

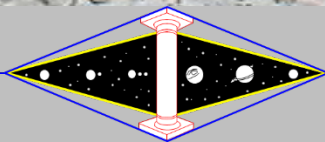


AIAA Sponsored
'Space Architecture Gathering'
Space Architecture @ the Tipping Point

Kriss J. Kennedy, Architect

August 22, 2020

TECHNE'



Architects LLC



*30 yr Career
NASA Space Architect*

**Three (3) degrees in Architecture
- One in Space Architecture**

Worked on over 45 designs and projects

**Written ~ 60 publications, papers, or
chapters in books**

**published in numerous magazines,
periodicals & books**

**Have two patents and numerous NASA Technology
Brief Awards. NASA Invention of the Year-2017**

**Recognized by his architect peers as one
of the new upcoming architects in Texas as
published in the millennium issue January
2000 Texas Architect magazine.**

**First space architect awarded the
prestigious Rotary National Award for
Space Achievement in March 2000**

**Registered licensed architect in the
State of Texas since 1995**

Human Exploration Destinations

sustained human presence...

Earth Independence...

Lunar Missions

- Lunar Orbit
- Lunar Surface

Deep Space Exploration

- Asteroids
- Near Earth Objects

Remote Earth Destinations

- Antarctica
- Ocean Exploration

Low-Earth Orbit

- International Space Station
- Commercialization
- In-Space Manufacturing
- Entertainment Destination

Near-Earth Space

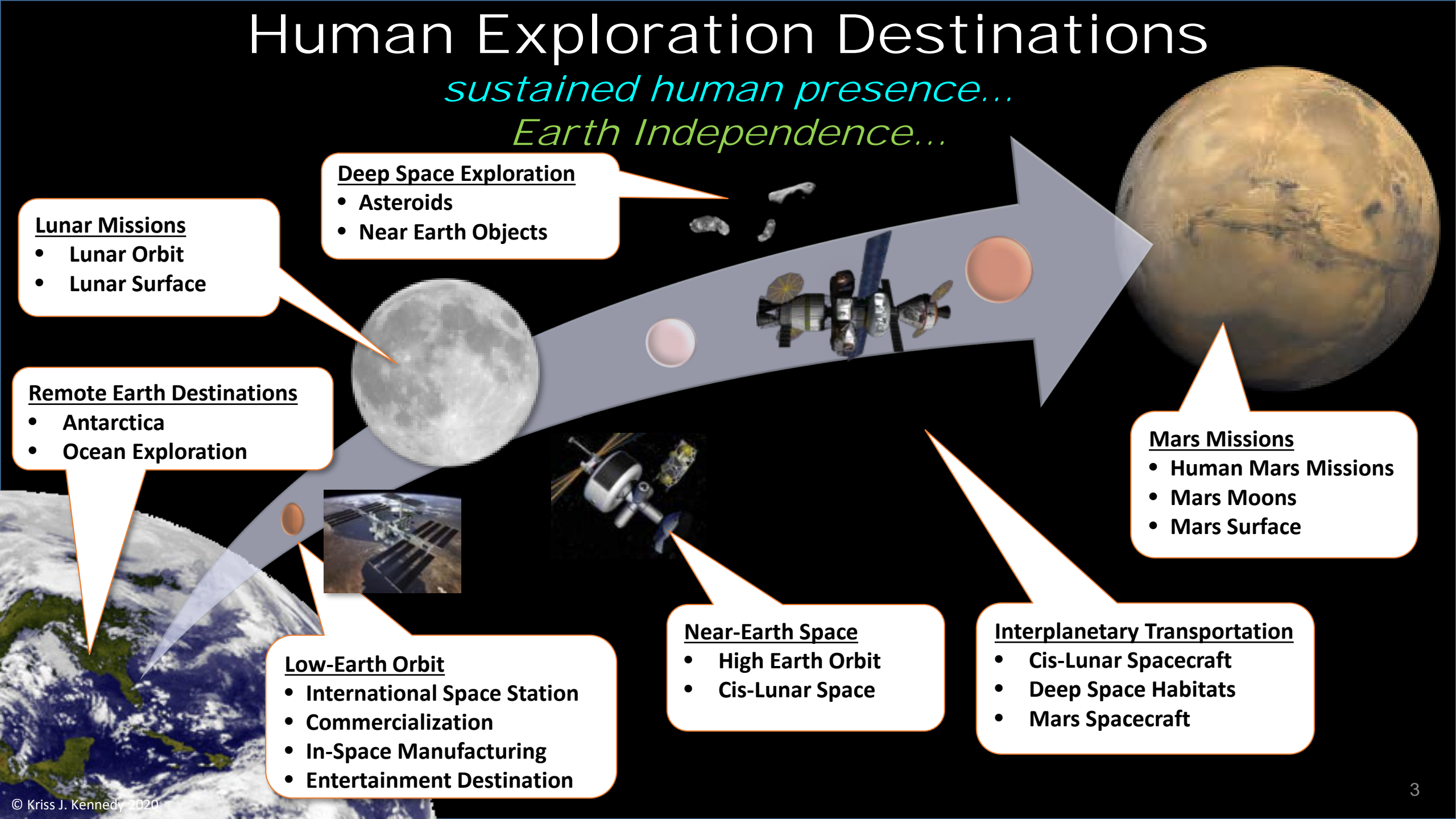
- High Earth Orbit
- Cis-Lunar Space

Interplanetary Transportation

- Cis-Lunar Spacecraft
- Deep Space Habitats
- Mars Spacecraft

Mars Missions

- Human Mars Missions
- Mars Moons
- Mars Surface



Human Exploration Operations



Crew Operations - IVA

Sustain crew on exploration mission. These functions are necessary to insure the safety of the crew. It also includes providing the functions necessary to sustain the crew from a physiological and psychological well-being.



