Outpost: V-001

J. Taylor Phillips - Hungerford

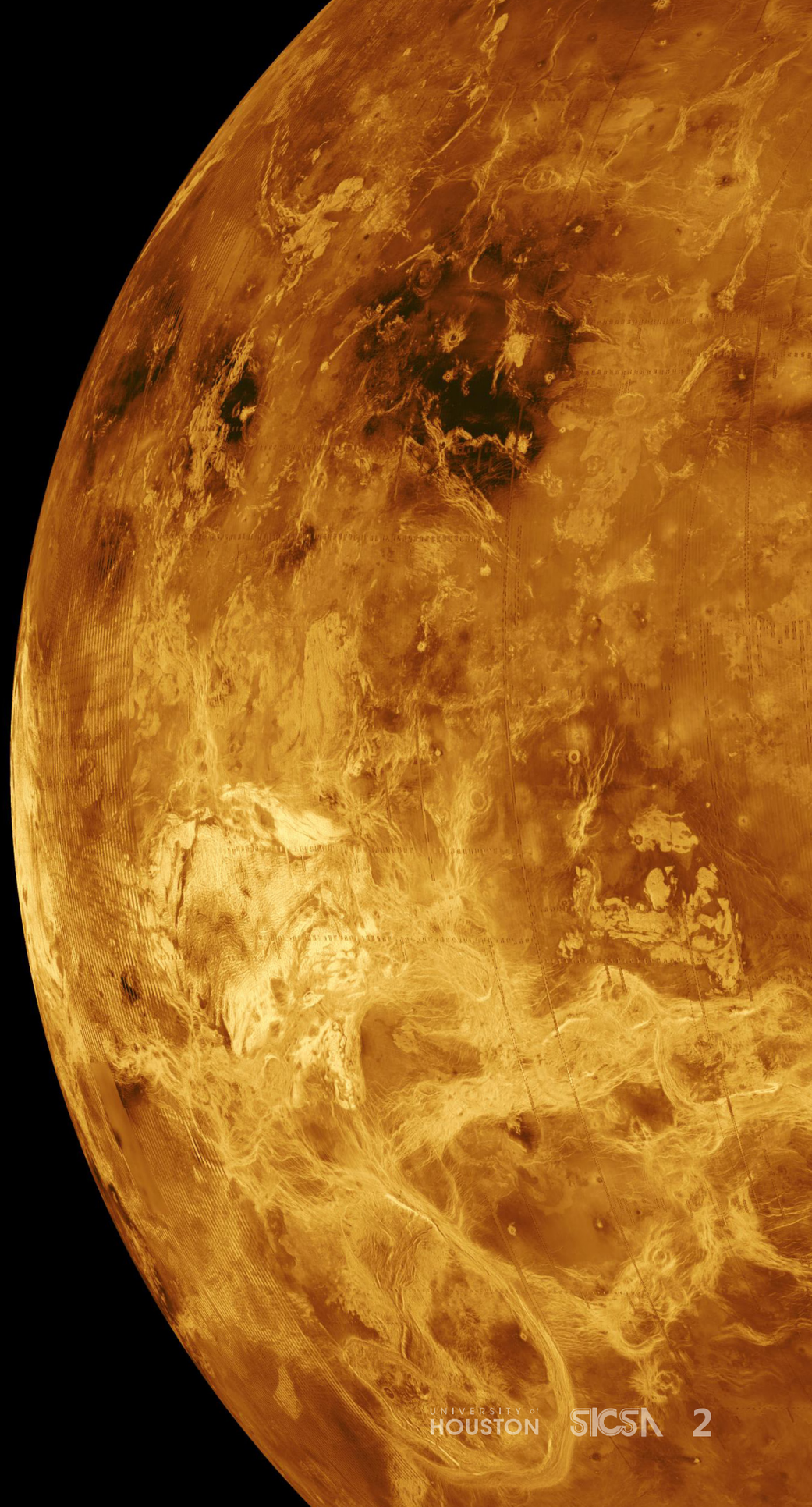
04/12/17

SPAC-7410 - Thesis Defense

The aim of this project is to explore architectural options presented by the Venusian atmosphere and, by proxy, bring sex appeal back to space travel by emphasizing the purpose of having a human out on the frontier, not in an aluminum can. Parking a work derrick at 54 km (+/- 4 km) above the surface of Venus provides environment where this can be achieved. Currently, the majority of programs and projects dictate a robust pressure vessel (aluminum can) to provide habitable volume for people. As demonstrated by the Vega probes, there is just over 1 bar at 40oC at an elevation of 50 km on Venus and this tapers off to .1 bar at -13oC at 67 km. This alone sets the environment, and therefore the design solutions, apart

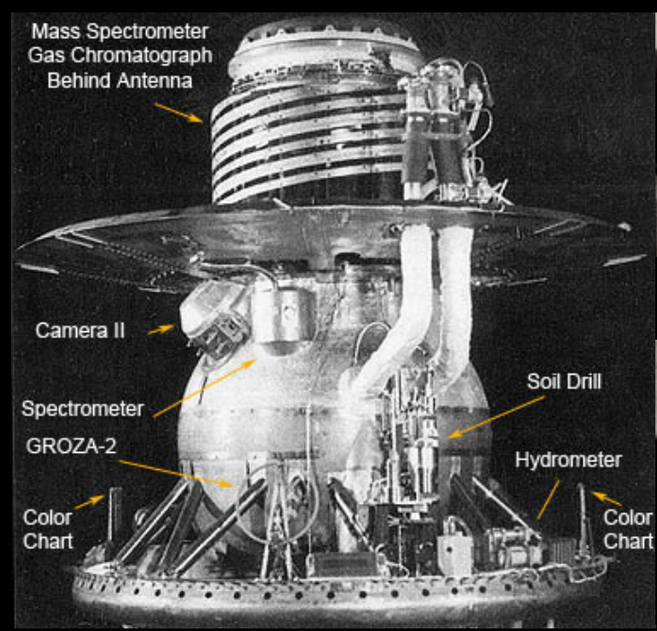
A manned work derrick suspended on the surface of the cloud deck is **the spot** for humanity's first step into the solar system. The planet provides many intriguing challenges; while initially very hostile, the atmosphere conceals a veritable oasis for human activity relative to anywhere we can get to that is not Earth.

The lack of surface contact creates a demand for a sustained human presence. Humans are the original HUMVEE, we are specialized to generalize and that makes us the perfect meat servo to solve most of our exploratory woes.



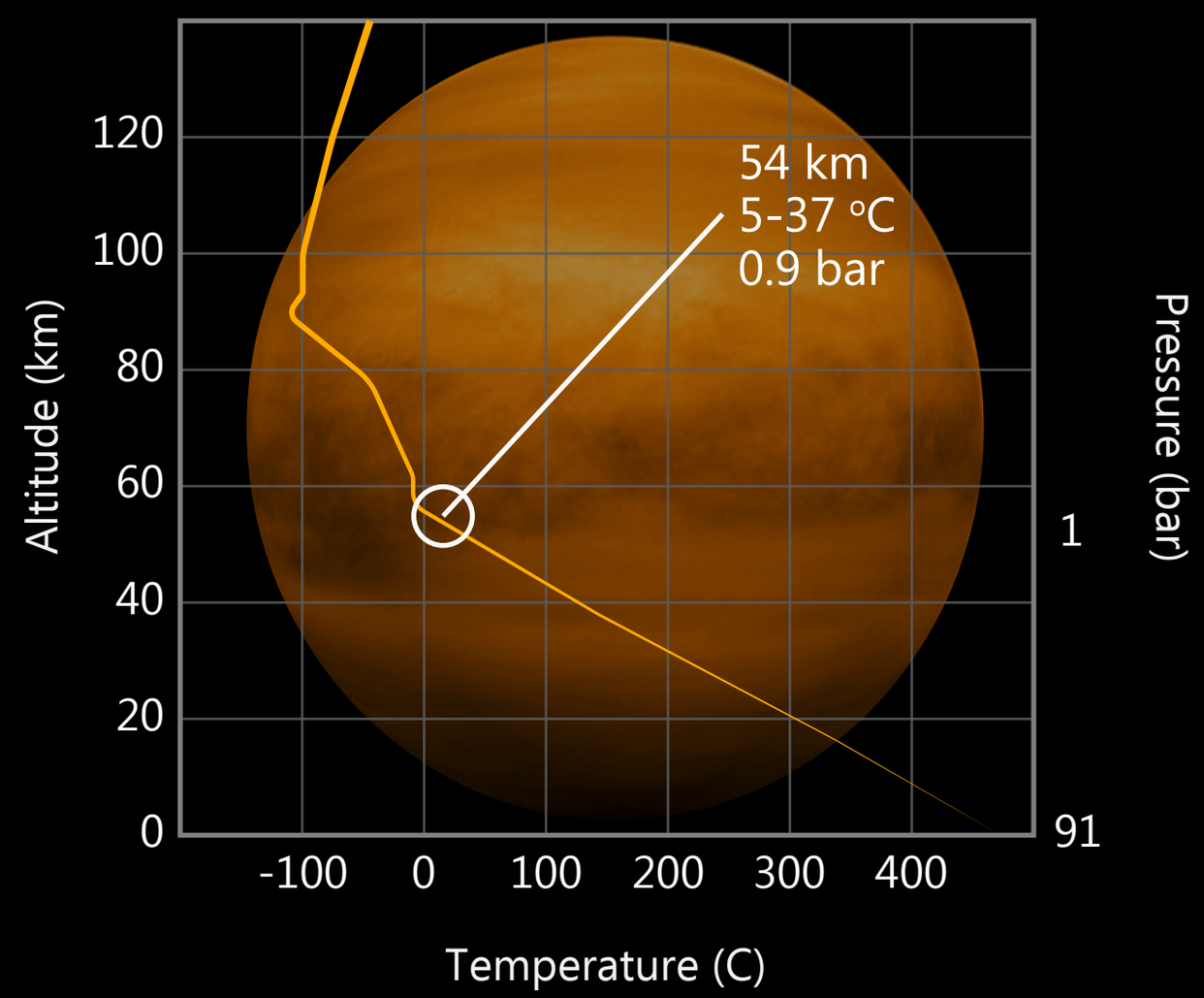
The Venera Program

Venera 13, lasted 127 minutes on the surface. To be fair, it was only designed to survive 32 minutes before succumbing to the heat and pressure



