alone and without the pathetic sobbing of mourners,



they realized that the Core was about restfulness, reassurance, and contemplation, rather than fear and sadness.

Stopping at the far side of the cavern beneath the closed eyes of another mysterious visage, Nakia turned to the two of them, looking from one to the other. "I have a feeling I know what it is we are about to discuss. But I would like to hear it from you first. Please, speak."

Kabira and Baqer exchanged a glance, their faces hiding something Nakia hadn't quite noticed. Kabira took the lead, "This isn't as easy for us to say as you may think, Nakia. To say we have had our differences is an understatement, I know. But, you have to know that this hurts us just as much as it does you. We never wanted it to come to this! We never thought it would. But we haven't seen eye to eye on a single decision in years and, you must admit, the current state of things does not fall solely on our shoulders. You have a share of the blame just as much as we do! Never a compromise! Never an admission of fault! You would follow this path if it led right into a black hole! You…"

"Oh! Out with it, Kabira!" Nakia spat, "I've had enough of your stalling! You speak to me like I'm one of your idiot friends who believe everything you have to say is the universal truth… Well, I'm done swallowing your tripe and I think you'll find that many others are also. I will not – will never be a part of your game. So, say what you've come to say. I think you'll agree we don't have time for this pissing match any longer."

Baqer stood, dumbstruck by Nakia's unexpected fire, and remained so as his sister, always the more outspoken, stepped forward to face Nakia directly. Her face had lost any appearance of a front or deception. She stood looking desperate and frightened, her hands clasping and wringing at the cloth of her tunic. Her appearance had shifted so much so that Nakia was shocked and felt suddenly ashamed for her emotional explosion. Kabira's words left her lips as a croaking whisper, "*Horizon* must divide."

These were the words she had anticipated but dreaded to hear. Clenching her jaw and letting out a deep sigh, Nakia nodded her affirmation, and continued to stare back and forth between the two youths who stood huddled before her in the dampness. Turning, and looking around the vast chamber she said, "For once, it seems we agree." Returning to gaze into their frightened faces, she continued, "Though, I promise you, my only care is for *Horizon* and her people. I would never intentionally or otherwise let them fall to harm. You must see that.

"So, *Progeny* is to leave her mother so soon after her birth…" she contemplated. "Have you thought of when this will happen or did you think that I would have an answer prepared."

Baqer finally found his tongue again, "We wanted to consult you first, to hear your opinion on the matter. We… uh… we weren't sure what would be enough time for everyone to prepare."

"Alright," Nakia conceded, "the sooner we act the better. We can all see how fast the situation is degrading… twenty-four hours. That should be enough time to…"

"WHAT?!" Baqer interjected excitedly, "A single day? You expect the entire population to be prepared for separation within a single day?! You're mad! You've no idea what…"

"*I know exactly what I'm doing!*" she snarled. "If you think that this will come as a surprise to anyone, you've been deluding yourselves more than I thought was possible. These people began the separation sequence the mo-

"I know exactly what I'm doing!"

ment you upended the order of things! They've completely segregated themselves from each other. *They're sabotaging the only home they have in the Universe!* If they haven't said goodbye to the life they had before by now, they're not going to! Twenty-four hours will be plenty of time for them to prepare. The question is: will it be enough for you? I know where my heart's desire lies; I've known from the moment I joined the Sisterhood. I would say it's time you asked yourself what you want but, it's a little late for that, wouldn't you agree?" She paused, neither Varian responded.

"Twenty-four hours. We'll meet at the Crux. Don't be late." Turning, she splashed back to the stairs, far less elegantly than when she had entered, leaving them alone and shivering in the dim starlight.

~ MITOSIS ~

DESPITE Nakia's expectations, the decision to divide *Horizon* threw the population into a chaotic flurry of pillaging, panic, and emotion. People ran to collect possessions from the homes they'd left behind and even family heirlooms from the Memory Fields. The Archive of *Horizon* actually became a prime target for most of the vandalism and theft; marauders stole any object not firmly bolted down, and even some that were. Snap decisions were made – to stay or to go, to find loved ones or abandon them for all time. What had been a slowly developing tumor, building over time in malignance and ill will between the factions on board, had burst into a festering abscess that consumed almost every inhabitant in their final moments of living as a whole body; a body preparing to tear itself apart limb from limb in an effort to save its own soul.

The Crux, an unassuming passage between *Horizon* and her daughter, was designed to be the final connective tissue between the two; its control room holding the power to separate the vessels in the event of emergency. *Well, I guess this qualifies as an emergency*, Nakia thought bitterly as she entered the darkened control room. By now, all other access points between the ships had been sealed, the transfer of personnel was complete save for Nakia, Kabira, and Baqer. With little to change in her own living circumstances, Nakia had spent the last twenty-four hours helping others adjust to the shocking news; facilitating departures and arrivals as best she could into what was now deemed as *her* section of the ship.

That had been difficult to handle, even to understand. Nakia's life had been dedicated to the ship and its well-being, to those who aided her in that task, and to the people as a whole, all of them friends and loved ones. A committee had always handled policy on both Horizon and its new addition. Now people were turning solely to Nakia for guidance, to help make the right decisions; personal, social, *and* political. The pressure had been building for weeks but, in the last few hours, it had hit a crescendo. Exhausted by the immense task and the thought of a still uncertain future, Nakia sat heavily in one of the control room chairs and waited for the twins to arrive.

She must have dozed off because the sound of rapid, overlapping footfalls in the hall startled her. In ran Baqer and Kabira, sweating, winded, and covered in filth. They were disheveled, emotional, and looked years older than they had yesterday – the announcement seemed to have received worse reception on *Progeny*. But when they compared numbers, they found that, surprisingly, there had been a relatively even split between the two groups. At least that was one less thing to worry about. Though this had been, and

would continue to be difficult for Nakia and for those staying on *Horizon*, she knew that it would be far harder in the long run for the people of *Progeny*. Of course, they had everything they needed to survive; food production, waste management, facilities that matched and were even improved upon from what was on *Horizon*. This was no death sentence. But what they didn't have was experience, something *Horizon* had in excess. *Their adjustment period will be very long*, Nakia thought to herself as she watched the Varians panting before her. It had been the greatest challenge in the world for those first explorers to venture across the endless oceans of ancient Earth, to blast off into space aiming squarely at the Moon. It hadn't been a simple task for the first people of *Horizon* either. *Exploration is never easy… and it doesn't come cheap*, she thought, getting slowly to her feet.

"I would like to say something," she said, stiffly at first, then softening, "since these are our final moments to physically face one another. For centuries, we have leaned on ritual as a foundation through a place that has no grounding, a place that is darker than any night human eyes have witnessed. We have relied on the slowness of its evolution, the simple answers it provides to complex questions, and its small comforts in trying times. But the past fifty years have burdened us with more change than *Horizon* has seen in its entire history. We've doubled in scale and, some of us anyway, have turned completely around in what our direction should be. How could we cope with this? There was no plan for *Horizon* beyond a schematic design to manage this newness, to allocate the space, to disperse the people… to guide the ideals. Nobody could have predicted what *Horizon* would become after *Launch Day*. No one could have predicted the impact of doubling the ship's size; it opened up so many possibilities… too many perhaps. We did, I think, the best anyone could have done. It seems that we were destined for this journey, the one that we've all made together, and the new path that you will cut fresh today. You are both strong, intelligent people. Despite the differences in our beliefs, you were born to lead – and so you shall. Lead your vessel well; let *Progeny* guide you in your decisions. Take care of her people; enrich their lives with your will to explore. But know that *belief* has just as much play in your lives as the science that protects you from destruction. It is your confidence. It is your strength. It is that which binds you together as a community that matures and improves with time. And most of all, remember what has happened here; this is the beginning of your own legend." Standing in a circle, they joined hands briefly, communicating their feelings by touch… saying their goodbyes.