Crew Operations – Supporting EVA

Enable Redundant EVA Function & Enhanced EVA Capability. These functions are necessary to provide the crew with additional means to conduct routine exploration EVAs. The extent provided is driven by the mission duration and the number of EVAs required to conduct that mission.



Mission Operations

Enable Enhanced Mission Operations Capability. These functions are those that enable the exploration crew to conduct mission operations in concert with the Earth based mission control. For longer and more distant ops, the Ops should establish autonomy from the Earth based "mission control" enabling command and control with other exploration assets such as rovers, landers, etc.



Science Operations

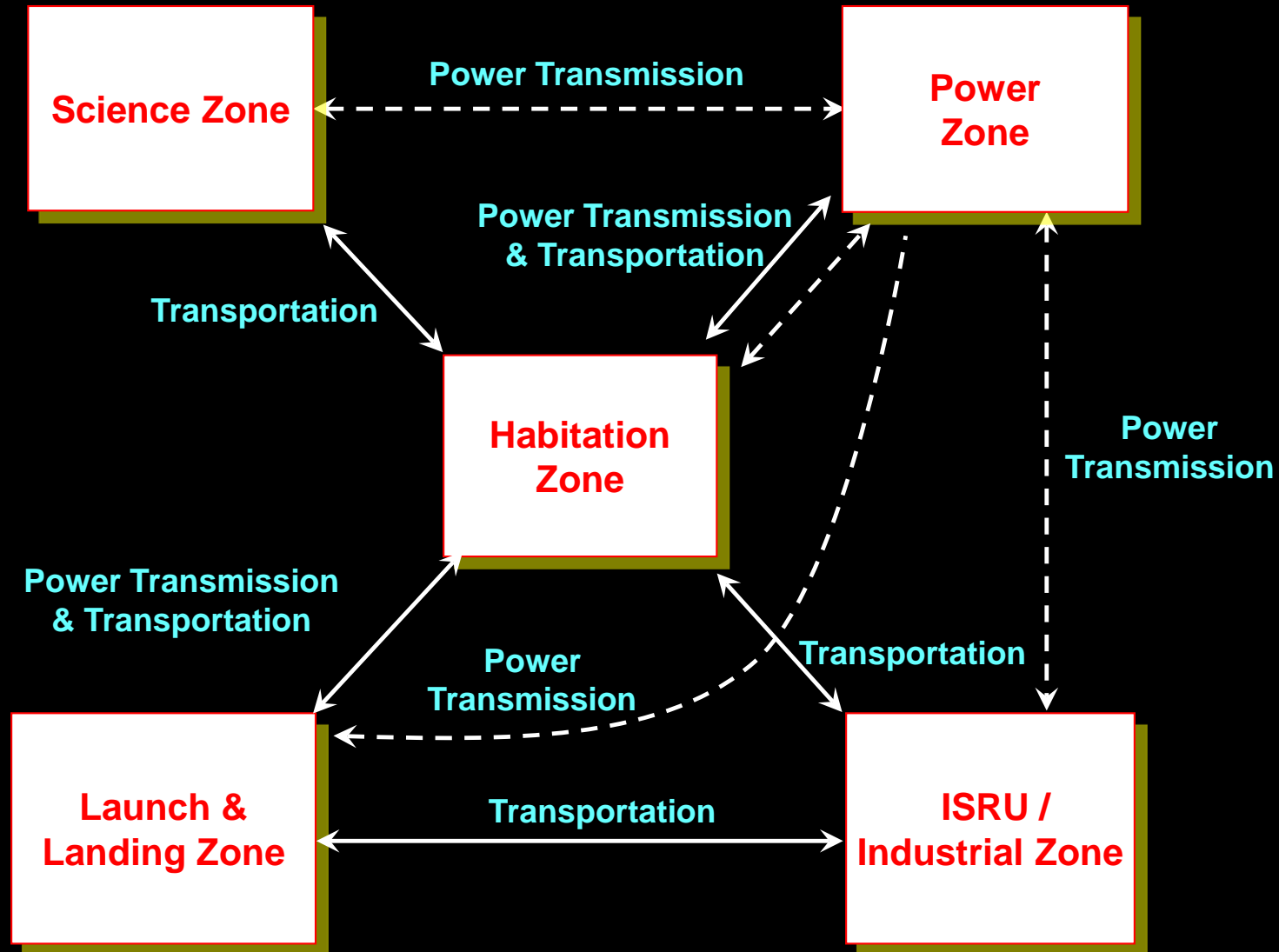
Enable IVA Biological and Life Science & GeoScience Capability. These functions are necessary to conduct the exploration science involved with the mission. It can include sample collection, sample analyses, sample prioritization and storage, and any sample returns. It also is meant to include any specific "environmental" requirements specific to Life Science or GeoScience.



