Columbia University Graduate School of Architecture, Planning and Preservation
Advanced Studio I Spring 2014 Section 008
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SPACE STUDIO VIII:
LUNAR HEALTH STATIONS

"*I think a future flight should include a poet, a priest and a philosopher. We might get a much better idea of what we saw.*"

Apollo 11 astronaut Michael Collins, 1969

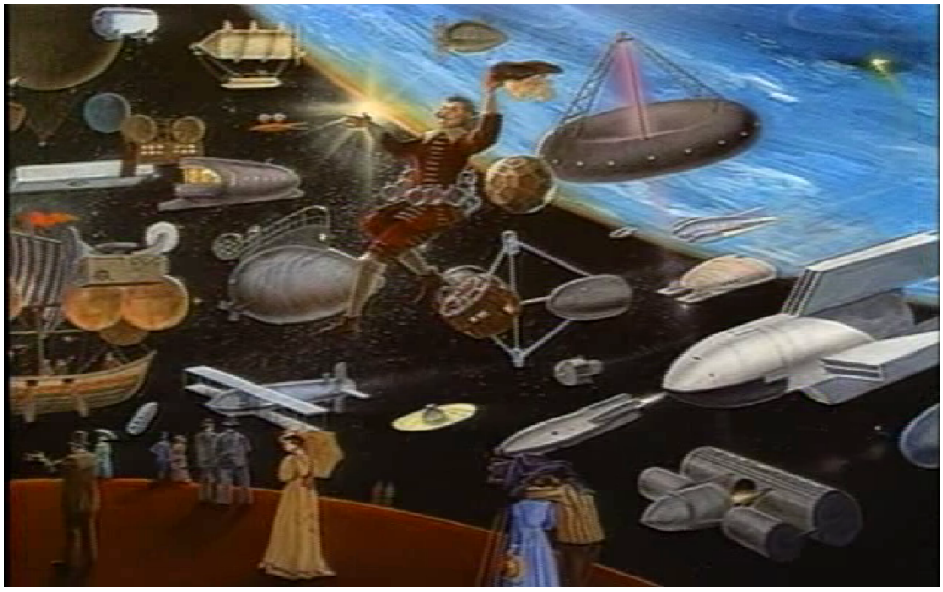


Image from "History of Spaceflight", Finley-Holiday Film Corp

Introduction:

Space Travel

One of the most provocative images that have defined our perception of space exploration from the 19th century to the end of the 20th century has been that of a space station floating above the Earth and Moon base to serve as a way station to the universe. As is evident by this image, the space station and lunar colony emerged in popular culture long before it became a viable concept or possibility in space exploration. The visionary images for inhabiting outer space as have appeared in art, literature, and film greatly inspired the imagination of scientists to probe the limitless territories of the outer atmosphere and the eventual implementation of our present day and future galactic outposts. Early science fiction projections urged us to believe that once rocket propulsion could overcome Earth's gravity to reach outer orbit, travelers would be "halfway to anywhere" they might want to go. The idea of a station, then, floating in Earth orbit, serving as a transit point and enabling travel from Earth to the Moon, our galaxy, and beyond takes root in this once mythical concept.

Although space tourism has been a theme for countless science fiction representations and speculations by the leading scientists in the 1950's, the idea and realization of vacationing in space has been greatly overshadowed by government space activities - military operations, scientific research, etc. The focus of space activity during the Cold War paralyzed the public's imagination of further possibilities for space travel in the following decades. In the mid-1990s, however, NASA re-presented "Space Tourism" as the next major target for the space industry in the post-Shuttle era of space architecture. The tourist industry operates as a highly competitive market for many nations, averaging about 15 times greater revenue than the space industry itself. Given that tourism is such a significant generator of revenue, often employing and popularizing the use of advanced technologies (mass aeronautical transportation, computers, telecommunications, etc.), the creation of future holiday space-spots project vast potential financial gains and a resulting linkage of new space industries to emerging technologies within the domain of public consumption. However, with today's skepticism about space travel, this brand of tourism is still seen as inaccessible—too special, too dangerous, and certainly too expensive for most people to experience or even entertain. Only history can dispute these many shortsighted preconceptions about entering into unknown realms made possible by joint efforts of technology and industry. In 1912, aviation was subjected to a similar apprehensive attitude. Virtually no one could have imagined that a mere two decades from its onset, more than 1 million people would fly over the expanses of the earth's oceans.