The Vega Program

In 1986 the Vega program included two balloons that caught a ride to Venus and survived for their entire battery life, bobbing between 53 and 57 km of elevation



What is known

Venus Atmospheric cross section

- Surface temperature 735K: lead, tin, and zinc melt at surface, with hot spots with temperatures in
- Excess of 975 K
- Atmospheric pressure 96 Bar (1300 PSI); similar to pressure at a depth of a kilometer under the ocean
- The surface is cloud covered; little or no solar energy
- Poisonous atmosphere of primarily carbon dioxide, with nitrogen and clouds of sulfuric acid droplets.

- Venus travels around the sun in 225 days
- A Venusian day is 243 days long
- The planet spins in retrograde, sun rises in the west
- 584 day Synodic Period with Earth (Mars is 687)

- Receives 40% more solar energy than the Earth
- 75% of that is then reflected off the surface of the upper cloud deck

- With a lifting ratio of **0.6kg:1m3,** it would take 3,383,333 m3 of air to float the Shuttle at 54km of elevation
- Helium can be used as an emergency spiking gas if the airship begins to sink. The lifting force is nearly triple that of standard air and would buy valuable repair time

- CO_2 ~ 1.8 kg/m3
- Air ~ 1.2 kg/m3
- He ~ .18 kg/m3

- Planet has an induced magnetosphere, this provides protection from solar particle events and GCR
- Winds travel the cloud deck at 360 kph, this would propel a craft around the equator in 5 days
- The winds are slower on the night side, night relative to a suspended craft would be roughly 65 hrs
- Day would be roughly 55 hrs (low # of data points)

Material Pallet

Worried about all that Sulfuric Acid?

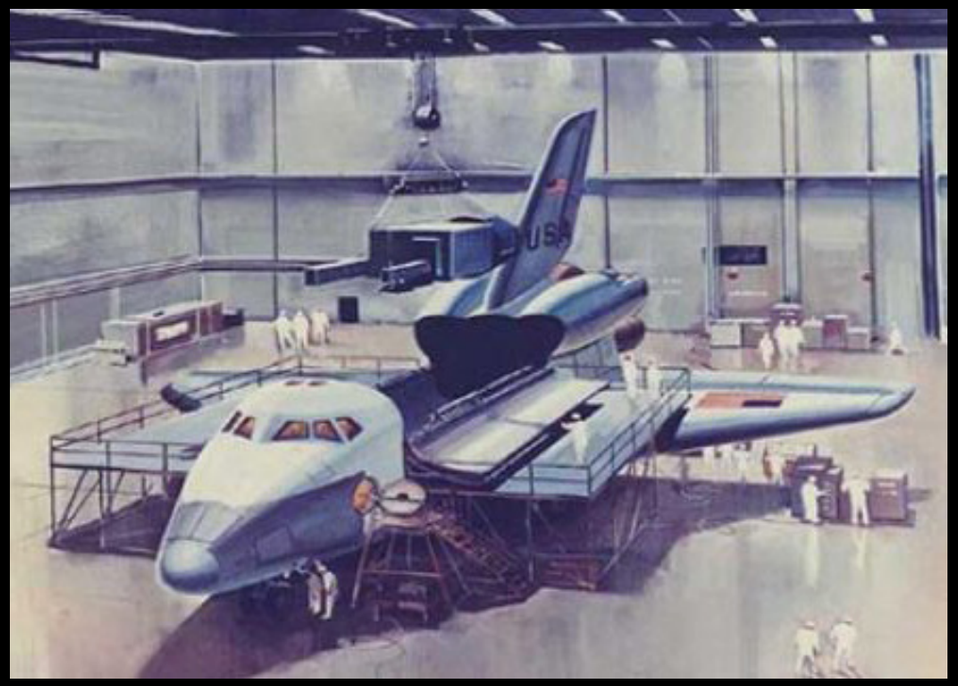
PTFE has got you covered, literally.
The 02 Arena in London, has a tensegrity structure spanning 80,000 m2 made from PTFE coated fiberglass panels. The structure weighs less than the volume of air it encompasses.
The O2 is one of many structures including airports and sporting arenas that are covered with PTFE fiberglass reinforced fabric.

This apparatus effectively all that is required to survive the atmosphere at 54 km elevation.

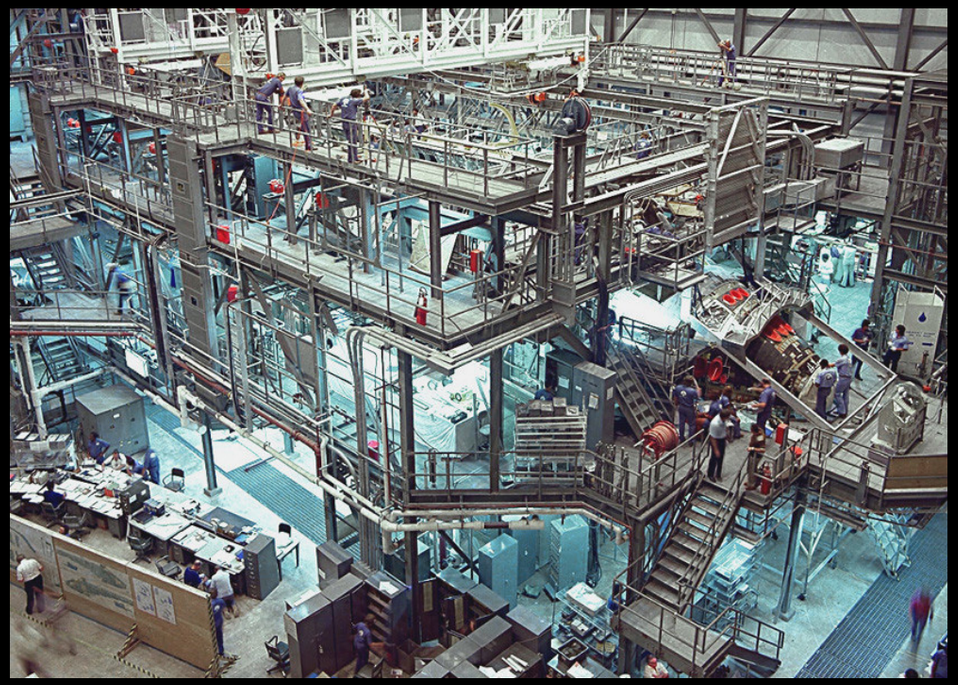
Combined with any fluoropolymer clothing (Think GorTex), EVA prep will take the same time as prepping for a SCUBA dive.

Assumptions & Considerations

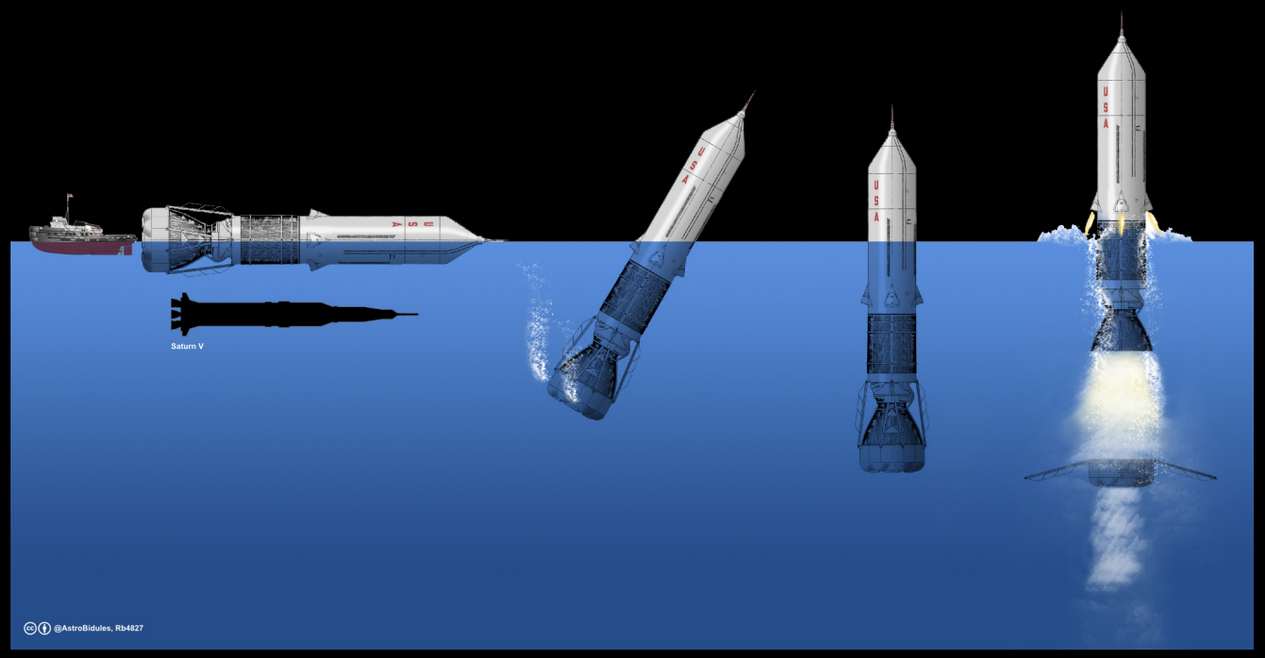
- Cis Lunar Economy
- LEO Construction
- Nuclear Power in Space
- Sea Dragon Type Rockets are Revived
- Medium, Single Stage to Orbit Lift Vehicles
- Terminal Class Space Stations