Nakia moved to the main instrument panel of the Crux control room, its displays suddenly active. The panel stood at the room's center like a meeting table, only slightly inclined for accessibility. It was covered by row after row of illuminated readouts and settings, but was dominated by a single, large image, an icon familiar to every person on board; the symbol of *Horizon*. Kabira and Baqer followed Nakia and hovered close behind to see what was about to happen. Nakia took a moment to survey the board, taking in the controls and remembering the steps necessary to initiate the process; one that had been performed only once before during system testing so many years ago. She began. Her fingers glided over the panel, touching various illuminated interfaces as they went, setting in motion an event that would alter the course of human history forever. After a few, anxious moments, she straightened and gestured to Kabira, the first born of the twins, to approach the panel. Her brother looked on, confused momentarily by the choice, but then understood. His face filled with pride for his sister and relief for himself; this would not be his burden to bear.

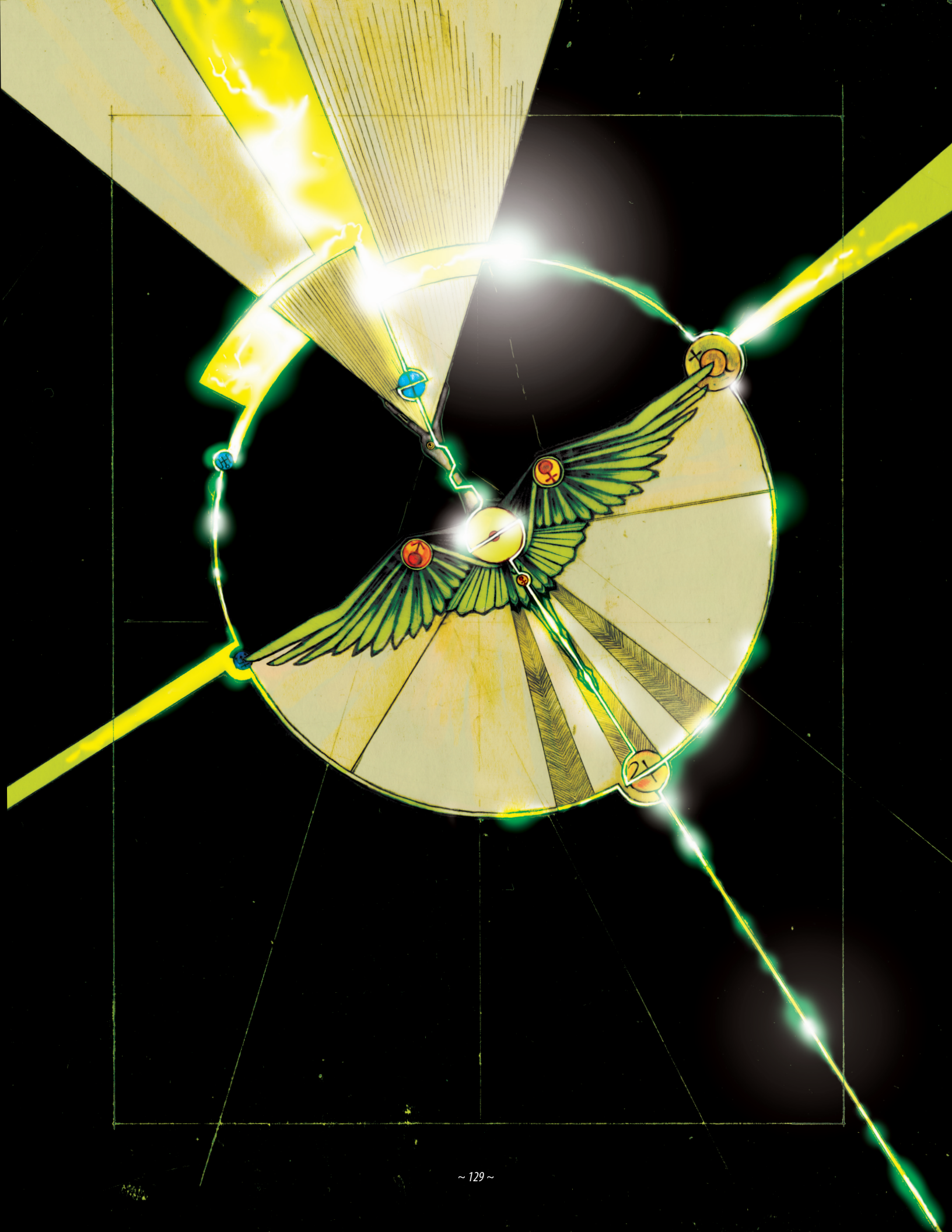
Standing side by side, their faces lit by the rainbow of photons that escaped from the panel, Nakia placed her right hand over the left side of the symbol, motioning for Kabira to take the opposite stance. *Horizon*, sensing their presence, initiated the separation sequence, releasing the symbol from its housing within the panel and, completing the cycle, broke it in two.

Kabira, still hovering her hand over the lonely half-piece of *Horizon*, was astonished by the speed and suddenness of the procedure. She picked the half up and held it tightly against her chest. Looking beside her, she found Nakia had done the same. They understood each other: the symbol of *Horizon*, now broken, was to remain separated eternally, guarded and protected by its two custodians; the two leaders of a society divided.

A legacy in two pairs of hands, they all stared as organic light pulsed through the control panel, stemming from where the symbol had been, and spreading from there to permeate through the rest of the control room. The light display would continue to spider on through the passageway until it met its destination; the Crux, the final seam connecting *Horizon* to her daughter – a seam that was about to be ripped of its threads.

After watching, enthralled by the light show for a few short moments, the twins looked one last time into the eyes of the woman who had nurtured and loved her people, despite their differences, never hesitating to shield anyone from harm. "Hurry," she said, "you must hurry unless want to be trapped here with me for the rest of your lives." She smiled. Their hands clasped in a final moment of sentiment before breaking again as the twins ran from the control room toward the Crux.

The Symbol of Horizon: *A crane, a symbol of faithfulness, prosperity, and immortality[1] was the chosen representation for Horizon's eternal voyage. Her mouth open in song, the Earth and other planets spiraled about her wings while the Sun burned through her fiery crest. It was a map; a symbol laid out to constantly remind the people of Horizon of their origins, their purpose, and that as long as they endured in peace and belief, they would never be alone.*


21

Nakia followed behind, watching their progress. After leaping through the final threshold, the gateway between the old and the new, Kabira and Baqer looked back to find Nakia making her approach. The transparent gate of the Crux slid quickly closed with a booming shudder, announcing with cold finality the end of their time together: an era of plenty and sure footing coming to a close while a time of exploration and uncertainty raced to greet them.

It happened quickly. Light coursed past Nakia in a flood, immersing her in its rich glare and encircling the gateway, it created a bonded ring. It brightened, and then flared, blinding the three of them and throwing them to their knees as the two ships pushed away from each other.

Baqer stood and pressed himself to the gateway that still glowed warmly at its edges. He stared into the face of Nakia as she and *Horizon* slowly receded, her features becoming indistinguishable. The people of *Progeny* had been made an individual race; separated from its parent to roam free on a path of its own choosing. It was everything Kabira and Baqer had dreamed of, to explore the Universe to its utter end. But as the distance between *Progeny* and *Horizon* progressively expanded, in a voice full of shock and bewilderment, all Baqer could say was,

"We're alone."