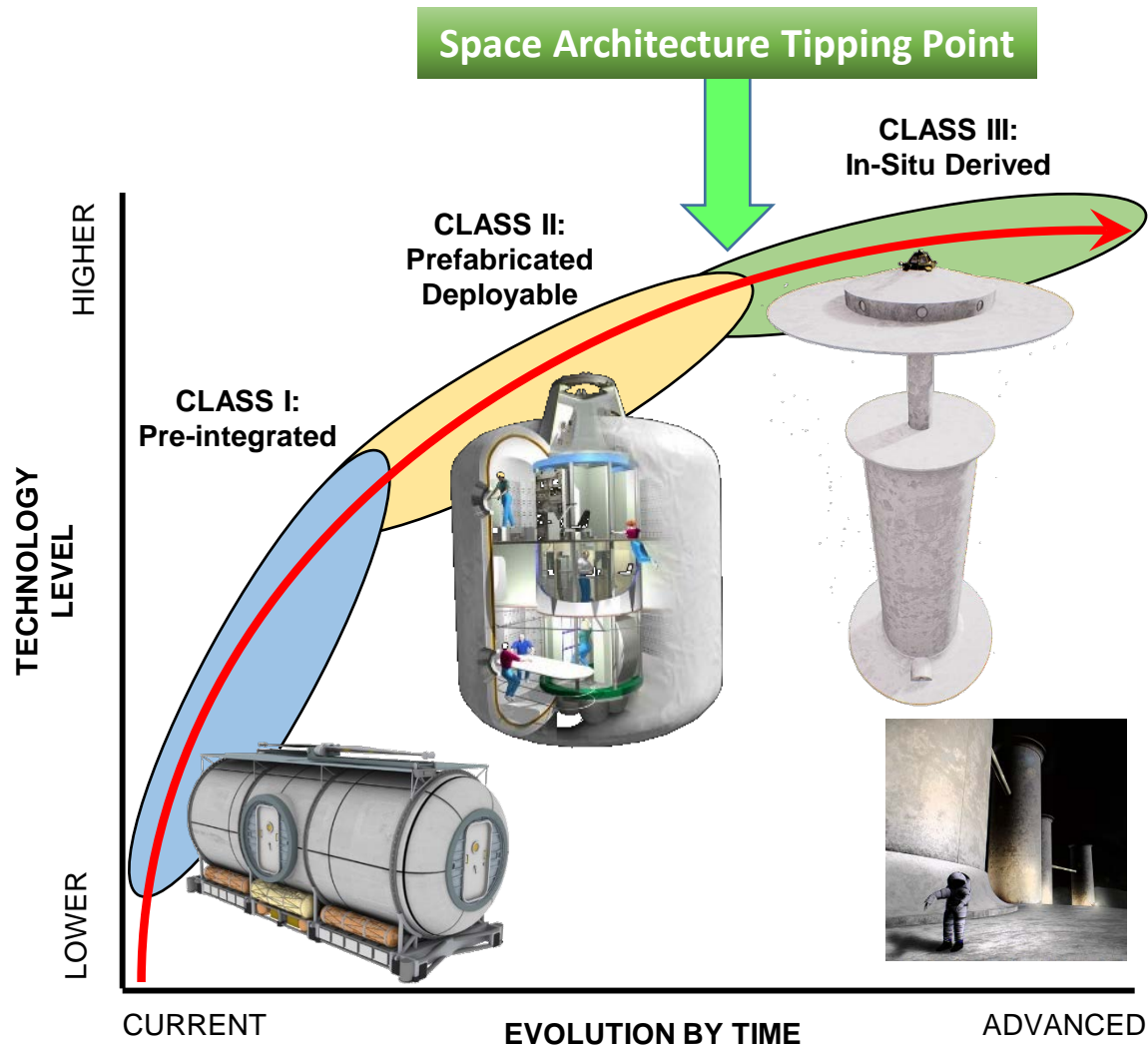
Logistics & Maintenance Operations - IVA & EVA




Enable Maintenance, Resupply, & Spares Cache. These exploration functions are those that allows for maintaining the exploration assets during recognized maintenance intervals. It also includes those functions necessary to resupply the habitat(s) with consumables (both pressurized and unpressurized) to support the crew for the mission. Lastly, it also includes the functions necessary to deliver and store the necessary spares related to the maintenance as well as unexpected failures. In-Situ Resource Utilization of local resource should be considered.