We are able to develop foresight from hindsight



In Order to Go, We Have to Leave



Step 1, Comms and Tracking Constellations

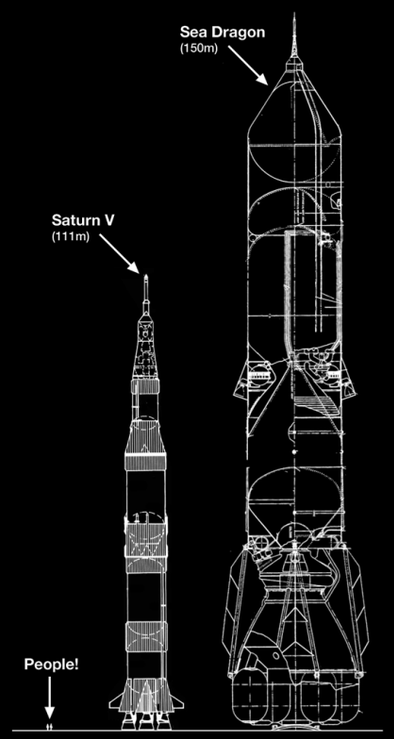
Step 2, Probes and Orbital Terminal Setup

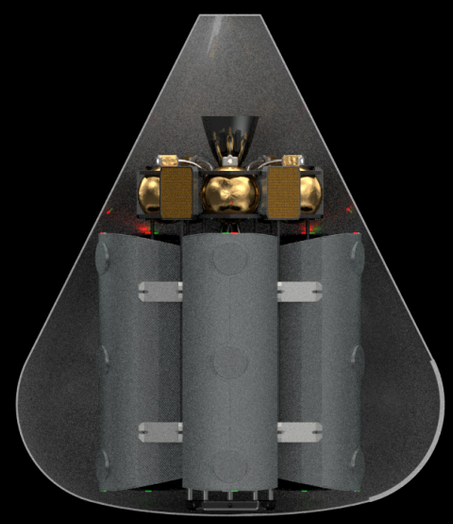
Step 3, Short Shot of Cargo & Skylons

Step 4, Cloud Deck Operations Begin

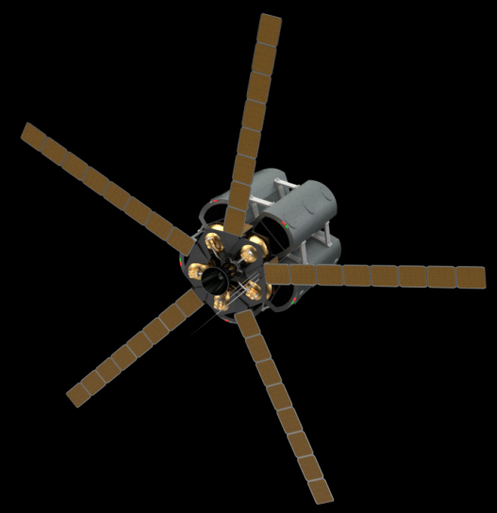
Name	Size	Earth Departure	Destination Arrival	Duration	Injection C3 (km^2/s^2)	Abs DLA	Injection ΔV (km/s)
Venus	12104 km	Sep-15-2018	Nov-18-2018	64 days	35.1	6°	4.72
Venus	12104 km	Sep-15-2018	Dec-04-2018	80 days	28.8	15°	4.46
Venus	12104 km	Apr-29-2020	Jul-02-2020	64 days	53.8	3°	5.44
Venus	12104 km	Dec-12-2021	Jan-29-2022	48 days	83.3	13°	6.52
Venus	12104 km	Dec-12-2021	Feb-14-2022	64 days	63.8	10°	5.82
Venus	12104 km	Jul-11-2023	Sep-13-2023	64 days	58.1	14°	5.61
Venus	12104 km	Sep-21-2026	Nov-24-2026	64 days	49.1	8°	5.27
Venus	12104 km	Feb-22-2025	Apr-27-2025	64 days	65.7	13°	5.89
Venus	12104 km	Feb-06-2025	Apr-27-2025	80 days	27.4	16°	4.41
Venus	12104 km	Sep-05-2026	Nov-24-2026	80 days	21	13°	4.14
Venus	12104 km	May-05-2028	Jul-08-2028	64 days	76.7	3°	6.28
Venus	12104 km	Dec-02-2029	Feb-04-2030	64 days	46.6	8°	5.17
Venus	12104 km	Dec-02-2029	Feb-20-2030	80 days	40.2	6°	4.92
Venus	12104 km	Jul-01-2031	Sep-03-2031	64 days	43.8	12°	5.06
Venus	12104 km	Jul-01-2031	Sep-19-2031	80 days	35.9	13°	4.75