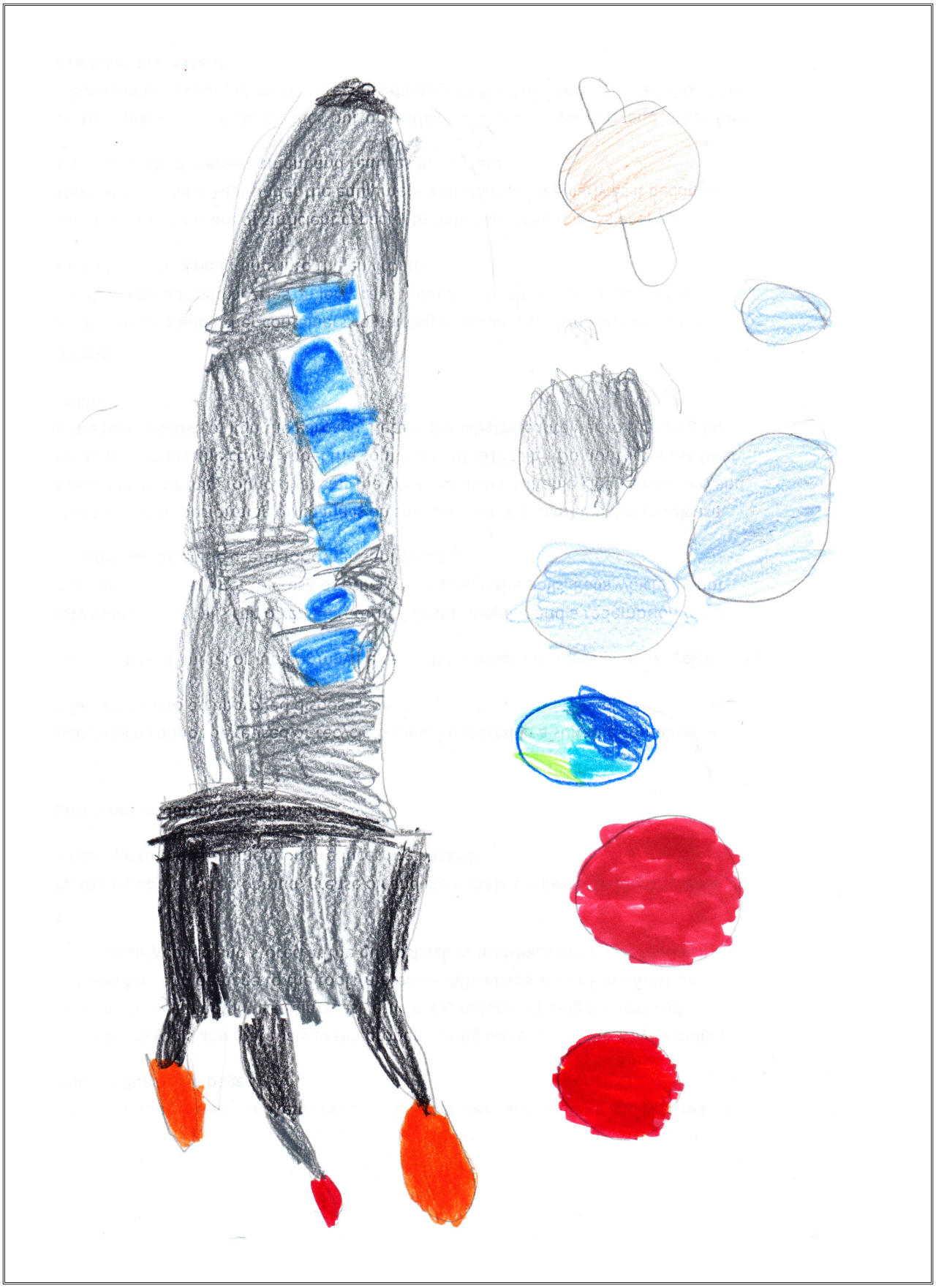


Fig. 92 ~ **Space Ship and Planets** *by Danica Zehr (2010).*

AFTERWORD

TO end this story, and this thesis, with the ultimate division of *Horizon*, goes beyond the fear laced final words of Baqer. This terrifying prospect of perpetual loneliness and wandering begs the questions: What's *next? What* do we do now?

It's a setup. I have an ulterior motive that is the driving force behind this thesis. I want the reader to wonder what will happen in the next chapter… of this story and of our future journey into space. I believe that moving through space beyond our solar system is an eventuality, one that has its roots buried in our passion for solving mysteries, our penchant for pushing through boundaries to find ourselves in new and exciting places, and most importantly, in our quest for more than mere survival. How our culture faces the oncoming challenge will be our own story, one that may be entirely different than the short narrative about *Horizon*.

As I mentioned earlier, I've discussed this story with many friends and colleagues to hear their thoughts and ideas. One particularly poignant question asked how it was possible that I could condemn the descendants of the original crew to a life confinement, no, of imprisonment on board such a vessel for all eternity, no matter how well it was designed. It was, and still is, a good question – and one I still can't completely answer. But this question led me to include the elements of strife experienced on board *Horizon* throughout the narrative. To me, the opportunity to explore indefinitely would be impossible to refuse, no matter the difficulties. But to someone else, it could be a living hell. No way out, no escape, no one to speak with beyond those who were also permanently trapped. What kind of future is that?

So, what is the next chapter? How can we overcome the inherent cultural difficulties associated with leaving our planet behind? The answer is that we need to keep asking these questions, examining how we live together, how we change over time, and how we must embrace our aspirations while always remembering our humanity. Despite the pain, hope is what I am reaching for – and I think I've found it.

The final image of this thesis is not of my own creation but it is still very important to me. I share my excitement for this subject with abandon – telling everyone and anyone of its possibilities – and no one hears more about it than the members of my family. This final illustration was presented to me by my niece, Danica. She said to me, as she placed it into my hands, "you can use it to help with your design." She doesn't know it yet but, her drawing was exactly what I needed to complete this *design*, this story of a yet unwritten future. Because now I see, the excitement I found in *Horizon* was not in its space-bound design concept, it was in its potential to create a world that would inspire the next generation to look beyond the edge of reason and out toward the horizon.

APPENDIX A

A DAY IN THE LIFE OF A CARTHUSIAN

This is a timetable of a typical week-day for a cloister monk. An average day which will vary from house to house, from monk to monk, and from one day to another. In grey are the conventual Offices in the Chapel.

Matins, Lauds, Prime, Terce, Sext, None, Vespers et Complines name the Offices which punctuate the day. Each canonical Office is accompanied (either preceeded or followed) by the Office of Our Lady, the Virgin Mary.

11:30pm	Rise - Prayer in Cell	This nocturnal prayer in solitude is particularly appreciated by many.
0:15am	Matins followed by Lauds	In the Chapel. This office last two to three hours depending on the day or the Feast.
	Lauds of Our Lady	In cell. Praise to God with the Virgin Mary. Then back to sleep.
6:30am	Rise	The time is approximate. To be ready for Prime.
7:00am	Prime - *Angelus*	After the *Angelus*, the time is consecrated to Prayer or *Lectio Divina* (e.g. prepartion of the Mass readings).
8:00am	Conventual Mass	In the Chapel.
	Thanksgiving - *Lectio Divina*	*Lectio Divina* is a meditative reading of the Bible. This time can also be used for prayer.
10:00am	Terce	Approximatively every two hours an Office is recited : Terce is one of them.
	Study or Manual Work	No manual work before Terce. It can be done morning and afternoon, or all at once.
12:00am	*Angélus* - Sext	Recitation of the Office of Sext
	Meal-Recreation	The time of recreation may be employed freely. reading, working, gardening, or enjoying the sun.....when it shines.
2:00pm	None	Recitation of the Office of None
	Manual Work (1hr) Study	The time accorded to each depends on the individual in negociation with his Superior. (Prior or Novice Master)
4:00pm	Vespers of Our Lady	Praise to God with the Virgin Mary.
4:15pm	Vespers	In Church
	Collation - Reading - Prayer	Reading of the Bible, a spiritual writer, or other appropriate material. The collation is a light meal, taken any time between Vespers and Complines.
6:45pm	*Angélus* - Complines	Recitation of Complines, the last Office of the day.
7:30pm	Bedtime	Advisable before 8:00pm.