Surface Base Organization, Zoning, & Site Infrastructure

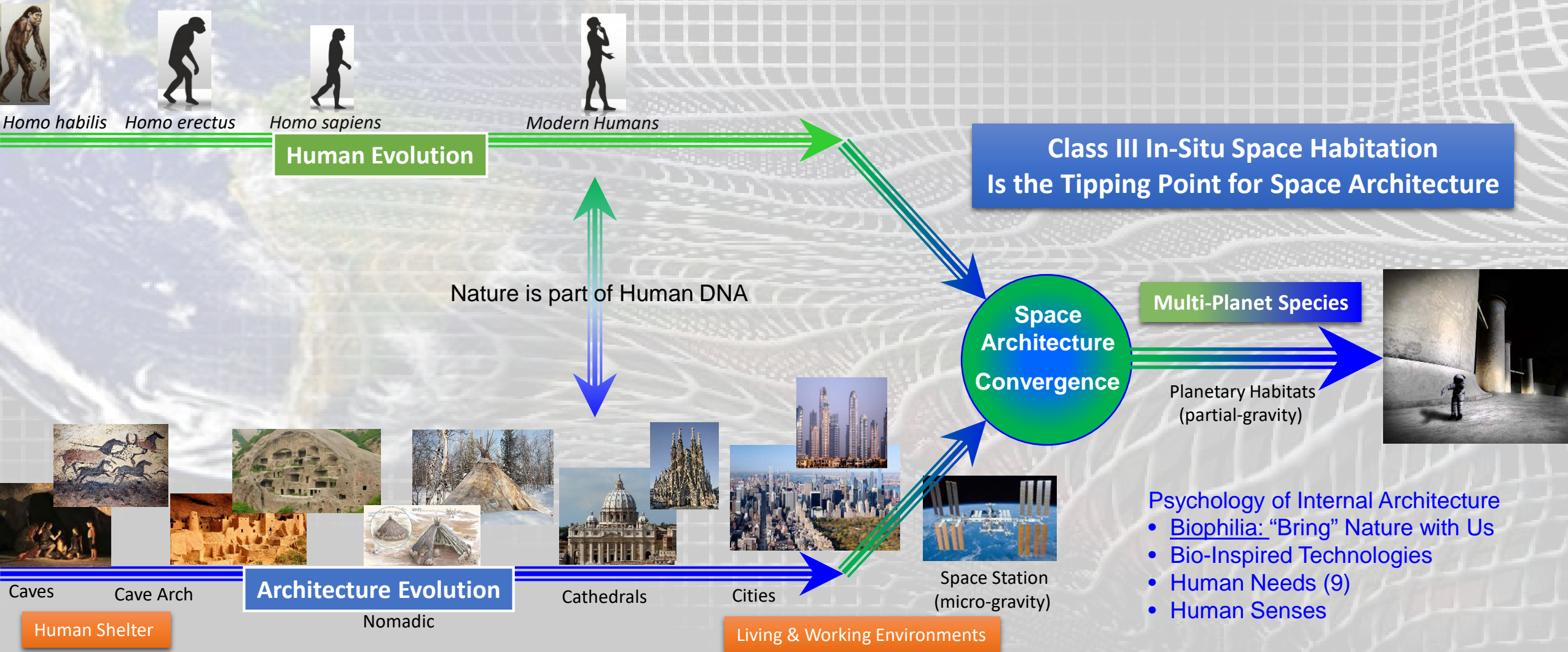


Space Habitation Classifications



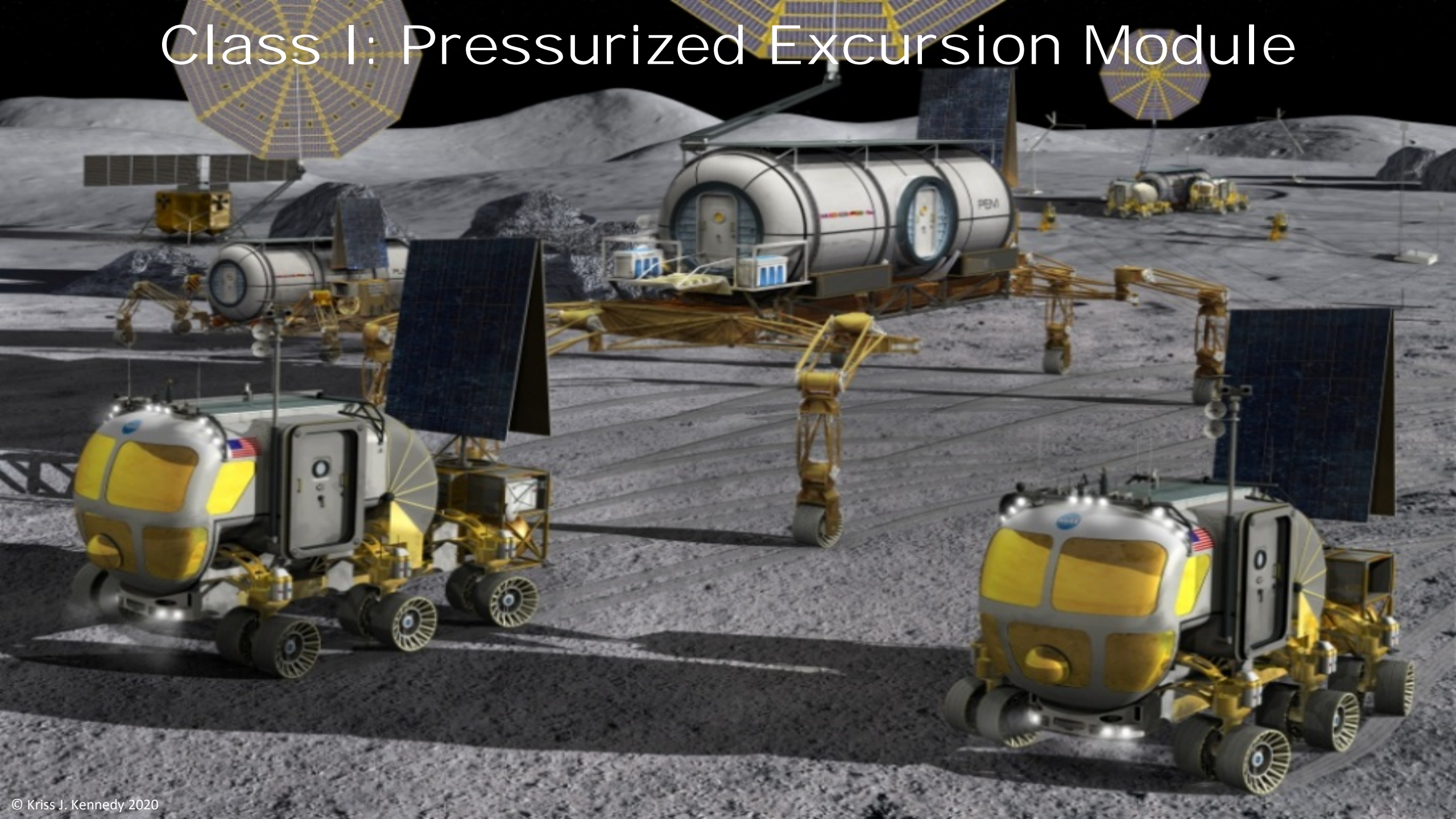
Habitat Classification	Key Characteristics
CLASS I Pre-integrated 	<ul style="list-style-type: none"> • Earth Manufactured • Earth Assembled & Fully Outfitted • Pre-Integrated & Tested prior to Launch • Space Delivered with Immediate Habitation Capability • Launch Shroud Constrained • Limited to Launch Vehicle Payload Size Capability • Limited to Launch Vehicle Payload Mass Capability
CLASS II Prefabricated Deployable. Space or Surface Deployed & Assembled 	<ul style="list-style-type: none"> • Earth Manufactured • Requires Space Deployment, Assembly & Outfitting • Requires Robotic and Human Labor During Assembly • Partial Integration Capable for Subsystems • Requires some or all Internal Outfitting emplacement • Critical Subsystems are Earth Based and Tested prior to Launch • Requires Assembly & Checkout prior to Human Occupancy • Larger Volumes Capable • Not Restricted to Launch Vehicle Shroud Size • Restricted to Launch Mass. Deliver on multiple vehicles
CLASS III In-Situ Derived and Constructed 	<ul style="list-style-type: none"> • Manufactured In-Situ Derived with Space Resources (Lunar or Mars) • In-Space Constructed • Requires Robotic Manufacturing Capability & Infrastructure • Requires Robotic and Human Labor During Construction • Requires Integration of Subsystems • Requires all Internal Outfitting emplacement • Critical Subsystems are Earth Based and Tested prior to Launch • Requires Assembly to become Operability • Larger Volumes Capable • Not Restricted to Launch Vehicle Size • Not Restricted to Launch Mass