Cloud Deck Prep

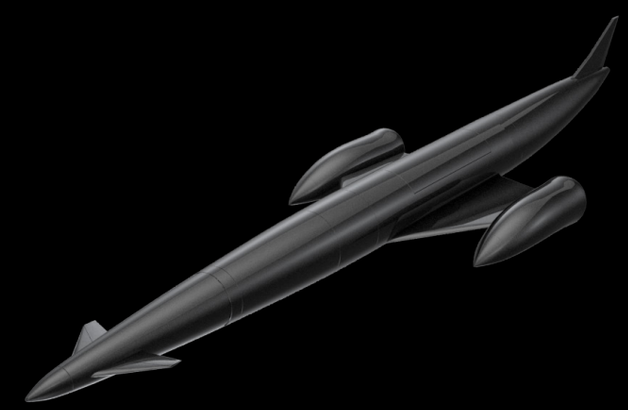




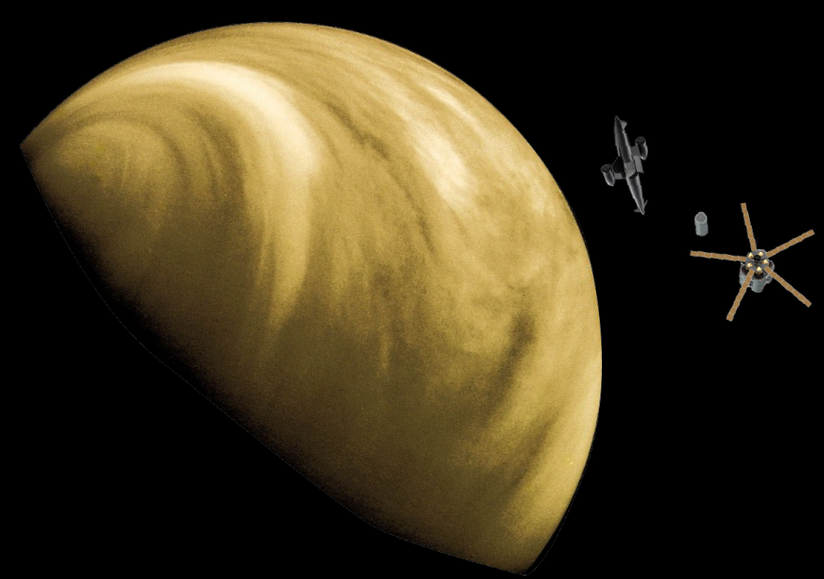
Sea Dragon Faring



Interplanetary Transport



Skylon



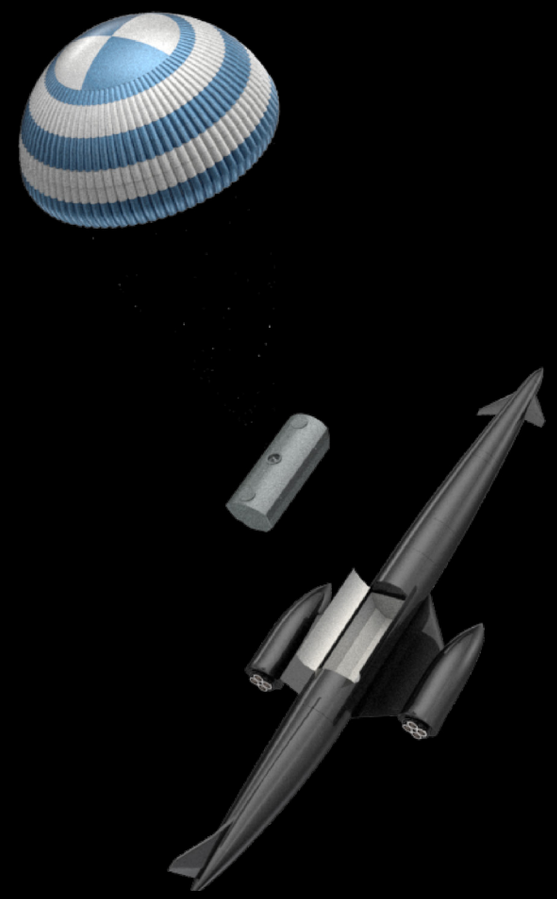
Venusian orbit cargo transfer

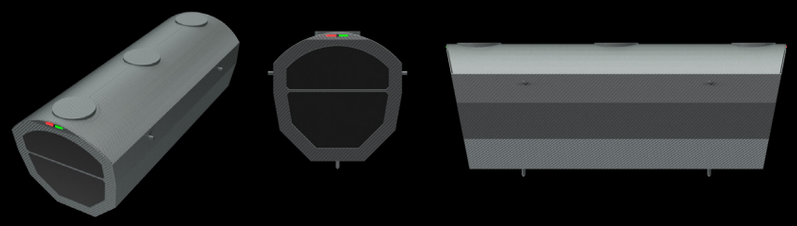
Cloud Deck Deployment

Skylon, single stage to orbit

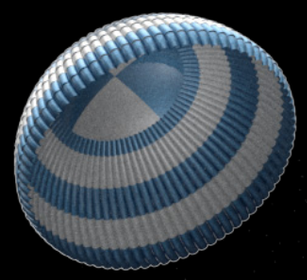
Skylon decent & aero braking

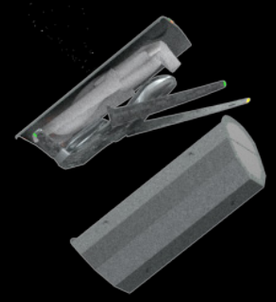
Skylon pneumatic payload ejection & drogue shoot deployment



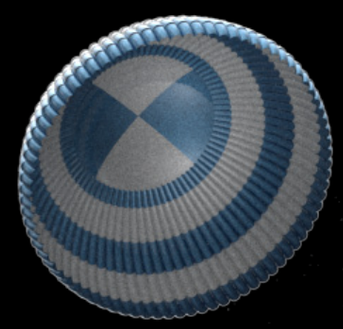


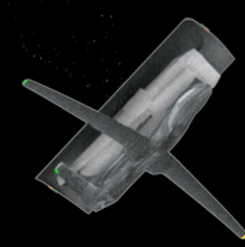
Drone Deployment



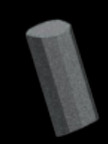


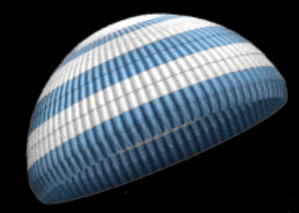
Skylon payload fairing separation

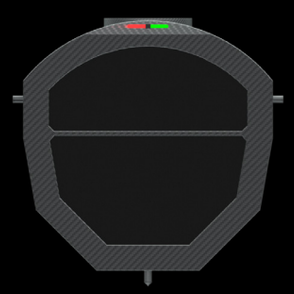




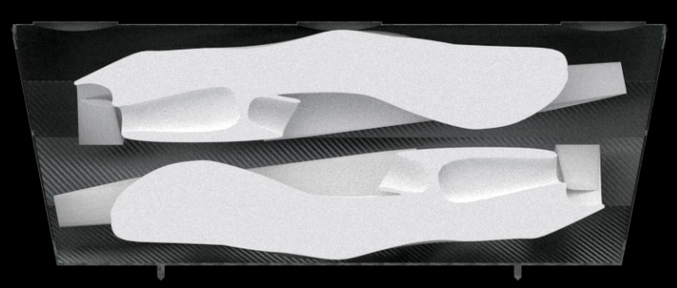
Wings Deploy







FRONT

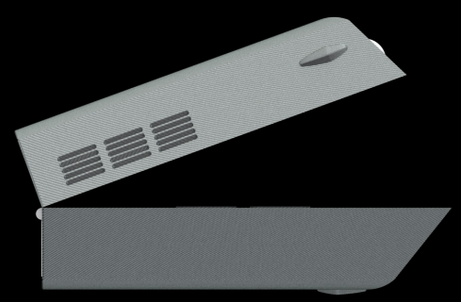


SECTION

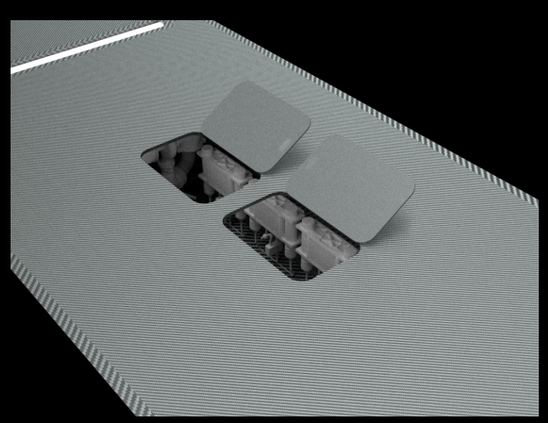
Spine Deployment w/ Lifting Body Airship