Carthusian Order, "A Day in the Life of a Carthusian," *Carthusian Monks and Carthusian Nuns*, Ordre des Chartreux, http://www.chartreux.org/en/frame.html (accessed 8 October 2010).

APPENDIX B

THE "OPUS DEI"

	June	*December*
Rising	1:45	1:20
Vigils (night office)	2:00-3:00	1:30-2:50
—	Interval	*(lectio divina)*
Lauds (at first light)	3:10	7:15
(Interval for private masses)		
Prime* (at sunrise)	4	8*
Chapter	4:15	9:35
Manual labor**	4:40-7:15	9:55-11:10,**
		11:35-12:50
Terce	7:45	9:20
Mass	8-8:50	8:20-9:10
Reading	8:50-10:40	
Sext (midday)	10:40	11:20
Dinner†	10:50	13:35†
Rest (meridian)	11:30-13:45	—
None	14	13:20
Manual labor	14:30-17:30	*(lectio divina)*
Vespers	18-18:45	14:50-15:30
Supper	18:45	—
Collatio	19:30	15:45
Compline	19:50	15:55
Sleep	20	16:05

* In winter season the sequence was Prime, Mass, Terce, Chapter.

** In winter season the work period was interrupted for Sext.

† In winter season the sequence was None, dinner, *lectio divina*. There was no evening meal except on Sundays.

Terryl N. Kinder, *Cistercian Europe: Architecture of Contemplation* (Grand Rapids: W.B. Eerdmans Publishing Company, 2002), 56.

APPENDIX C

SPACE HABITABILITY

Operational habitability refers to the design, integration and support of human, machine, mission, and environmental elements that promote optimal performance, physical and psychological health, and safety in long duration spaceflight. Habitability pertains to the qualities of a mission that enable people to live and work in a safe and productive manner. Habitability specialists at NASA JSC provide support in the following areas: architecture, acoustics, clothing, command structure, communications, crew interface/displays, dining, environmental conditions, emergency, exercise, EVA, fatigue, equipment, food & nutrition, group interaction, housekeeping, hygiene, lighting, maintenance, multicultural issues, psychological effects, privacy, recreation, restraints, supplies/provisioning, scheduling, sleep, stowage, translation/mobility, trash, training, and waste collection.

Table 2. Effects of Long Duration Spaceflight on Crew Performance & Functioning

1. Exhaustion & Asthenia:
    - Fatigue, feeling of tiredness
    - Emotional instability
    - Sleeplessness
    - Sharpening of Personality
    - Incapacity for work
    - Disruption in psychophysiological reaction
    - Psychosomatic Dysfunction
2. Euphoria
3. Depression
4. Neurosis
5. Accentuation of negative personality traits
6. Cognitive effects:
    - Psychomotor performance
    - Dual-task performance
    - Tracking performance
    - Fine manual control
    - Sleep-decrement induced cognitive factors:
        - Alertness
        - Vigilance
        - Response Time
        - Ability to Focus

Some areas recently studied by the Operational Habitability Team at JSC include 1) the need for windows in spacecraft, 2) astronaut disorientation in long duration spaceflight, 3) the importance of group dining in long duration spaceflight, and 4) specifications for a minimum clearance for crew movement through spacecraft modules. See references 21-24 for more about spaceflight habitability and its relation to performance in space.

M. Ephimia Morphew, "Psychological and Human Factors in Long Duration Spaceflight," *McGill journal of Medicine* 6, no. 74-80 (2001): 77-78.

APPENDIX D

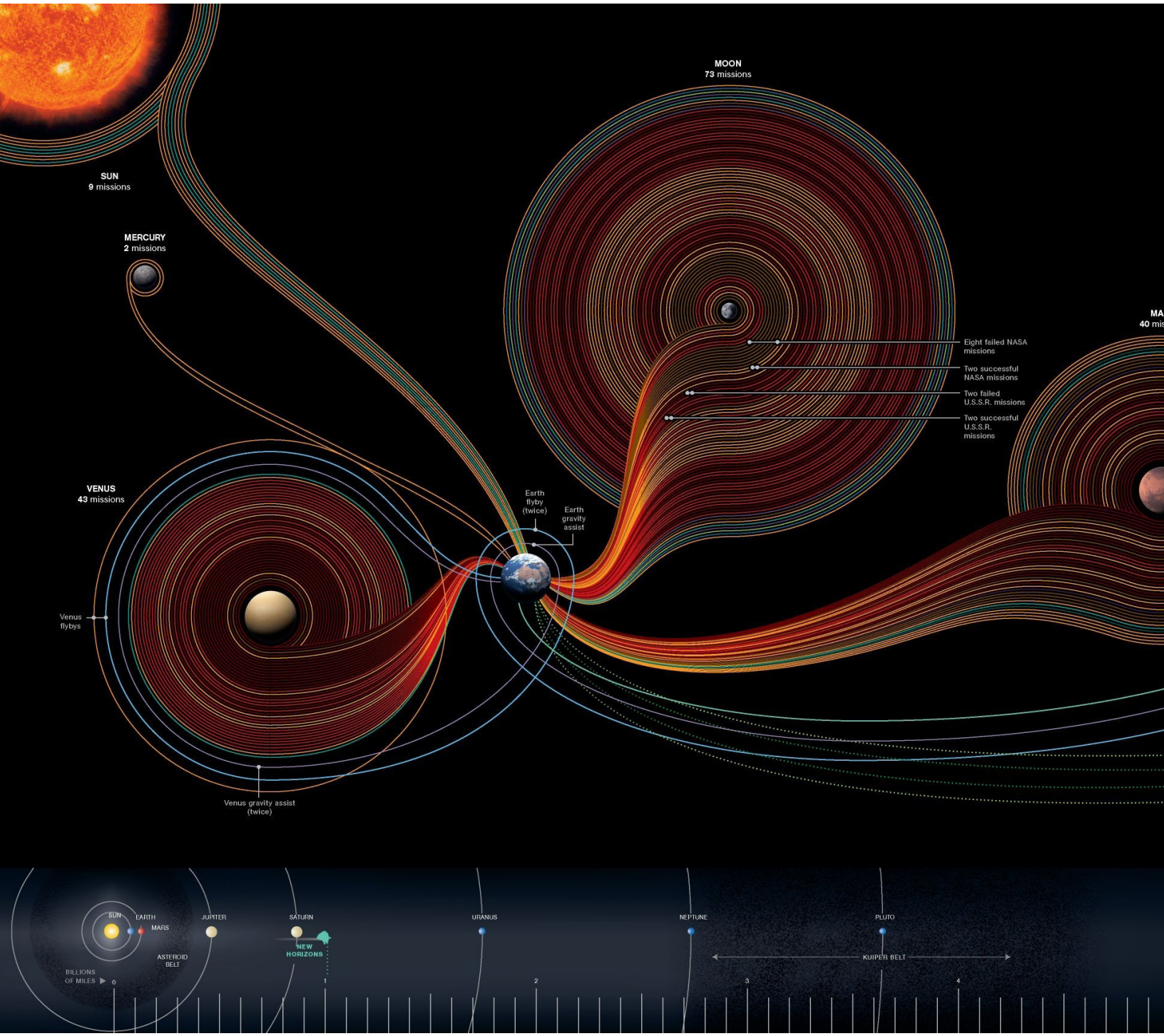
Table 1. Stressors of Long Duration Spaceflight