Space Tourism

Space Tourism has finally arrived. Although currently still reserved for the few who can afford the whopping price of a ticket, the day of space travel as accessible to the greater public is nearing rapidly. Encouraging signs continually appear. Commercial space agencies such as Space X are making huge strides in producing rocketry that once only governments could afford. After years of testing, Virgin Galactic plans to launch its first tourists from Spaceport America by the end of this year. Although the $200,000 ticket for a sub-orbital trip 360,000 feet above earth is still prohibitively expensive, the price will inevitably drop. It is already far less than the Russian Federal Space Agency's program, which is the only currently available opportunity for space tourism, and which charges upwards of $20M for a trip to the international space station. Among other private and semi-private initiatives in space tourism is Robert Bigelow's Bigelow Aerospace, which is developing habitation modules for low earth orbit for possible use as a space hotel. As opportunities for new business continue to emerge, investors will continue to get involved and the industry will therefore grow, streamline, and increase its client base.

Medical Tourism

Medical tourism is the last phase in the long history of people traveling in search of better health, long ago evident on the shores of the Mediterranean. Migration to distant places and therapeutic landscapes has taken place for over 2000 years in multiple forms. Over time, travelers sought more complex and holistic solutions, spiritual and psychological well-being became important, and new medical possibilities emerged. As transportation costs fell and incomes increased, interests shifted to the East, and diversified to more obvious alternative therapies. Medical tourism has continued to emphasize Asia but alternative therapies, outside saps and ashrams, have given way to more prosaic mobility for biomedical procedures at reduced costs. While 'wellness or health tourism' has more pleasurable and positive connotations than 'medical tourism' (or 'illness tourism'), they are not inseparable. As 'clusters" have developed, where clinics, hospitals, medical institutions, spas and related industries work together, health care has slowly become more inclusive, and a part of the growing global integration between linked facilities, modern technology and holistic care. As the concept of the medical tourist has become increasingly integrated into our health care structure, it has begun to play important role in binding the medical and wellness industries. The boundaries between biomedical and alternative therapies have become blurred, though never indistinguishable, even as 'expertise romps authenticity' and spirituality founders. (1)

Site Background:

The distance between Earth and the Moon is 30 times Earth's diameter.

Finally, after 40 years we are ready to re-immerse ourselves in the venture of space exploration. As technology has advanced and concerns about the future of humanity on Earth increase, some argue, that Space colonization is an achievable and worthwhile goal. Because of its proximity to Earth and the early telescopic observation of familiar landforms such as mountains and plains, the Moon has long been seen as a logical candidate for possible human settlement.

In 2004 the Bush Administration announced a new vision for space exploration for the National Aeronautics and Space Administration (NASA) that would return humans to the Moon, this time "to stay" with a lunar outpost by 2020 in preparation for human exploration of Mars. This mission statement stimulated vigorous debates arguing for robots to replace humans on these missions. Additionally, this reinvigoration of space exploration launched the discussion of whether it might be more worthwhile to send humans to Mars given that the Mars environment has more natural resources to become an earth-like place than the moon.