Spine arrives inside a Skylon payload fairing

SECTION

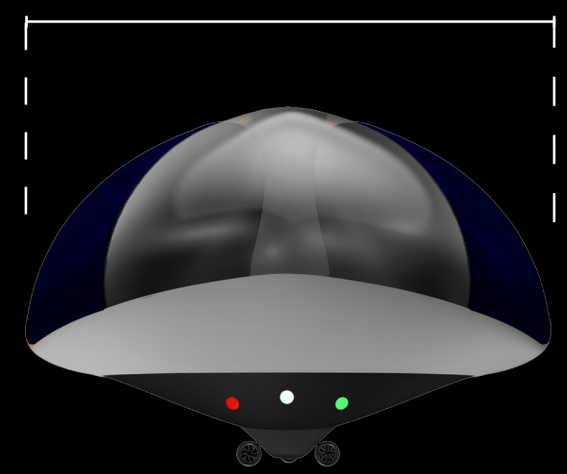


Deploys by unfolding & inflating the lifting envelope



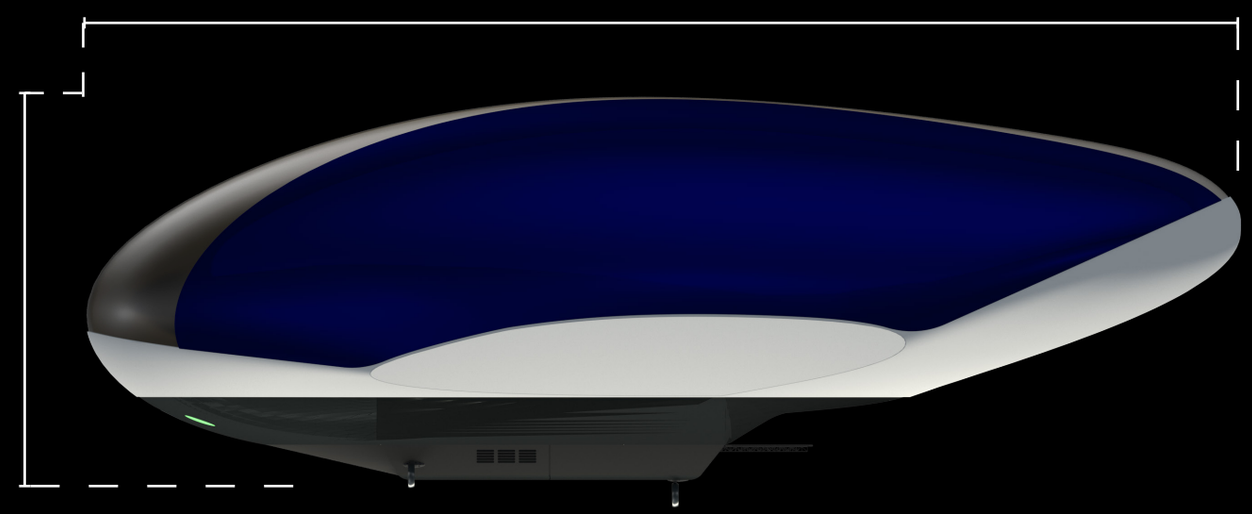
Landing Lights

35m

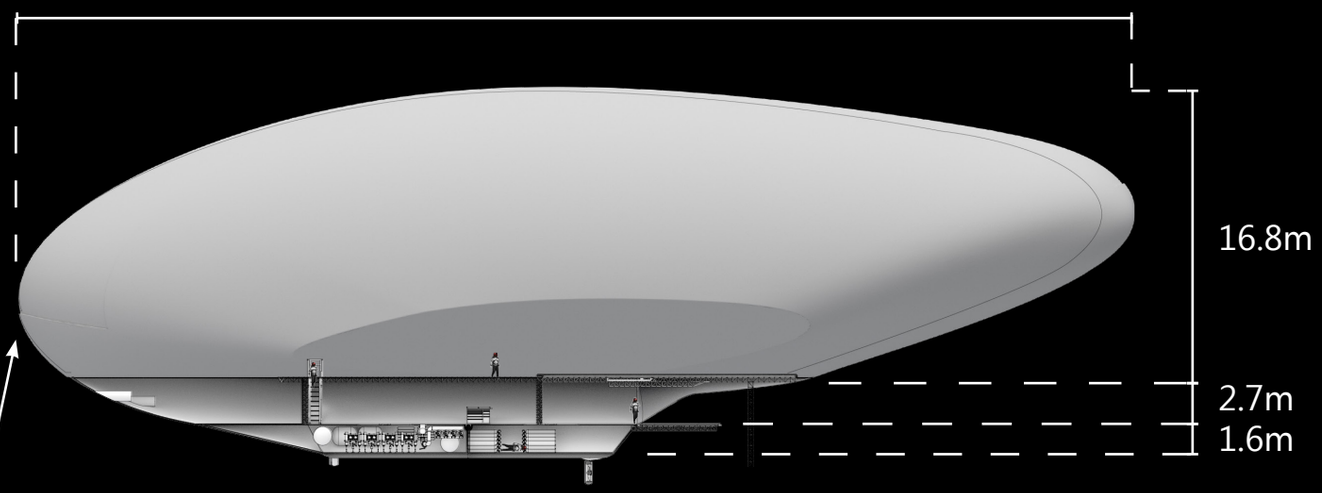


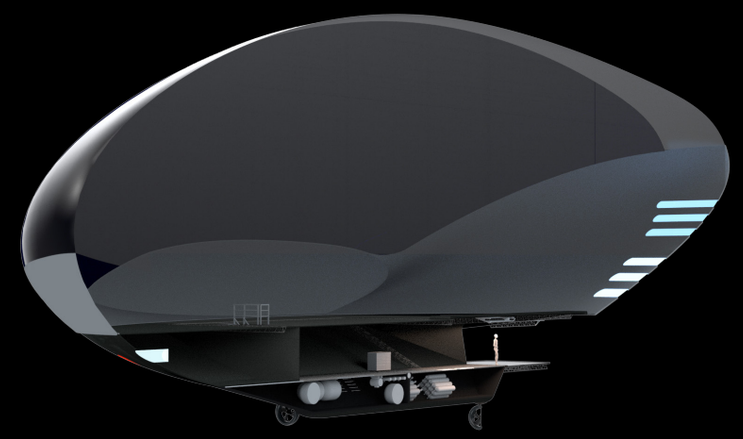
65.5m

21.9m

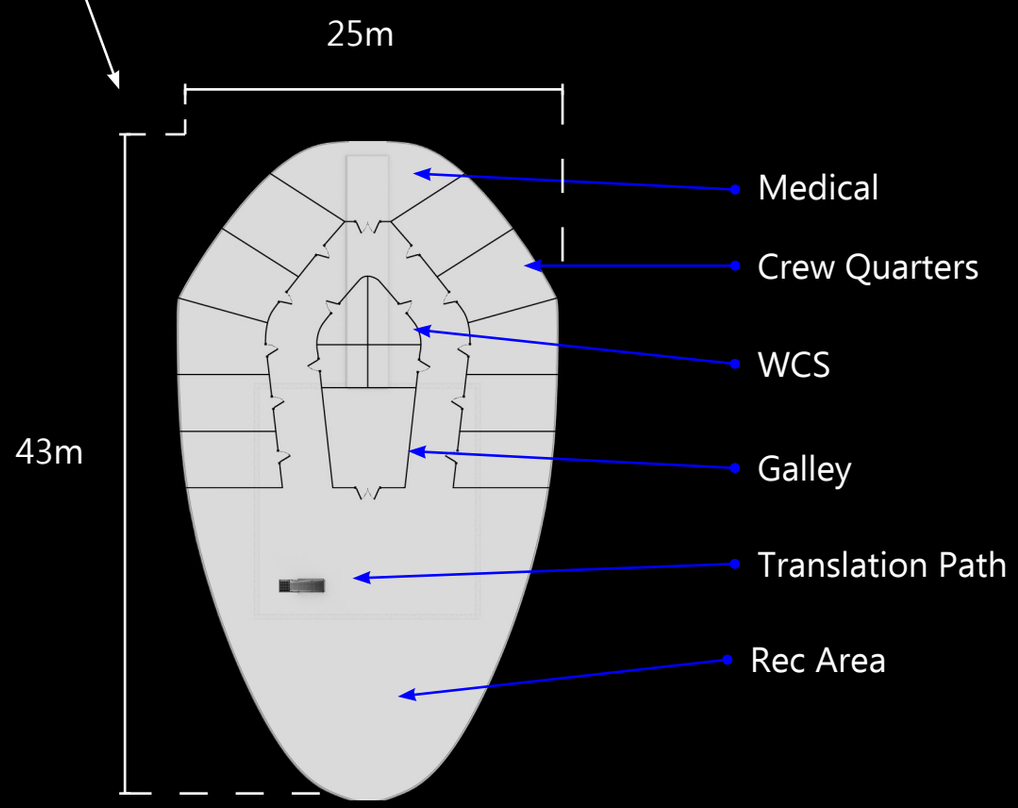


Habitation Layout

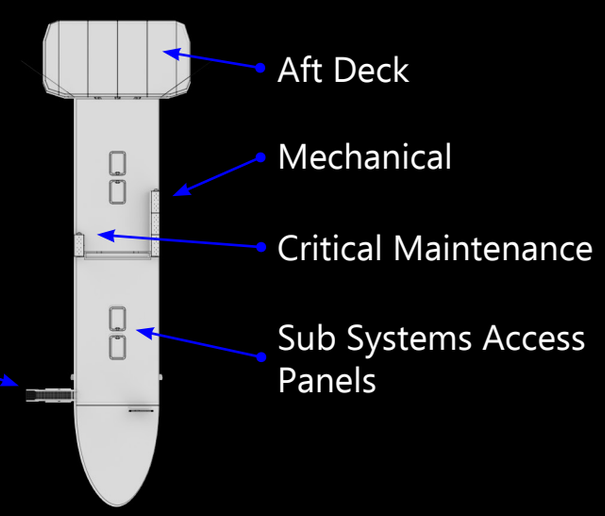