Physiological/Physical	Psychological	Psychosocial	Human Factors	Habitability
Radiation	Isolation & confinement	High team coordination demands	High & low levels of workload	Limited hygiene
Absence of natural time parameters	Limited possibility for abort/rescue	Interpersonal tension between crew/ground	Limited exchange of info/comms with external environment	Chronic exposure to vibration and noise
Altered circadian rhythms	High-risk conditions & potential for loss of life	Family life disruption	Limited equipment, facilities and supplies	Limited sleep facilities
Decrease in exposure to sunlight	System & mission complexity	Enforced interpersonal contact	Mission danger & risk associated with: equipment failure, malfunction, or damage	Lighting & illumination
Adaptation to micro-gravity	Hostile external environment	Crew factors (i.e., gender, size, personality, etc.)	Adaptation to the artificially engineered environment	Lack of privacy
Sensory/perceptual deprivation of varied natural sources	Alterations in sensory stimuli	Mulitcultural issues	Food restrictions/ limitations	Isolation from support systems
Sleep disturbance	Disruptions in sleep (readjustment with crew changeovers)	"Host-Guest" phenomenon	Technology-interface challenges	
Space Adaptation Sickness (SAS)	Limited habitability (e.g., limited hygiene)	Social conflict	Use of equipment in microgravity conditions	

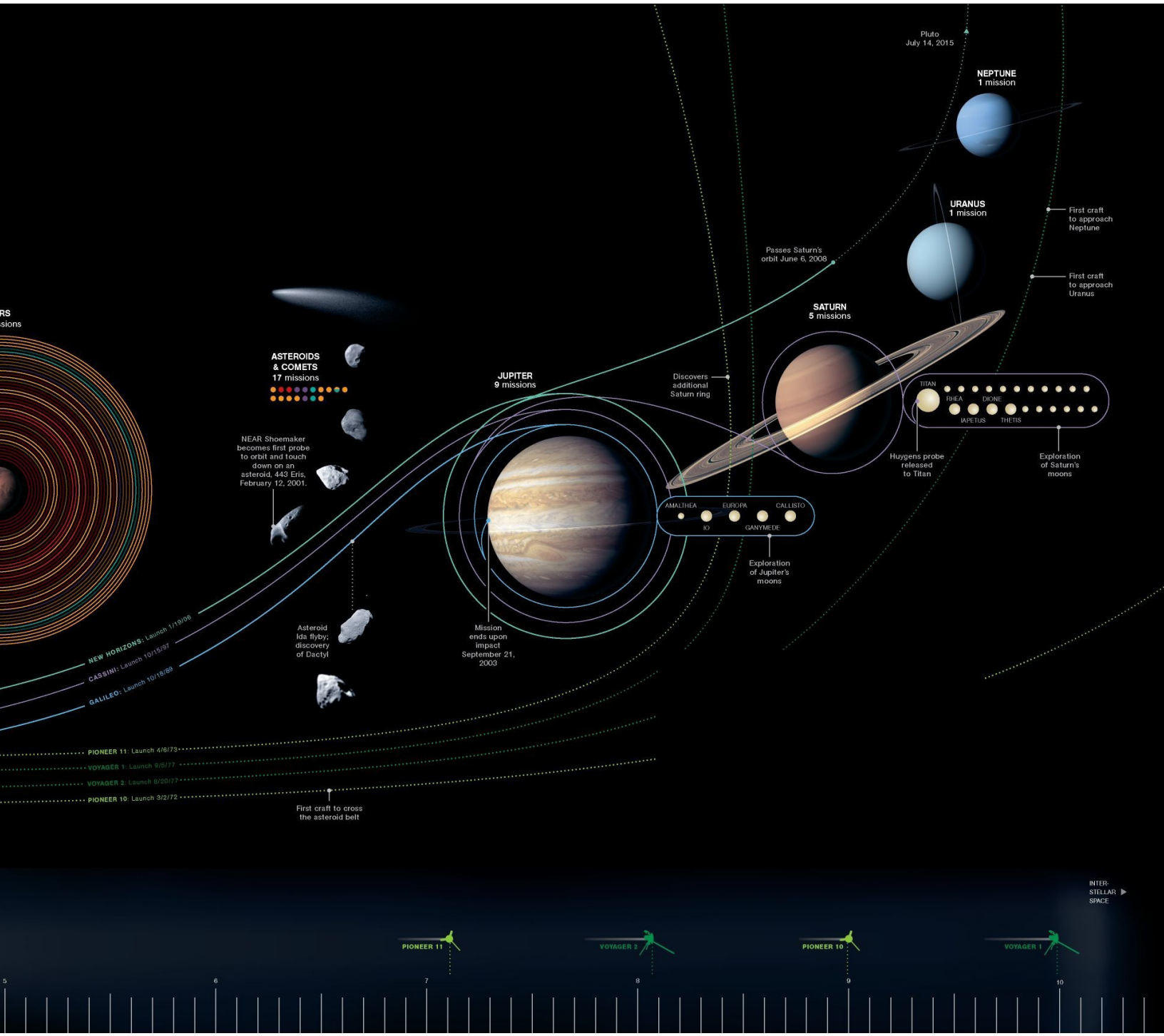
M. Ephimia Morphew, "Psychological and Human Factors in Long Duration Spaceflight," *McGill journal of Medicine* 6, no. 74-80 (2001): 75.

APPENDIX E

"50 YEARS OF EXPLORATION"



Sean McNaughton and Samuel Velasco, "50 Years of Exploration," *National Geographic*, http://books.nationalgeographic.com/map/map-day/index (accessed 7 October 2010).


Pluto
July 14, 2015
NEPTUNE
1 mission
URANUS
1 mission
First craft to approach Neptune
First craft to approach Uranus
Passes Saturn's orbit June 6, 2008
SATURN
5 missions
TITAN
RHEA
DIONE
IAPETUS
THETIS
Huygens probe released to Titan
Exploration of Saturn's moons
Discovers additional Saturn ring
JUPITER
9 missions
AMALTHEA
EUROPA
CALLISTO
IO
GANYMEDE
Exploration of Jupiter's moons
Mission ends upon impact September 21, 2003
ASTEROIDS & COMETS
17 missions
NEAR Shoemaker becomes first probe to orbit and touch down on an asteroid, 443 Eros, February 12, 2001.
Asteroid Ida flyby; discovery of Dactyl
First craft to cross the asteroid belt
NEW HORIZONS: Launch 1/19/06
CASSINI: Launch 10/15/97
GALILEO: Launch 10/18/89
PIONEER 11: Launch 4/6/73
VOYAGER 1: Launch 9/5/77
VOYAGER 2: Launch 8/20/77
PIONEER 10: Launch 3/2/72
INTER-STELLAR SPACE
PIONEER 11
VOYAGER 2
PIONEER 10
VOYAGER 1
5
6
7
8
9
10

NOTES

INTRODUCTION

1. Andrew Dermont, "Month of Thinking Dangerously – Idea #5: Stephen Hawking's Warning: Abandon Earth – Or Face Extinction," *Big Think*, http://bigthink.com/ideas/21570 (accessed 12 August 2010).

2. "International Space University: Space Studies Program," *International Space University*, http://www.isunet.edu/index.php?option=com_content&task=blogcategory&id=59&Itemid=185 (accessed 10 October 2010). The International Space University offers a two month program that is held in a different city every year through the months of July and August. Its purpose is to gather professionals from a wide variety of fields to produce individual and team based work that is focused on worldwide issues of concern. The university's dedication to exploration, the space industry, and diversity is exemplified by its philosophy of the 3 i's: international, intercultural, and interdisciplinary. My experience as a part of the Space Studies Program in 2009 was integral to moving my thesis forward. I learned a great deal about the science and physics behind spaceflight as well as its various applications within our world economy. It was a major highlight within my masters as it offered a great opportunity to meet leaders in a variety of industries and create lasting relationships between new friends the world over.

EXPLORATION

1. Ray Bradbury, *Bradbury Speaks: Too Soon from the Cave, too Far from the Stars* (New York: William Morrow, 2005), 47.

2. Stephen W. Hawking, *A Brief History of Time: From the Big Bang to Black Holes* (Toronto: Bantam Books, 1988), 13.

3. Johathan Z. Smith, *To Take Place: Toward Theory in Ritual* (Chicago: University of Chicago Press, 1987), 28.

4. Ibid., 25.

5. Stephen W. Hawking, *A Brief History of Time: The Updated and Expanded Tenth Anniversary Edition* (Toronto: Bantam Books, 1998), 2.