Space Architecture @ Tipping Point



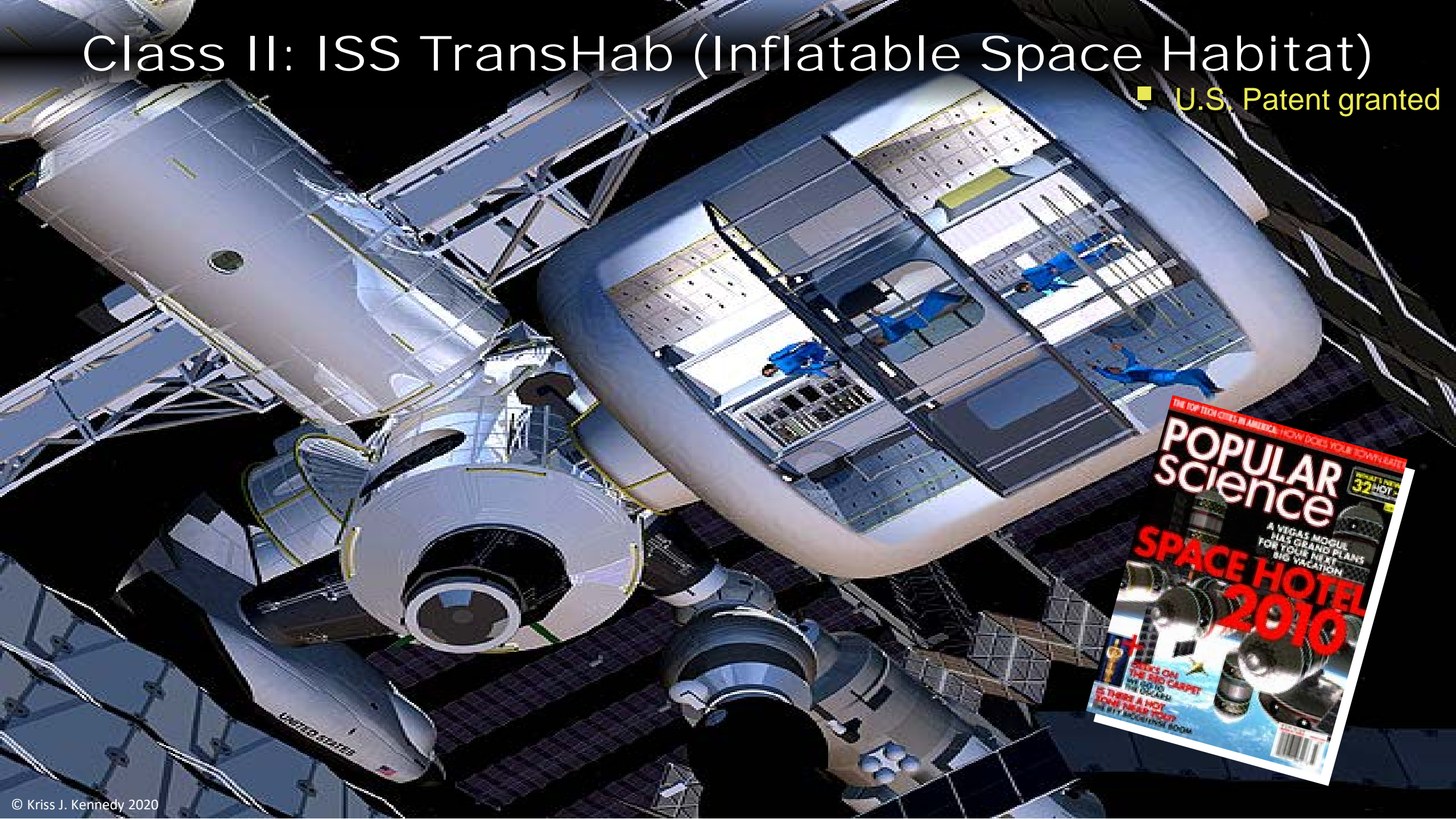
Biophilia: bringing nature into the built environment. Patterns found in nature comfort humans. Like wood grain patterns, plants, lighting, art, color. It has a positive affect on human beings. It stimulates the senses and promotes “active” physiological restoration. Satisfaction of Basic Human Needs!