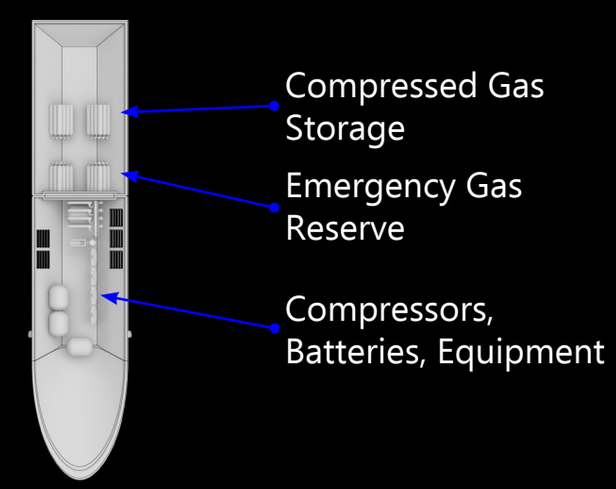
Main Volume



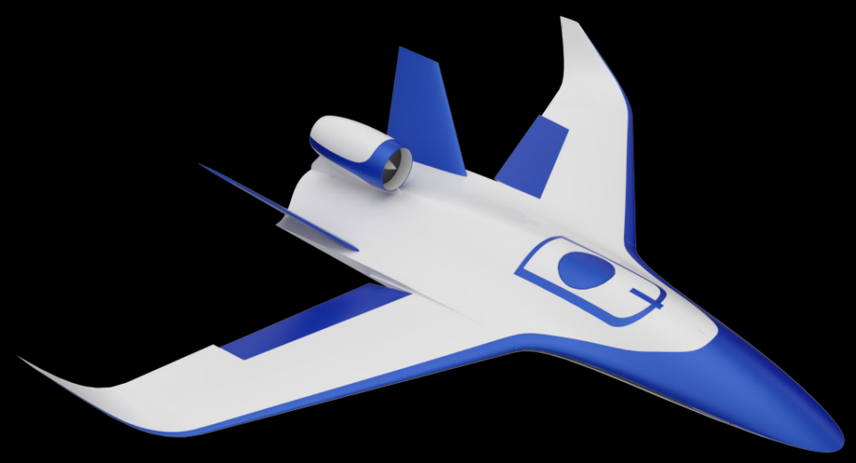
Flight Deck



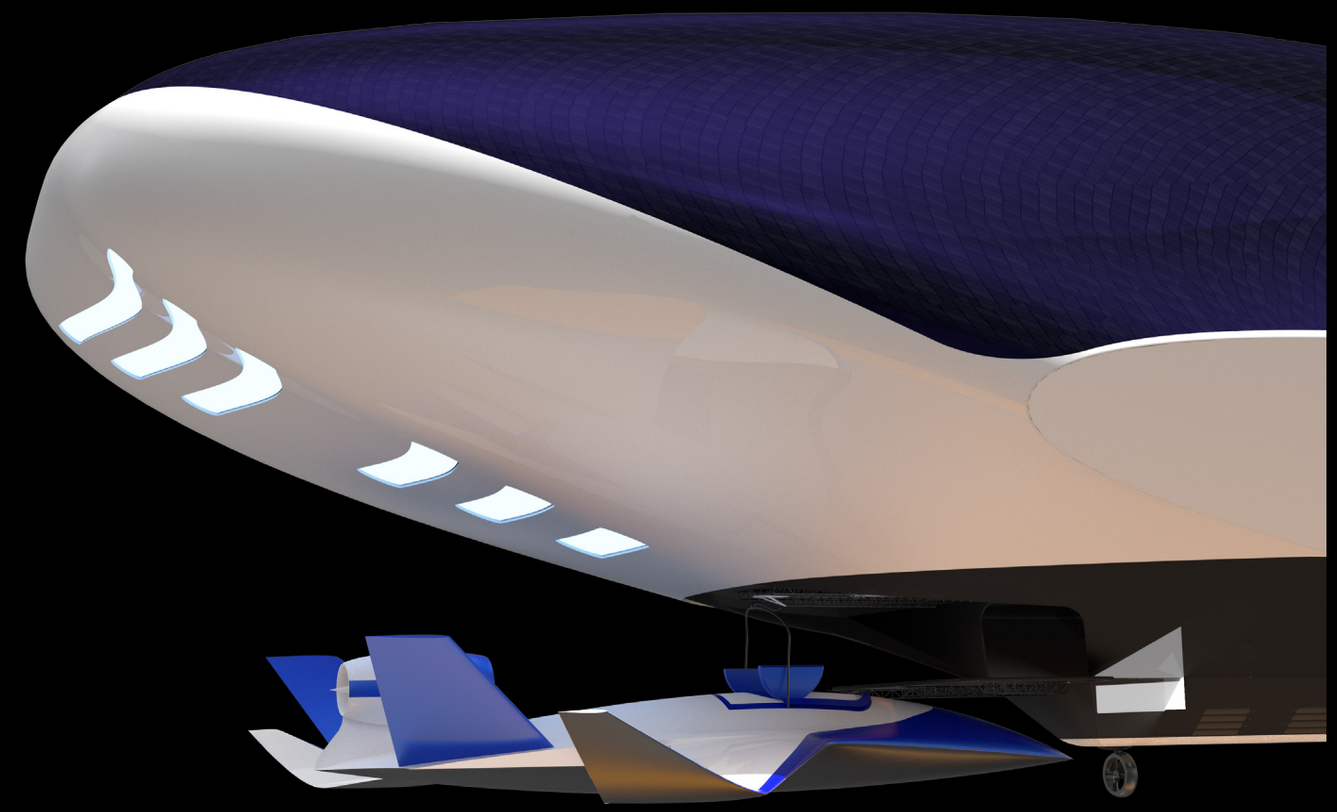
Sub Systems Access

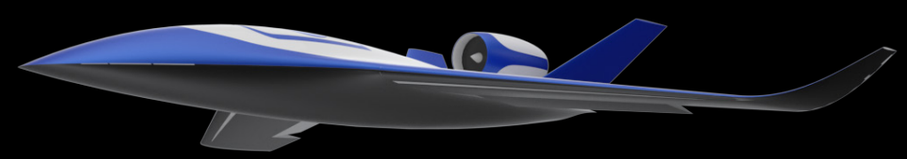


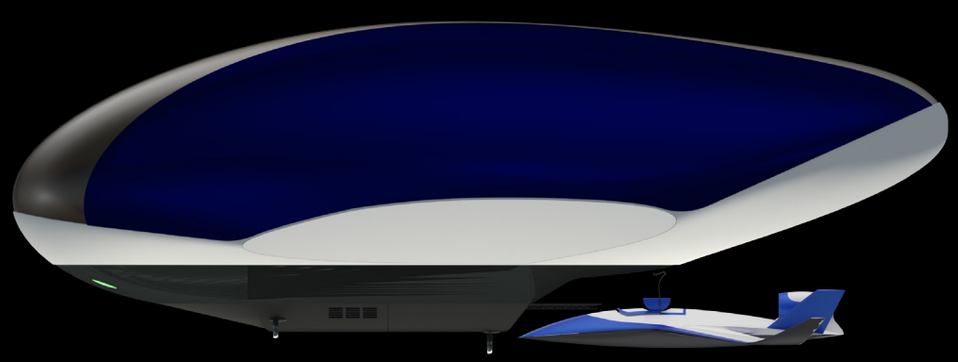
EAVs

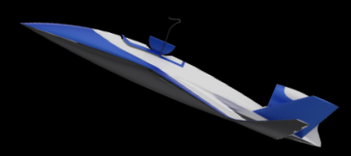


Entry & Assent Vehicle capable of ferrying up to 9 crew between orbit and the cloud deck