6. Ibid., 4.

7. Benedeiz, Ian Short, and Brian S. Merrilees, *The Anglo-Norman Voyage of St. Brendan* (Manchester: Manchester University Press, 1979), 1.

8. T.J. Oleson, "BRENDAN (Bréanainn), SAINT," *Dictionary of Canadian Biography Online*, http://www.biographi.ca/009004-119.01-e.php?&id_nbr=87&interval=25&&PHPSESSID=peb752nmi3o5hmt8cj5rklcrk2 (accessed 25 August 2010).

9. Charles McKew Parr, *Ferdinand Magellan, Circumnavigator* (New York: Cromwell, 1964), 370.

10. Ibid., viii.

11. Alan Cook, "Edmond Halley and the Magnetic Field of the Earth," *Notes and Records of the Royal Society of London* 55 no. 3 (September 2001): 480.

12. Ibid., 481.

13. John Jeffrey Hester et al, *21st Century Astronomy* (New York: Norton, 2002), 481.

14. Ibid., 113.

15. Hawking, *A Brief History of Time: The Updated and Expanded Tenth Anniversary Edition*, 41.

16. Andrew Chaikin and Victoria Kohl, *Voices from the Moon: Apollo astronauts describe their lunar experiences* (New York; London: Viking Studio, 2009), 61.

17. Bradbury, *Bradbury Speaks: Too Soon from the Cave, too Far from the Stars*, 45.

18. Ibid., 46.

19. Chaikin, *Voices from the Moon: Apollo astronauts describe their lunar experiences*, 66.

20. William Goyen, *The House of Breath* (Evanston: TriQuarterly Books/Northwestern University Press, 1999), 40-41.

PLACES OF DISCOVERY

1. Roger Shattuck, *Marcel Proust* (New York: Viking Press, 1974), 131.

2. Francois Cali and Lucien Hervé, *Architecture of truth; the Cistercian abbey of Le Thoronnet in Provence* (New York: G. Braziller, 1957), v.

3. Ibid., 12.

4. Terryl N. Kinder, *Cistercian Europe: Architecture of Contemplation* (Grand Rapids: W.B. Eerdmans Publishing Company, 2002), 27.

5. Benedict and Timoth Fry ed., *The Rule of St. Benedict* (New York: Vintage Books, 1998), xxvii.

6. Kinder, *Cistercian Europe: Architecture of Contemplation*, 30.

7. Robin Bruce Lockhart, *Halfway to Heaven: The Hidden Life of the Sublime Carthusian* (London: T. Methuen, 1985), 30.

8. Ibid., 31.

9. Eugène Emmanuel Viollet-le-Duc, *Dictionnaire raisonńe le l'architecture française du XIe au XVIe siècle* (Paris: E. Martinet, 1868), 307.

10. Lockhart, *Halfway to Heaven: The Hidden Life of the Sublime Carthusian*, 103.

11. Ibid., 36.

12. James Freeman Clarke, *Events and epochs in religious history;being the substance of a course of twelve lectures* (Boston: J.R. Osgood and Company, 1881), 105.

13. *Into Great Silence.* Produced by Philip Gröning. Directed by Philip Gröning. 162 minutes. Zeitgeist Films, 2008. DVD.

14. Kinder, *Cistercian Europe: Architecture of Contemplation*, 385.

15. Lockhart, *Halfway to Heaven: The Hidden Life of the Sublime Carthusian*, 35.

16. Cali, *Architecture of truth; the Cistercian abbey of Le Thoronnet in Provence*, xii.

17. Kinder, *Cistercian Europe: Architecture of Contemplation*, 34.

18. Clarke, *Events and epochs in religious history;being the substance of a course of twelve lectures*, 96.

19. Marcel Aubert, *L'Architecture cistercienne en France: Avec la collaboration de la Marquise de Maillé, Deuxième Édition, Tome Premier* (Paris: Vanoest, 1947), 45.

20. Ibid., 40.

21. Kinder, *Cistercian Europe: Architecture of Contemplation*, 58.

22. Ibid., 110.

23. Ibid., 133.

24. Ibid., 386.

25. Jules Verne, *20,000 Leagues Under the Sea* (New York: Penguin Books, 1981), 72.

26. Ibid., 78.

27. Fridtjof Nansen, *Farthest North: The Epic Adventure of a Visionary Explorer* (New York: Skyhorse Publishing, 2008), 49.

28. Ibid., 38.

29. Ibid., 40.

30. Ibid., 44.

31. Ibid., 49-50.

32. Arthur C. Clarke, *2001: A Space Odyssey* (New York: ROC, 2000), 254.

33. Ibid., 227.

34. Ibid., 108.

35. Angie Bukley and Gilles Clément eds., *Artificial Gravity* (Hawthorne, Microcosm Press, 2007), 4.

36. Clarke, *2001: A Space Odyssey*, 220.

37. Barbara Aggerholm, "Looks like Mars, feels like Mars…," *The Record*, 22 August 2007, http://news.therecord.com/article/231567 (accessed 10 October 2010).

38. Simon Auclair, "Message from Mars," *International Space University*, http://www.isunet.edu/index.php?option=com_content&task=view&id=369&Itemid=351 (accessed 20 August 2010).

39. G. Sandal, G. Leon, and L. Palinkas, "Human Challenges in Polar and Space Environments," *Reviews in Environmental Science and Biotechnology* 5 no. 2-3 (28 July 2006): 291.

40. "Amundsen-Scott South Pole Station," *Office of Polar Programs*, National Science Foundation, http://www.nsf.gov/od/opp/support/southp.jsp (accessed 17 November 2009).

41. Richard Panek, "Benign Space: South Pole offers ideal location to observe the mysteries of the universe," *The Antarctic Sun*, 2 October 2009, http://antarcticsun.usap.gov/features/contentHandler.cfm?id=1915 (accessed 20 November 2009): 1.

42. "South Pole Station for Science," *United States Antarctic Program*, Nation Science Foundation, http://www.usap.gov/videoClipsAndMaps/spWebCam.cfm (accessed 11 October 2010).

43. Ibid. Another major project currently underway is IceCube, "a one-cubic-kilometer international high-energy neutrino detector being built in the clear ice, 1.25-2.5 kilometers below the South Pole station."

44. Sandal, "Human Challenges in Polar and Space Environments," (28 July 2006): 295.

45. Albert A. Harrison, Yvonne A. Clearwater, and Christopher P. McKay eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991), 58-59.

46. Ibid., 15.

47. Ibid., 137-138.

48. Peter Watts, *Starfish* (New York: Tor, 2000), 45-46.

49. Ibid., 15.

50. Harrison, *From Antarctica to Outer Space: Life in Isolation and Confinement*, 60.

51. Watts, *Starfish*, 13.

52. Peter Watts, "Beebe Station: General Layout," *Rifters*, Peter Watts, http://www.rifters.com/starfish/beebe.htm (accessed 26 September 2010).

53. Watts, *Starfish*, 32.

54. National Aeronautics and Space Administration (NASA), Charles Holbrow, and Richard D. Johnson, *Space Settlements: A Design Study* (Washington: United States Government Printing Office, 1977), vii.

55. NASA/JPL, "Jupiter – Io In Front of Jupiter's Turbulent Clouds," NASA Planetary Photo Journal Collection*, NASA/JPL*, http://photojournal.jpl.nasa.gov/catalog/PIA00371 (accessed 26 September 2010).

56. NASA, *Space Settlements: A Design Study*, 33.

57. *Silent Running*. Produced by Michael Gruskoff. Directed by Douglas Trumbull. 89 minutes. Universal Pictures, 1972. DVD.