Class I: Pressurized Excursion Module



Class II: ISS TransHab (Inflatable Space Habitat)

- U.S. Patent granted



Class III: Lunar Lava Tube Tower Facility Architecture

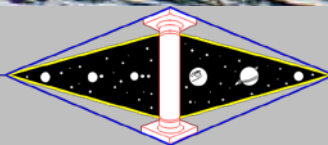
Client: United Space Structures

Vision: *Providing habitation capabilities to enable a space commerce to thrive in support of human exploration and resource consumption to become Earth-independent while establishing permanent sustainable human presence on the Moon and Mars.*

Mission: *Design and development of a Planetary Architecture capability that enables a thriving space economy to support humans working and living on the Moon within a decade while establishing a permanent presence on the Moon and enabling humanity to become a multi-planet species.*

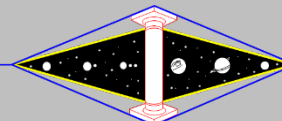
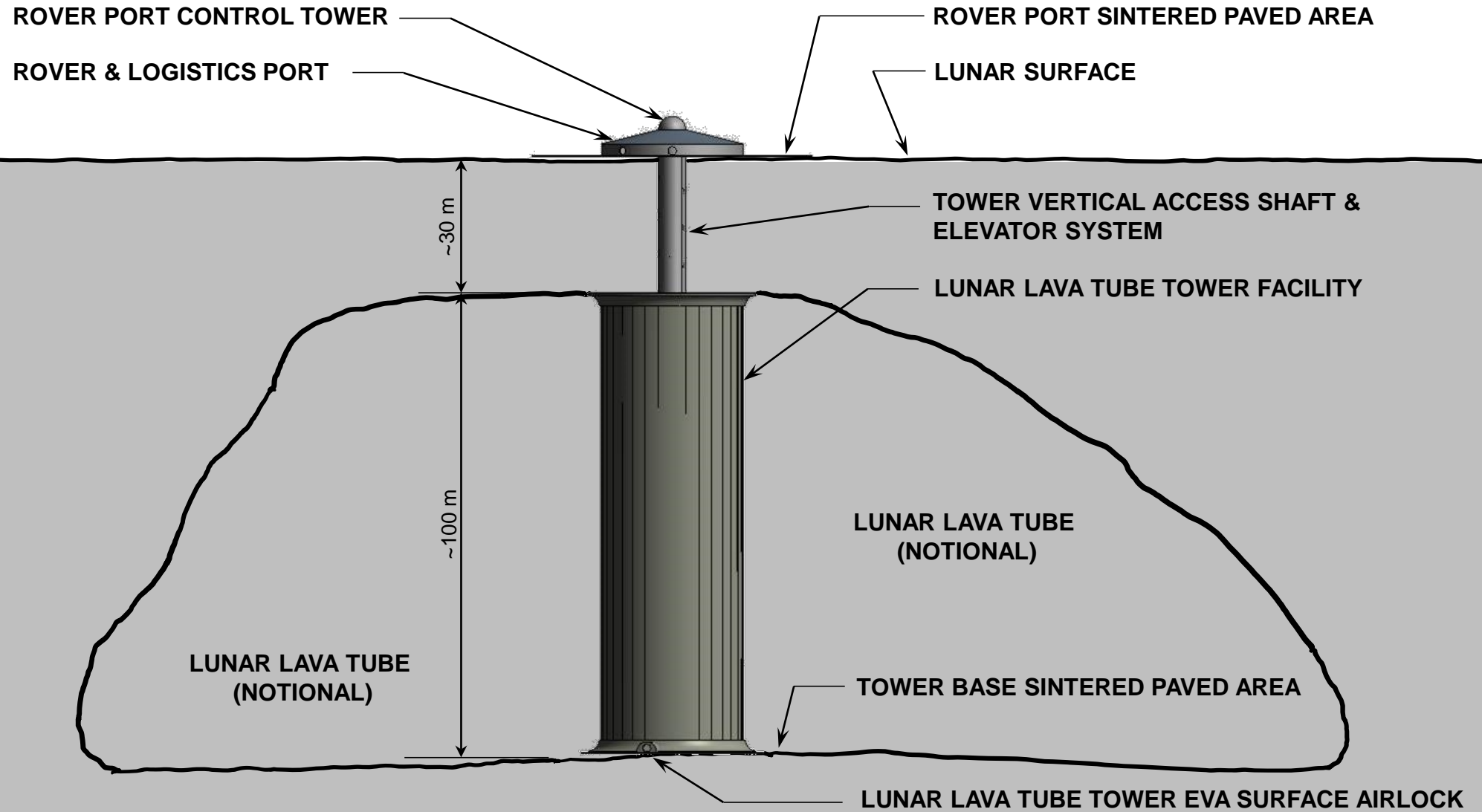