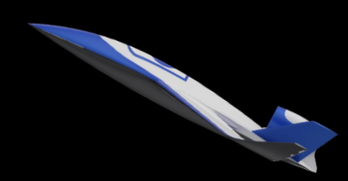


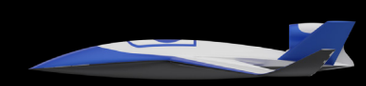


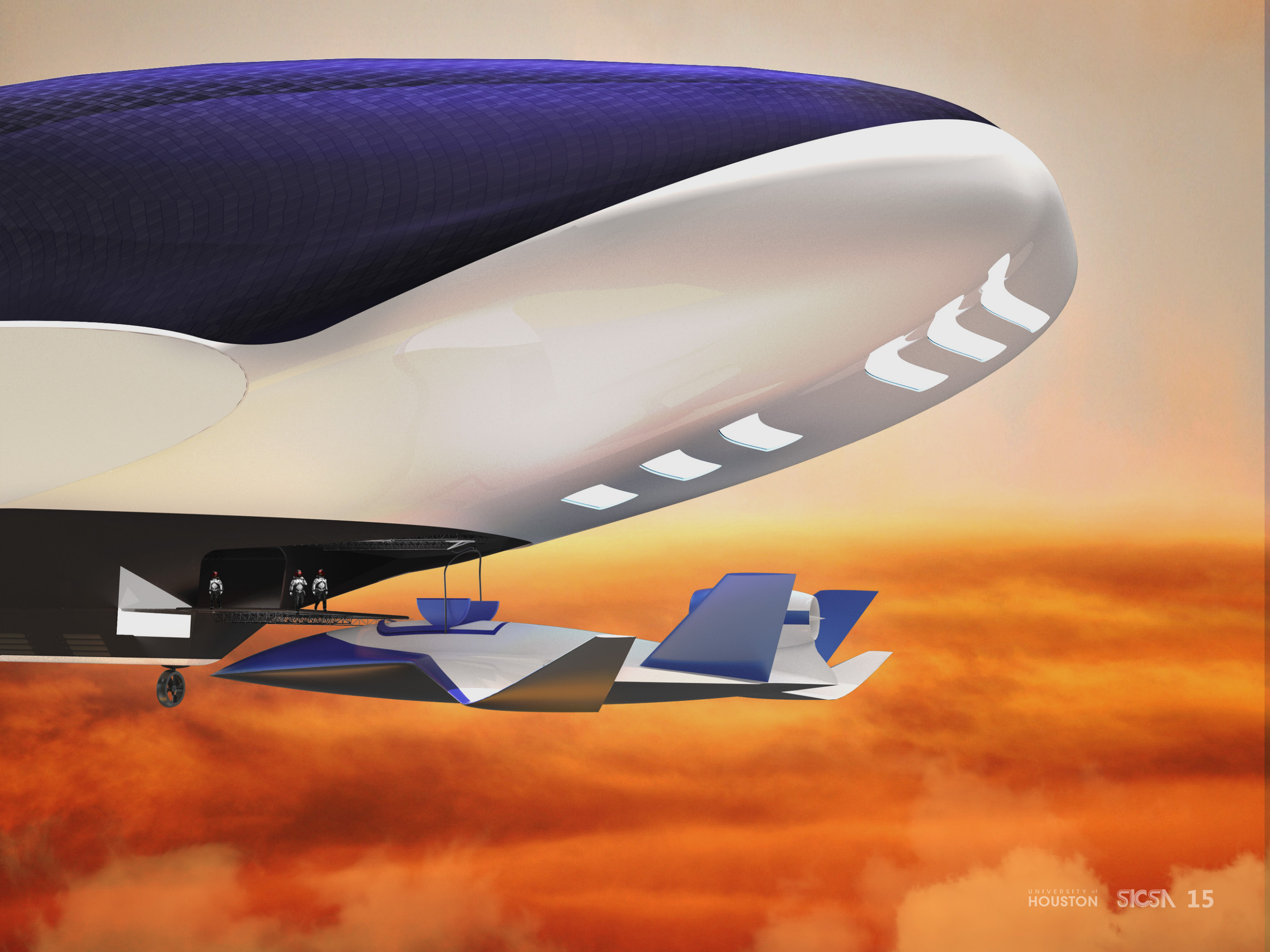




Deploys Hook







We have done that before

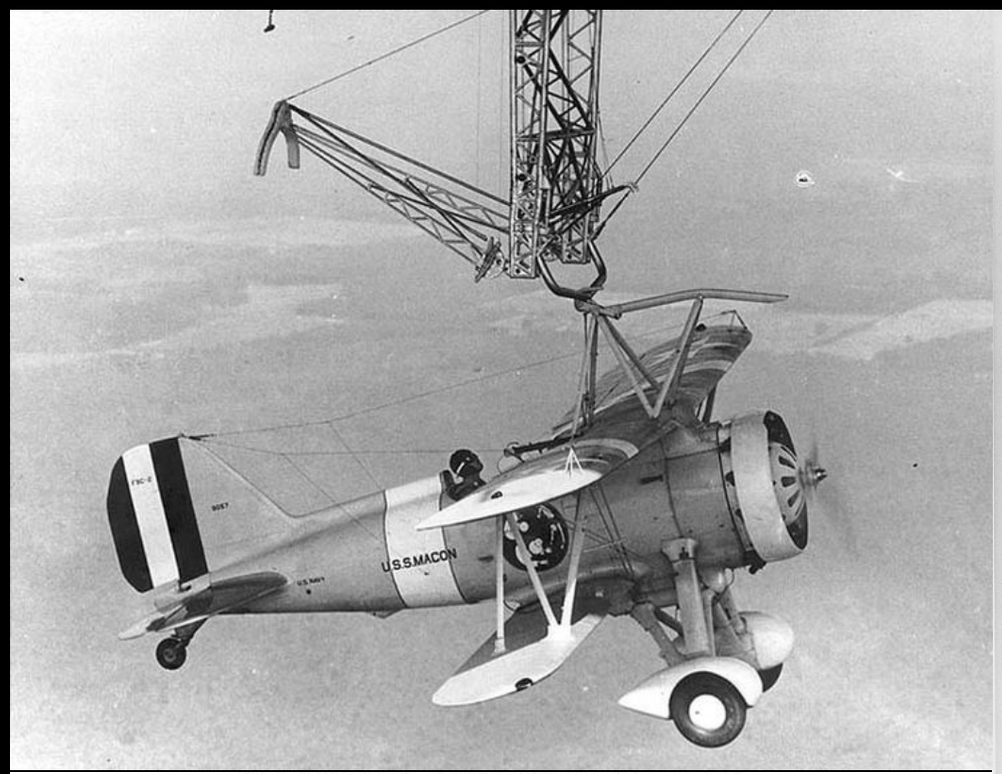
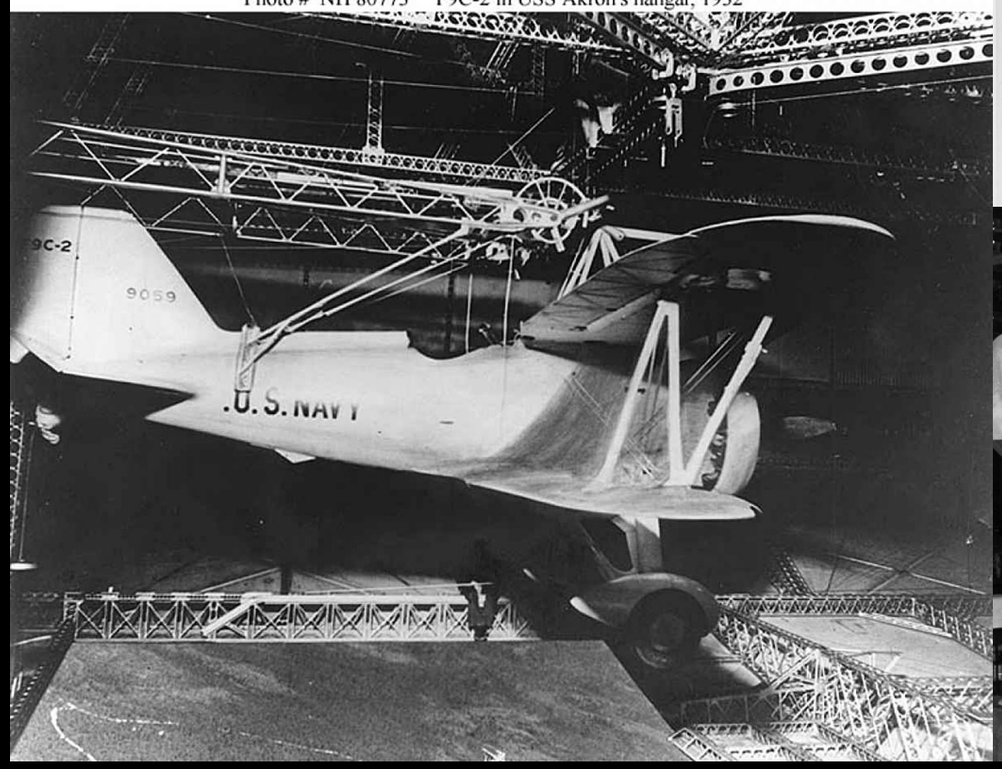
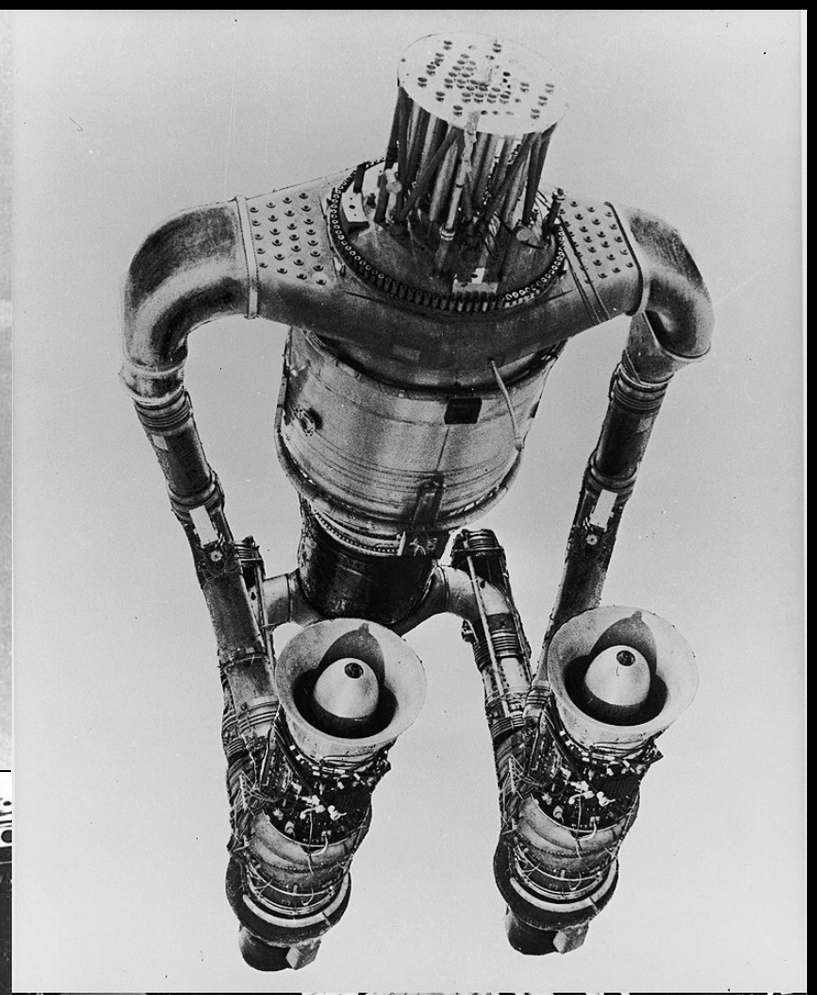
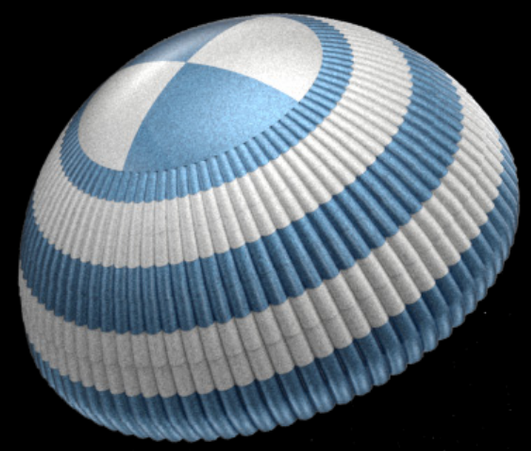


Photo # NH 80773 F9C-2 in USS Akron's hangar, 1932





Farms

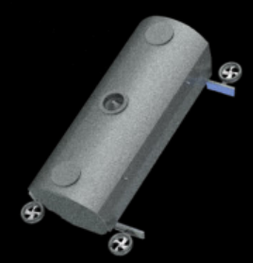


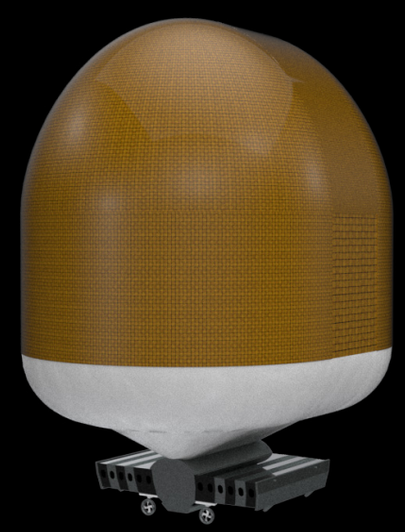
These farms are standalone, automated aeroponic units.