58. T.S. Kelso, "SATCAT Boxscore," *Celestrak*, http://www.celestrak.com/satcat/boxscore.asp (accessed 11 October 2010). 3,463 payloads on orbit as of this date.

59. Sven Lütticken, "Planet of the Remakes," *New Left Review* 25 (January/February 2004): 113.

FRAMING THE INFINITE

1. Jean Chevalier and Alain Gheerbrant, The Penguin Dictionary of Symbols, Translated by John Buchanan-Brown (London: Penguin Books, 1996), 728.

2. Ibid., 729.

3. Gareth Williams and the Victoria and Albert Museum, *Telling Tales: Fantasy and Fear in Contemporary Design* (London; New York: V&A Publishing; distributed in North America by Harry N. Abrams, 2009), 9.

4. C.S. Lewis, *The Space Trilogy: Out of the Silent Planet, Perelandra, and That Hideous Strength*," (New York: Quality Paperback Book Club, 1997), 34.

THE JOURNEY

1. Chevalier, *The Penguin Dictionary of Symbols*, 240-241.

BIBLIOGRAPHY

BOOKS & ARTICLES

"Amundsen-Scott South Pole Station," *Office of Polar Programs*, National Science Foundation, http://www.nsf.gov/od/opp/support/southp.jsp (accessed 17 November 2009).

"International Space University: Space Studies Program," *International Space University*, http://www.isunet.edu/index.php?option=com_content&task=blogcategory&id=59&Itemid=185 (accessed 10 October 2010).

"South Pole Station for Science," *United States Antarctic Program*, Nation Science Foundation, http://www.usap.gov/videoClipsAndMaps/spWebCam.cfm (accessed 11 October 2010).

Barbara Aggerholm, "Looks like Mars, feels like Mars…," *The Record*, 22 August 2007, http://news.therecord.com/article/231567 (accessed 10 October 2010).

Isaac Asimov, *Nightfall and Other Stories* (Greenwich: Fawcett, 1969).

Isaac Asimov, *Nightfall* (New York: Doubleday, 1990).

Marcel Aubert, *L'Architecture cistercienne en France: Avec la collaboration de la Marquise de Maillé, Deuxième Édition, Tome Premier* (Paris: Vanoest, 1947).

Marcel Aubert, *L'Architecture cistercienne en France: Avec la collaboration de la Marquise de Maillé, Deuxième Édition, Tome Second* (Paris: Vanoest, 1947).

Simon Auclair, "Message from Mars," *International Space University*, http://www.isunet.edu/index.php?option=com_content&task=view&id=369&Itemid=351 (accessed 20 August 2010).

Jean Baudrillard, *Utopia deferred : writings from Utopie, (1967-1978)* (New York: Semiotexte, 2006).

Stephen Baxter, *Manifold: Time* (New York: Ballantine Publishing Group, 2000).

Benedeiz, Ian Short, and Brian S. Merrilees, *The Anglo-Norman Voyage of St. Brendan* (Manchester: Manchester University Press, 1979).

Benedict and Timoth Fry ed., *The Rule of St. Benedict* (New York: Vintage Books, 1998).

Ray Bradbury, *Bradbury Speaks: Too Soon from the Cave, too Far from the Stars* (New York: William Morrow, 2005).

Angie Bukley and Gilles Clément eds., *Artificial Gravity* (Hawthorne, Microcosm Press, 2007).

Francois Cali and Lucien Hervé, *Architecture of truth; the Cistercian abbey of Le Thoronnet in Provence* (New York: G. Braziller, 1957).

Carthusian Order, "A Day in the Life of a Carthusian," Carthusian Monks and Carthusian Nuns, Ordre des Chartreux, http://www.chartreux.org/en/frame.html (accessed 8 October 2010).

Andrew Chaikin and Victoria Kohl, *Voices from the Moon: Apollo astronauts describe their lunar experiences* (New York; London: Viking Studio, 2009).

Jean Chevalier and Alain Gheerbrant, The Penguin Dictionary of Symbols, Translated by John Buchanan-Brown (London: Penguin Books, 1996).

Arthur C. Clarke, *2001: A Space Odyssey* (New York: ROC, 2000).

James Freeman Clarke, *Events and epochs in religious history; being the substance of a course of twelve lectures* (Boston: J.R. Osgood and Company, 1881).

Alan Cook, "Edmond Halley and the Magnetic Field of the Earth," *Notes and Records of the Royal Society of London* 55 no. 3 (September 2001): 473-490.

Massimo Corradi, *I Quattro Elementi: Aria, Acqua, Terra e Fuoco* (Genova: Edizioni di Storia, Scienza, Tecnica &, 2008).

Andrew Dermont, "Month of Thinking Dangerously – Idea #5: Stephen Hawking's Warning: Abandon Earth – Or Face Extinction," *Big Think*, http://bigthink.com/ideas/21570 (accessed 12 August 2010).

William Goyen, *The House of Breath* (Evanston: TriQuarterly Books/Northwestern University Press, 1999).

Hugh S. Gregory, *MDRS Hab Operations Manual – Version 8.9* (Version Released 24 March 2007).

Albert A. Harrison, Yvonne A. Clearwater, and Christopher P. McKay eds., *From Antarctica to Outer Space: Life in Isolation and Confinement* (New York: Springer-Verlag, 1991).

Seiichi Hatano, *Time and Eternity.* Translated by Ichiro Suzuki (New York: Greenwood Press, 1988).

Stephen W. Hawking, *A Brief History of Time: From the Big Bang to Black Holes* (Toronto: Bantam Books, 1988).

Stephen W. Hawking, *A Brief History of Time: The Updated and Expanded Tenth Anniversary Edition* (Toronto: Bantam Books, 1998).

Dolores Hayden, *The Power of Place: Urban Landscapes as Public History* (Cambridge: MIT Press, 1997).

John Jeffrey Hester et al, *21st Century Astronomy* (New York: Norton, 2002).

T.S. Kelso, "SATCAT Boxscore," *Celestrak*, http://www.celestrak.com/satcat/boxscore.asp (accessed 11 October 2010).

Terryl N. Kinder, *Cistercian Europe: Architecture of Contemplation* (Grand Rapids: W.B. Eerdmans Publishing Company, 2002).

C.S. Lewis, *The Space Trilogy: Out of the Silent Planet, Perelandra, and That Hideous Strength*," (New York: Quality Paperback Book Club, 1997).

Robin Bruce Lockhart, *Halfway to Heaven: The Hidden Life of the Sublime Carthusian* (London: T. Methuen, 1985).

Sven Lütticken, "Planet of the Remakes," *New Left Review* 25 (January/February 2004): 103-119.

Giuseppe Mazzotta, *Cosmopoiesis the Renaissance Experiment* (Toronto: University of Toronto Press, 2001).

Sean McNaughton and Samuel Velasco, "50 Years of Exploration," *National Geographic*, http://books.nationalgeographic.com/map/map-day/index (accessed 7 October 2010).

Alan Moore, Eddie Campbell, *From Hell: Being a Melodrama in Sixteen Parts* (London: Knockabout Comics, 2006).

M. Ephimia Morphew, "Psychological and Human Factors in Long Duration Spaceflight," *McGill Journal of Medicine* 6, no. 74-80 (2001): 74-80.

Lewis Mumford, *The Culture of Cities* (New York: Harcourt, Brace, 1938).

Lewis Mumford, *The Story of Utopias* (New York: Boni and Liveright, 1922).

National Aeronautics and Space Administration (NASA), Charles Holbrow, and Richard D. Johnson, *Space Settlements: A Design Study* (Washington: United States Government Printing Office, 1977).

Fridtjof Nansen, *Farthest North: The Epic Adventure of a Visionary Explorer* (New York: Skyhorse Publishing, 2008).

Lois E. Nesbitt, Ronald Feldmann, Alexander Brodsky, and Ilya Utkin, *Brodsky & Utkin: The Complete Works* (New York: Princeton Architectural Press, 2003).