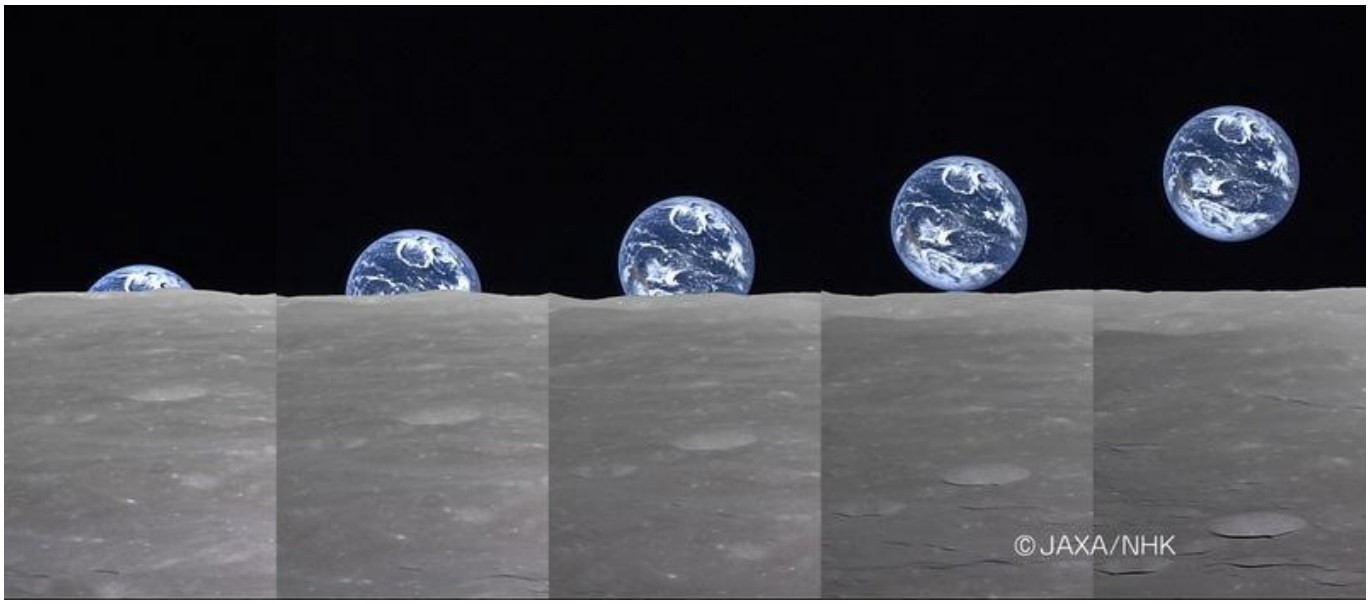
> *"Returning to the moon is an important step for our space program. Establishing an extended human presence on the moon could vastly reduce the costs of further space exploration, making possible ever more ambitious missions. Lifting heavy spacecraft and fuel out of the Earth's gravity is expensive. Spacecraft assembled and provisioned on the moon could escape its far lower gravity using far less energy, and thus, far less cost. Also, the moon is home to abundant resources. Its soil contains raw materials that might be harvested and processed into rocket fuel or breathable air. We can use our time on the moon to develop and test new approaches and technologies and systems that will allow us to function in other, more challenging environments. The moon is a logical step toward further progress and achievement."* - President George W. Bush, 2004

Inhabiting the moon for a prolonged period of time would be far different from the initial trips taken between 1969 and 1972 when men lived up to three days in admittedly cramped quarters. Because of the extraordinary circumstances of the Cold war, the lunar missions undertaken were on an accelerated schedule and, as Arthur C. Clarke noted in an essay published the week of the Apollo 11 landing, too much happened too fast for anyone to properly appreciate what had been done and where all of it might lead. The space industry has changed incredibly since then and future missions to the moon, undertaken through both government programs and private industry, will have multiple purposes–scientific and (eventually) touristic.

While the Bush administration invested heavily in the Constellation mission and lunar architecture, the end of the Space Shuttle era and the Obama administration shifted the responsibility of taxi service for the International Space Station to commercial companies, diverting many of the resources for the moon to developing technology for missions to asteroids and Mars.

In the ensuing vacuum of US government interests, many other countries and private enterprises renewed their interest in the Moon. On December 13, 2013, China landed its first rover, the Jade Rabit, at the Sidus Iridum. Similar efforts are underway by the Japanese, Indian, and European Union governments who are now developing new technologies for rockets, rover, and both short term and long-term habitation modules. In early 2013, the European Space Agency announced findings from research they had conducted with Foster and Partners in the development of 3D printing technologies for lunar habitats. Recently, United States private enterprises have similarly begun interest in the industry once monopolized by the government. The Google Lunar X Prize promises to reward the first privately funded team that can successfully land, travel, and submit high quality images from the lunar surface.

Humanity's future missions into space, particularly regarding colonizing the Moon and Mars, raise not only physiological challenges but also serious psychological issues for the traveler. Once the leisurely nature of tourism becomes a part of extended stays on the Moon, the psychological effects of the experience become increasingly important, requiring the prospect of space travel to provide accommodations far beyond basic human necessity as these travelers are no longer scientists with a mission to study, but tourists seeking pleasure and excitement as well.