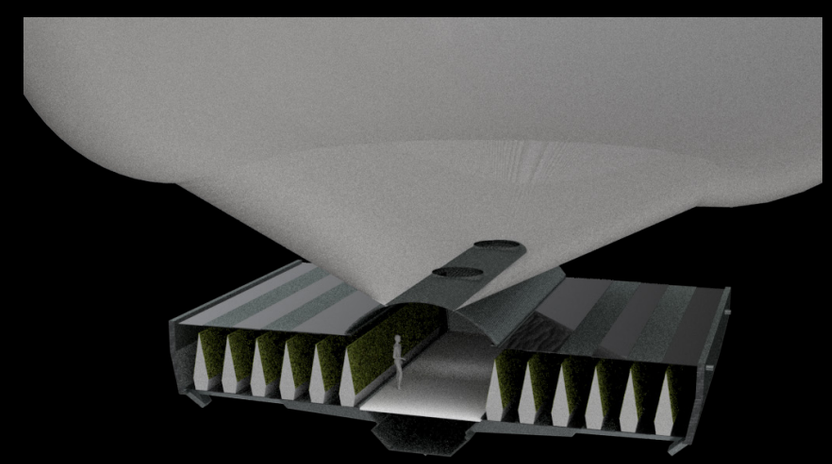
As these farms draw 95% of their requirements from the Venusian environment, they only require the slightest replenishment.

A secondary function stems from this, the farms can act as life boats.

- Suck in CO_2 plants produce O_2, a lifting gas
- They will require Nitrogen as a nutrient, this too can be collected from the atmosphere

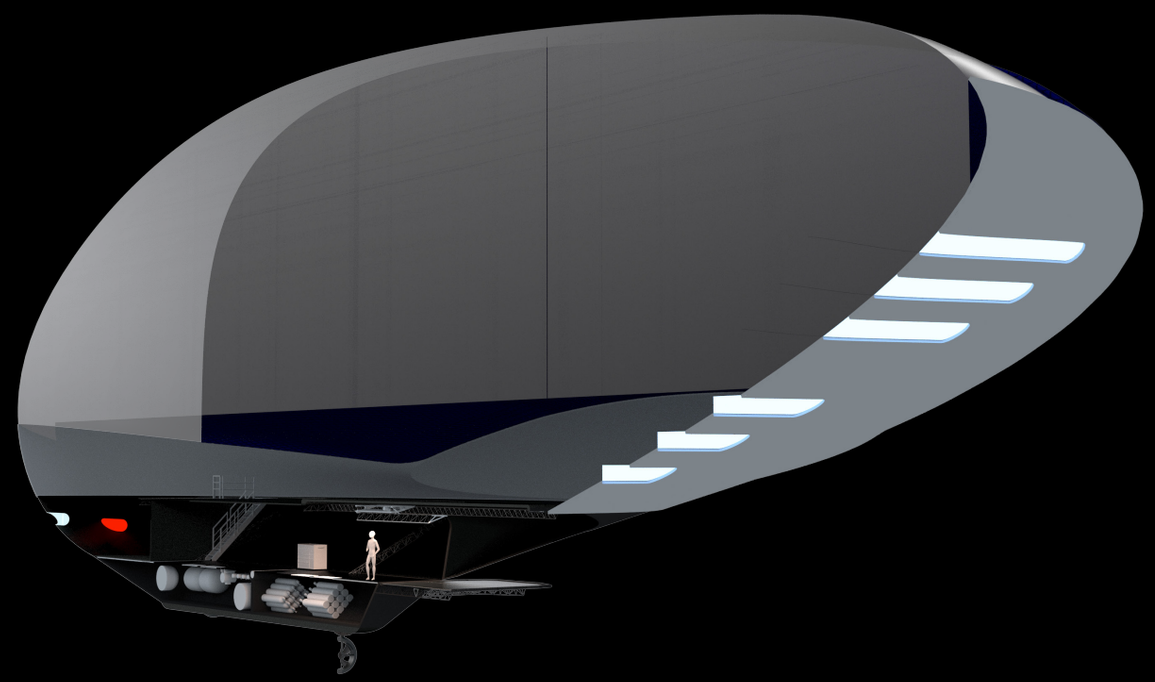






The Farms will require harvesting
Leaving this up to the Venusians will create a living, breathing oasis in the clouds

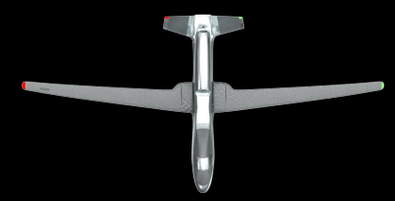
ISRU

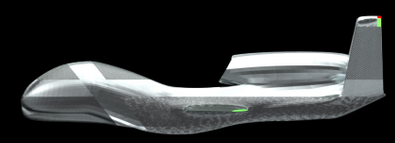


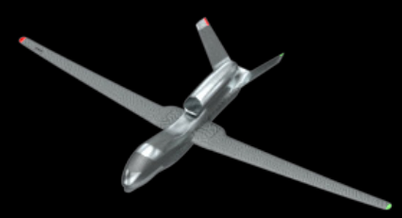
Collecting resources on Venus will require a different outlook:
- You are mining gas
- Carbon is your friend

Initial ships will be outfitted with “pilot plants,” to decrease mass and increase on the job flexibility.

There are two main resource groups:
- Ambient gas
- Condensate



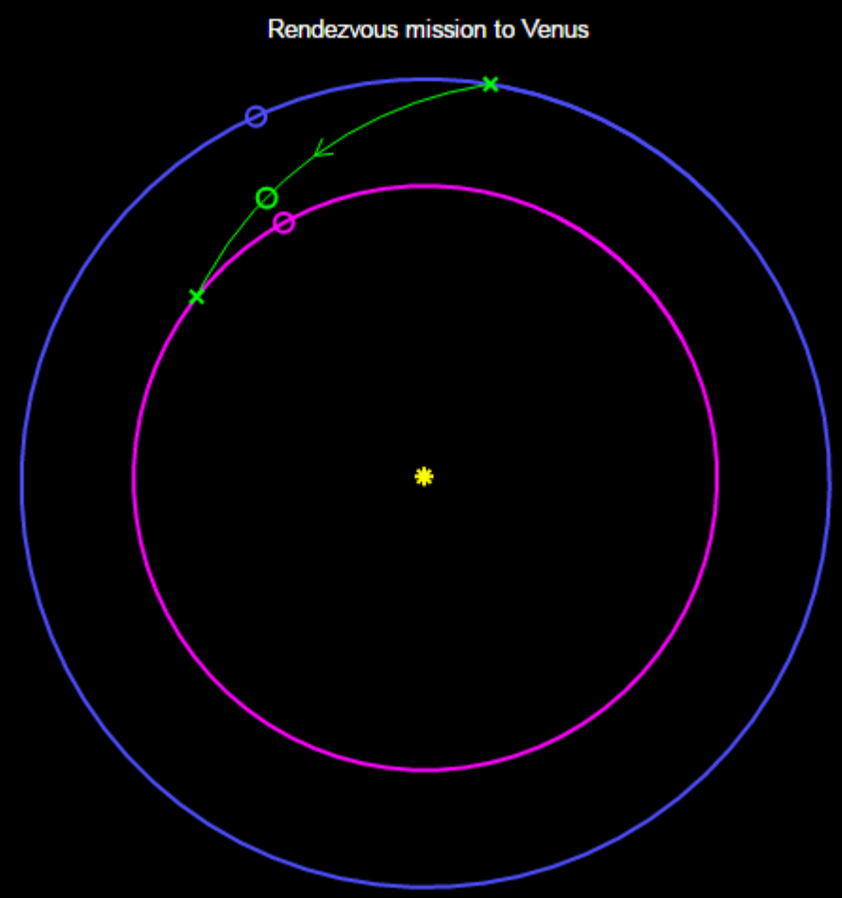




Ambient Gas Collection
- Large Airships that gather primarily CO_2 and N_2
- Provide filtration, extraction, refinement and storage
- Primary Resources: O_2, N_2, and Carbon filament

Condensates
- Smaller, faster drones collecting H_2SO_4 and H_2S
- Drag collection devices through the cloud deck
- Primary Resources: H_2O, S, O_2,

The Future



Venus [Solar Sytem Exploration]

SPK-ID	299	Orbit Condition Code	0
Size	12104 km	Semi-major axis	0.723 AU
Eccentricity	0.007	Inclination	3.39°

Trajectory Itinerary

	Date	ΔV	
Earth Departure	Dec-12-2021	6.52 km/s	C3 = 83.3 km^2/s^2 DLA = -13°
48-day transfer			
Venus Arrival	Jan-29-2022	3.38 km/s*	
48-day total mission		3.38 km/s 9.89 km/s	post-injection ΔV total ΔV

Solar range: 0.72 - 0.98 AU Earth range: 0 - 0.33 AU

* ΔV to/from a C3 = 0 km^2/s^2 local planetary orbit.