Gearóid Ó Donnchadha, *St. Brendan of Kerry, the Navigator: His life and Voyages* (Dublin; Portland: Open Air; Four Courts Press, 2004).

T.J. Oleson, "BRENDAN (Bréanainn), SAINT," *Dictionary of Canadian Biography Online*, http://www.biographi.ca/009004-119.01-e.php?&id_nbr=87&interval=25&&PHPSESSID=peb752nmi3o5hmt8cj5rklcrk2 (accessed 25 August 2010).

John Joseph O'Meara, *The voyage of Saint Brendan: Journey to the Promised Land* (Dublin: Domen Press, 1976).

Richard Panek, "Benign Space: South Pole offers ideal location to observe the mysteries of the universe," *The Antarctic Sun*, 2 October 2009, http://antarcticsun.usap.gov/features/contentHandler.cfm?id=1915 (accessed 20 November 2009).

Charles McKew Parr, *Ferdinand Magellan, Circumnavigator* (New York: Cromwell, 1964).

Frederik Pohl, *Starburst* (New York: Ballantine Books, 1982).

Frederik Pohl, *Gateway* (New York: St. Martin's Press, 1977).

G. Sandal, G. Leon, and L. Palinkas, "Human Challenges in Polar and Space Environments," *Reviews in Environmental Science and Biotechnology* 5 no. 2-3 (28 July 2006): 281-296.

Roger Shattuck, *Marcel Proust* (New York: Viking Press, 1974).

Johathan Z. Smith, *To Take Place: Toward Theory in Ritual* (Chicago: University of Chicago Press, 1987).

Jules Verne, *20,000 Leagues Under the Sea* (New York: Penguin Books, 1981).

Jules Verne, *Vingt mille lieues sous les mers* (Paris: J. Hetzel Librairie Hachette, 1966).

Eugène Emmanuel Viollet-le-Duc, *Dictionnaire raisonné le l'architecture française du XIe au XVIe siècle* (Paris: E. Martinet, 1868).

Peter Watts, "Beebe Station: General Layout," *Rifters*, Peter Watts, http://www.rifters.com/starfish/beebe.htm (accessed 26 September 2010).

Peter Watts, *Starfish* (New York: Tor, 2000).

Gareth Williams and the Victoria and Albert Museum, *Telling Tales: Fantasy and Fear in Contemporary Design* (London; New York: V&A Publishing; distributed in North America by Harry N. Abrams, 2009).

Robert Wojtowicz, *Lewis Mumford and American Modernism: Eutopian Theories for Architecture and Urban Planning* (Cambridge, England; New York: Cambridge University Press, 1996).

FILMS

Solaris. Produced by Viacheslav Tarasov. Directed by Andrei Tarkovsky. 165 minutes. Mosfilm Studios, 1972. DVD.

2001: A Space Odyssey. Produced by Stanley Kubrick. Directed by Stanley Kubrick. 170 minutes. Metro-Goldwyn-Mayer, 1968. DVD.

Outland. Produced by Richard A. Roth. Directed by Peter Hyams. 109 minutes. The Ladd Company, 1981. DVD.

WALL•E. Produced by Jim Morris. Directed by Andrew Stanton. 98 minutes Pixar Animation Studios, 2008. DVD.

Silent Running. Produced by Michael Gruskoff. Directed by Douglas Trumbull. 89 minutes. Universal Pictures, 1972. DVD.

Into Great Silence. Produced by Philip Gröning. Directed by Philip Gröning. 162 minutes. Zeitgeist Films, 2008. DVD.

An Optical Poem. Produced by Oscar Fischinger. Directed by Oscar Fischinger. 7 minutes. Metro-Goldwyn-Mayer, 1938. DVD.

IMAGES SOURCED FROM INTERNET

"Antarctica_Station_South_Pole," Wikimedia Commons, www.commons.wikimedia.org/wiki/File:Antarctica_Station_South_Pole.gif (accessed 10 October 2010).

"Chili Dinner - MDRS Crew 57/58," *Mars Desert Research Station*, The Mars Society, http://desert.marssociety.org/media/mdrs/fs06/images/crew57/c57d14hab03.jpg (accessed 26 September 2010).

"Danielle Cormier – MDRS Crew 57," *Mars Desert Research Station*, The Mars Society, http://desert.marssociety.org/mdrs/fs06/0213/ (accessed 26 September 2010).

"Nordpolkart," *FRAMMUSEET*, http://fram.museum.no/filesystem/2004/03/nordpolkart_138.jpg (accessed 9 October 2010).

Jonathan Berry, "Moon Over Station," National Science Foundation, http://www.nsf.gov/od/lpa/news/02/images/moon_over_station.jpg (accessed 18 June 2010).

Scott Clarke, "Rifters," *Rifters*, Peter Watts, http://www.rifters.com/real/gallery.htm (accessed 26 September 2010).

Charles Eisen, "Essai sur l'Architecture – Frontispiece," Wikimedia Commons, http://upload.wikimedia.org/wikipedia/commons/7/78/Essai_sur_l'Architecture_-_Frontispiece.jpg (accessed 9 October 2010).

Jaime Fernandez, "The Annotated Galactic Center," *Astronomy Picture of the Day*, NASA, http://apod.nasa.gov/apod/ap100831.html (accessed 7 September 2010).

Alex Grey, "Oversoul," Alex Grey, www.alexgrey.com (accessed 22 August 2010).

Moebius (Jean Giraud), "The Desire," *Moebius (Jean Giraud) Art*, The Book Palace, www.bookpalace.com/acatalog/MoebiusDesire.jpg (accessed 7 October 2010).

NASA, ESA and J. Hester, "Hubble Captures a Perfect Storm of Turbulent Gases," *Hubblesite*, http://hubblesite.org/newscenter/archive/releases/2003/13/image/a *(accessed 9 October 2010).*

NASA/JPL, "Jupiter – Io In Front of Jupiter's Turbulent Clouds," *NASA Planetary Photo Journal Collection*, NASA/JPL, http://photojournal.jpl.nasa.gov/catalog/PIA00371 (accessed 26 September 2010).

NASA/JPL, "Volcanic Explosion on Io," *NASA Planetary Photo Journal Collection*, NASA/JPL, http://photojournal.jpl.nasa.gov/catalog/PIA01971 (accessed 26 September 2010).

Joseph Smith, "Silent Running Movie Poster," Wrong Side of the Art!, www.wrongsideoftheart.com/wp-content/gallery/posters-s/silent_running_poster_01.jpg (accessed 9 October 2010).

Keith Vanderlinde, "Antarctic Photo Library," *United States Antarctic Program*, National Science Foundation, http://photolibrary.usap.gov/Portscripts/PortWeb.dll?query&field1=Filename&op1=matches&value=10MSPT_NIGHTSKY2.JPG&catalog=Antarctica&template=USAPgovMidThumbs (accessed 26 September 2010).

Bartolomeu Velho, "Carta General do Orbe," Wikipedia, http://pt.wikipedia.org/wiki/Bartolomeu_Velho (accessed 9 October 2010).

Peter Watts, "Beebe Station: General Layout," *Rifters*, Peter Watts, http://www.rifters.com/starfish/beebe.htm (accessed 26 September 2010).

Jerry Woodfill, "From the Earth to the Moon and the Sequel: Round the Moon by Jules Verne," *The Space Educators' Handbook*, NASA Johnson Space Center, http://er.jsc.nasa.gov/seh/arrival_of_the_projectile_at_stone_hill.jpg *(accessed 9 October 2010)*.

Lebbeus Woods, "The Einstein Tomb," *The Vagrant Light of Stars*, Lebbeus Woods, www.lebbeuswoods.wordpress.com/2009/09/27/the-vagrant-light-of-stars/ (accessed 7 October, 2010).