The First “Full Earth-Rise” recorded on the Moon, April 6, 2008

Lunar Health Stations

Space Sanitarium (health resorts) / Space Sanatorium (hospitals)

> “Humans live short lives, but as a species we have always thought and planned for the distant future. In the past, this might have meant simply caring for offspring who would outlive us; increasingly, we plan for the future as a society. This capacity—underlined by our ability for abstract thought that can reach beyond the horizons of space and time—is perhaps our most remarkable trait…. If anything will enable life to endure past the limited lifetime of planets, it will have to be our ability to think.”
>
> Dimitar Sasselov, The Life of Super-Earths, 2012

Studio Objectives:

The overarching objective of this studio is to understand and design an architectural solution to support and accommodate the needs of human beings living in extraterrestrial environments for extended periods. The project combines medical tourism + space tourism with the understanding that these two market trends and forces combined may prove to provide the pioneering ground work and prototypes for physical, psychological, and holistic health facilities for humans, both well and unwell, to live and die in outer space.

Some of the primary and identifiable human health concerns to address include; space sickness (micro gravity, gravity changes, etc.); mental illness (loneliness, depression, boredom, etc.); claustrophobia; bone density loss; injury due to impact (requires surgery, reconstructive body parts, etc.); short term treatment; long term treatment; and birthing or reproduction.

In the Health (Space) Station, closed loop ecology, replenishing supplies such oxygen and water, waste management, and hygiene is paramount for survival. Pharmaceuticals and botanic, as food and medicine, may be grown for use, support, health, quarantine, and research purposes.

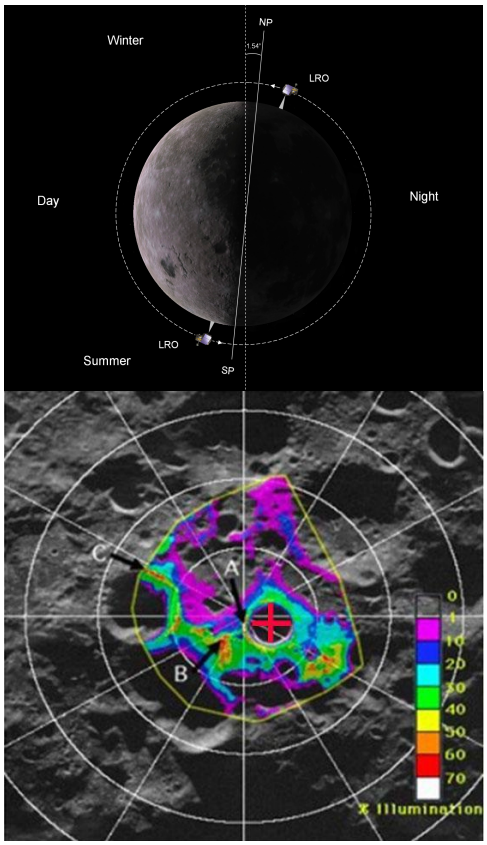
Project:

At the semester's end each student is required to present the architectural design for an approx. 400 beds Space Sanitarium/Sanatorium identified for a specific researched medical facility catering to an identifiable clientele, modality, and protocol.

FORMAT: The semester will initiate with a series of short exercises and beginning with an interpretive movie short animating the perceptions, aspirations, visions of the individual student about life and travel in outer space.

The exercise will be followed by an independent analysis and research of our site the Moon and Lunar Orbit, historical missions and the existing International Space Station (ISS), which is currently circumnavigating Low Earth Orbit (LEO). The focus of this research is to learn about the existing habitation modules and design attitudes towards human life in outer space. Additionally form a comparison between these actual missions and facilities and the influence of science fiction, artists' interpretations, etc. (i.e. life on Star Trek's USS Enterprise /Sick Bay and Battlestar Gallactica's /Sick Bay, feature films, Gravity 3 D, Elysium, 2002 Space Odyssey, Solaris, and Moon etc.).