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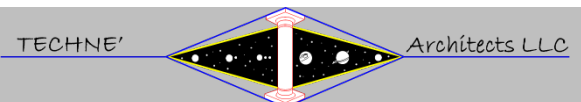
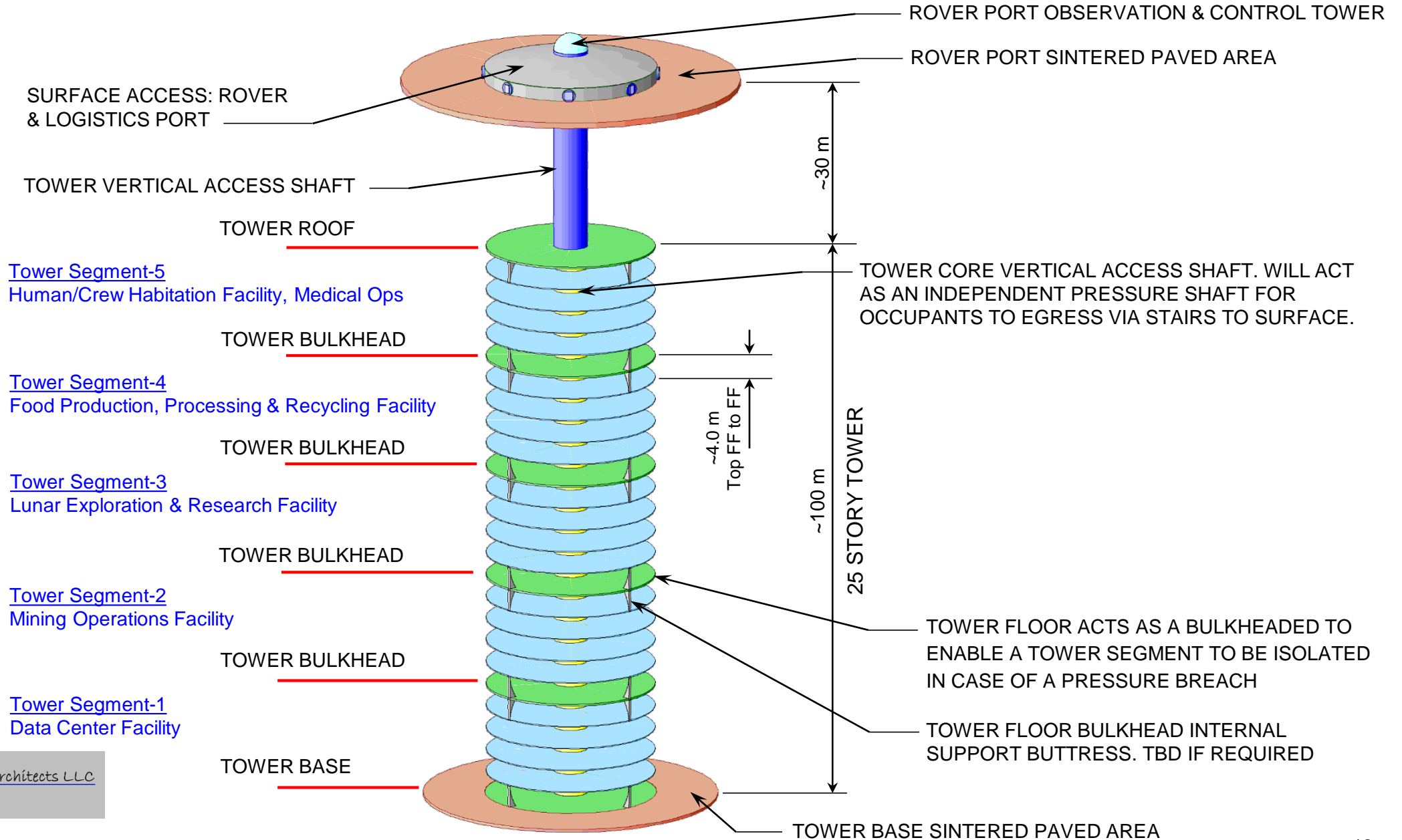


Architects LLC

Lunar Lava Tube Tower Facility Architecture



Tower Facility Architecture



Lunar Lava Tube Tower Facility

- ISRU-Derived Structures
- Permanent Settlement
- Earth-Independence
- Self-Sustaining

- Bold...
- Aggressive...
- Forcing Function...
- Paradigm shift...