This research will be conducted in parallel with the development of a programmatic thesis on medical modalities, specializations, patient demographics, and architectural precedents. The application of your initial program research is to manifest the design of a Health Station individual unit/patient room that balances the architecture of cure with the architecture of care at 1"= 1-0 scale. This research will be applied to the aggregation of the unit and the definition of any parallel support or leisure programs necessary for the mission of the Sanitorium/Sanitarium.



SITE: **Shackleton Crater at the Moon's South Pole**

In October 2009 NASA's LCROSS rocket modules discovered 25 gallons of water at the Cabeus A crater near its south pole, further inspiring hope for the possibility of long-term habitation. Shackleton crater has long been considered prime for habitation because of

it's position to the sun which allows peaks along the crater's rim to be exposed to almost continual sunlight for energy generation, while the interior is perpetually in shadow keeping temperatures low enough to keep frozen ice from leaving the atmosphere.

The lunar surface presents many challenges including:
27 Earth Days = 1 Lunar Day, 1 / 6 Earth's Gravity, Temperature Extremes, Lack of Atmosphere, Risks of High Radiation, Risks of Meteorite Impact, Lunar Dust/Regolith

Lunar Orbit
A parallel station in Lunar orbit will provide a way lay transfer station between thee Moon, the Earth, and the Galaxy beyond.

Similar challenges in low earth orbit include:
Expose to Radiation, Microgravity, Temperature Extremes, and Prolonged periods of day and night

PROGRAM: Health Stations (Sanatorium/ Sanitarium) 400 Beds

In keeping with the programmatic thesis developing the individual unit/patient room and medical facilities.

Support and Leisure Program:
In addition to the aggregation of individual units for the medical facilities, the future sanitarium/ sanatorium should include amenities for leisure and support such as:

Earth and Astronomical Observation Areas
Restaurant/Lounge
Offices
Library
Farms/gardens
Micro-gravity gym
Hydrotherapy
Recreation

and any additional programs your research discovers is necessary to support the stay and journey.

OBJECTIVES:

1 Explore spatial strategies and programmatic challenges for alleviating and supporting the psychological and physiological challenges of living in this extreme environment.

2 Use as many locally mined resources (one of the more advanced methods of construction on the Moon) as possible for survival and self-sustainability.

3 Develop and define the temporal and programmatic coordinates between the orbital and surface stations, between incoming and outbound galactic patients.

4 Develop module and unit systems by considering and integrating structural/mechanical/ environmental/architectural/furniture/product design/technological/communication aspects.

Methodology:

The course assignment will be structured by desk crits, seminars, and presentations. There will be a mandatory weekly pin up and the periodic reviews and semester milestones as follows (subject to change)

Academic Calendar: http://www.arch.columbia.edu/courses/academic-calendar

Semester Milestones:

1/24/14	Syllabus Overview/ Assignment 1/ Portfolio Review
2/3/14	Film assignment due
2/10/14	Moon / Apollo - Lunar Missions / ISS research due
2/21/14	Program research & 1' = 1'-0" scale model of patient unit due
3/14/14	TBA Mid Term Review Aggregated units and schematic addition of support programs due
3/17 - 3/21/14	Spring Break
4/2-4/6-14	¾ Review **NASA - Johnson Space Center, Houston 3/4 (TBA dates tentative)**
4/28 - 5/2 /14	Final (TBA)
5/17/14	EOYS

*Over the course of the semester, the studio will travel (unfortunately not to Space *and only in our moonage daydreams*) to **NASA Johnson Human Space Flight Center in Houston, Texas** for consultation and collaboration with astronauts, space architects and engineers for additional understanding of the logistical requirements for expeditions into space.

*The Studio's work will be a part of the archive and a future publication for Columbia's SPACE STUDIO series produced in conjunction with GSAPP's J-SEARC (Japan Lab - Space, Exploration, Architecture, and Culture).

1) Connell, John, *Medical Tourism*, University of Sydney, Australia, 2011, p 172

> "*The most terrifying fact about the universe is not that it is hostile, but it is indifferent. But if we can come to terms with this indifference and accept the challenges of life within the bounds of death, our existence as a species can have genuine meaning. However vast the darkness, we must supply our own light.*"
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> Stanley Kubrick, director of "2001: A Space Odyssey", 1968