Space Architecture...



Setting the standards for human exploration and settlement of space.

The ability to develop human support systems and architectures.

Human space mission requirements definition.

Human Systems Integration.

Adapt to all levels of exploration and spiral development activities.

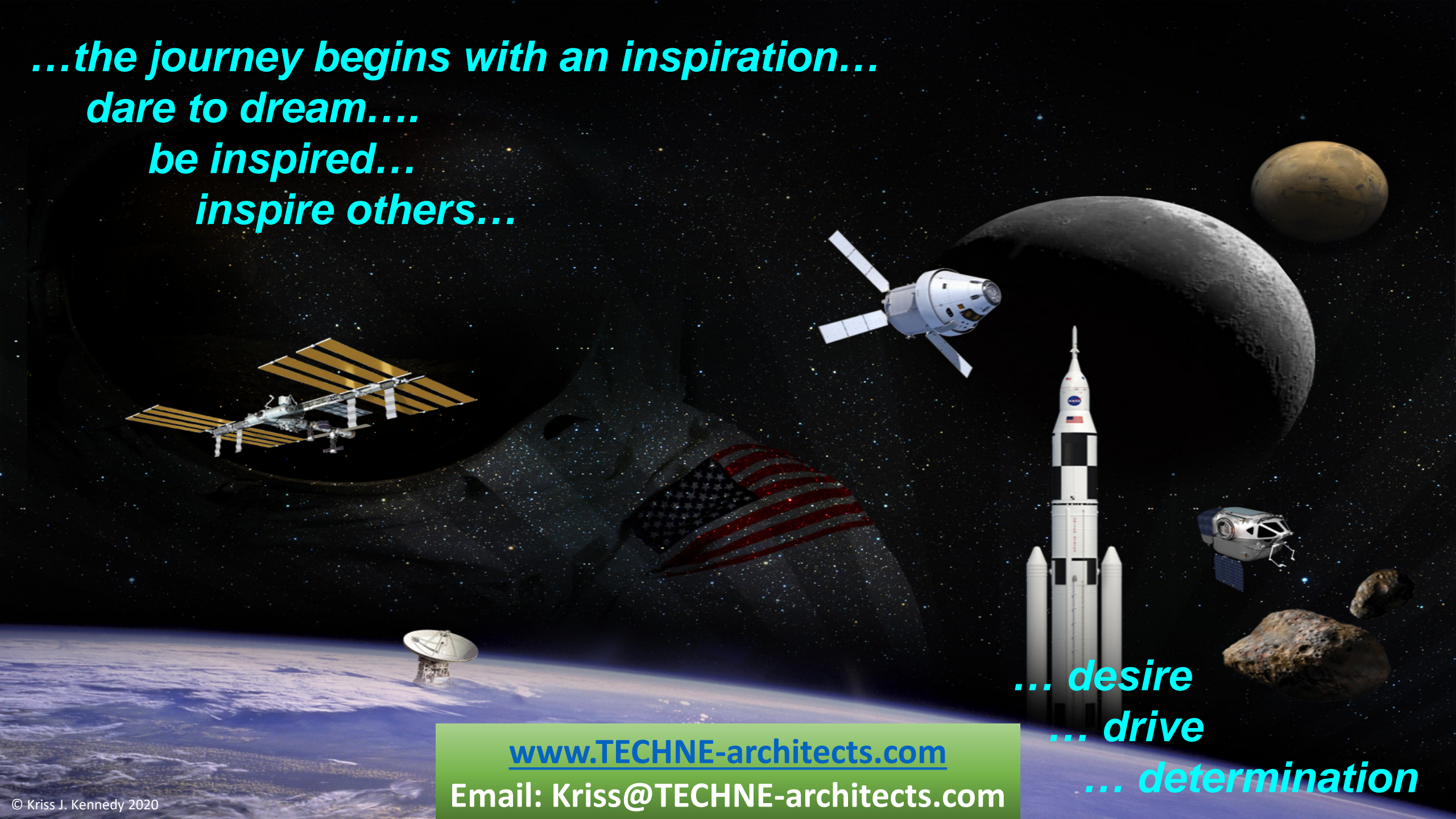
Experts in providing human systems, habitation systems, and space architecture design & planning.



space architecture @ the tipping point

1. With the tremendous **growth** of Space Commerce and new “start-up companies,” the profession of **Space Architecture** has moved to the **forefront** of **design and development planning** for space agencies and private industry.
2. **Space Architecture** is a **renaissance** of traditional architecture. A rebirth of the profession, getting back to the basics of providing humans shelter, protection, and physiological / psychological well-being.
3. **Architecture** has **evolved** along side **humanity**. From the early beginnings as shelter and protection for the environments...caves, cliff dwellings, nomadic shelters in the form of sticks and skins. As humans evolved, so has architecture. We are at the **tipping point** of space commercialization and a space architecture convergence to enable humans to become a **multi-planet species**.
4. **Psychology of Internal Architecture**. Humans need physiological and psychological well-being. An internal architecture requires psychological features to promote human health and well-being.
5. **Space Architecture Paradigm Shift**: Lunar and Mars partial-gravity **Planetary Architecture** should evaluate shifting to use of Earth-derived hybrid MEP systems.

*...the journey begins with an inspiration...
dare to dream....
be inspired...
inspire others...*



*... desire
... drive
... determination*

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