# Space Settlement Laboratory

Resolving the Issues of Space Settlement Rapidly

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# The Grand Challenges

Launch/LEO	Deep Space	Moon/Mars	Settlement
Affordable Launch	Solar Flares	Moon Landing	Air/Water
Large Vehicle Launch	GCR: Cell Damage	Mars EDL	Fuel
Mass Fraction beyond Earth Orbit	Medication/ Food Expiration	Spacesuit Lifespan	Power
Space Junk	Life Support Closed Loop	Reliable Ascent Vehicle	Food
Microgravity (health issues)	Medical Entropy	Reliable Return Vehicle in Orbit	Assembly
	Psychology	Flight to Earth	Mining
	Mechanical Entropy	Earth Reentry	Manufacture
Earth Labs	LEO	SSL	Moon/Mars

# Space Settlement Laboratory





# Original Design (2011)



# Modules: Legos for Settlement



## Life Sciences Lab/Habitat









### **Nested Sections**







# Spin Arm (2 RPM)



Phase	Micro	Lunar	Martian
Core Modules	7	36	78
Frame Modules	6	36	36
Spin Labs	0	14	34
Total Modules	16	92	166
Cost	\$371M	\$2.13 B	\$3.85 B



# Cross Sections (Non-spinning)

# Functions

• Solar power:

- X Photovoltaic, Y Light Collection, Z Heat Exchangers
- 2 Static Arms, Momentum Gyros (2, 3, 4, or 6 as expanded)
  - Robotic docking ports, Communications arrays
  - Power storage
- 3 "Hot Lab" Foundry using solar collectors, etc.
  - Heat pipes back to main body
- 4 Asteroid Mining Hardware
- 5 Asteroid Storage and Science (Hangar)
- 6 Liquid, Gas tank storage
- 7 Docking Adaptors
- 8 Spin Section Interface

# Science: Bits and Atoms

Extract all Data from an asteroid before consuming it

**Do Full Non-Destructive Cross-Section Scan** with X-Ray, Radar, etc.

 Identity any density structures or other unusual components for later analysis

#### Isolate and Remove Anything Unusual

• Density Changes, crystals, meteorites, etc.

Take sample cores from one end to the other through each axis.

• Also gather characteristic samples across the surface or of any deeper structures.

In the process, categorize the NEO as compared to remote data

- Goal to be able to find more like it from a distance.
- Should be able to isolate higher value targets with minimal fuel/time consumed.



### Science

#### At Capture

- Remote Science
- Sampling
- Precision Orbital Data

### Arrival at SSL "Hangar"

- Do Internal scanning
- Do Deep Core Sampling

#### **During Mining Process**

 Run Mass Spectroscopy, Relative Quantities of all extracted products



# Fabrication Labs

#### Metals

- Additive Manufacturing
- Subtractive Manufacturing
- Layered Coating

### Volatiles

- Separate by Boiling/Condensation/Freezing Points
- Store as Liquids, use as Shielding, Life Support, Fuel

#### Non-Metals

- May use Volatiles for further separation
- Soils, solar panels, ceramics, glass, etc.

# **Economics: Mining/Fabrication**

- Able to test mining/Fabrication Equipment
  From NEO to Mars in Single Facility
- Risk reduction prior to deep space testing.
- Close development cycles from a decade to a few weeks.





# From SSL to SFF

 As sections built from asteroid materials, can eventually split off (similar to mitosis) a Space-Fabricated Facility.

- Can build:
  - Cyclers
  - Deep Space Settlements
  - Asteroid Miners
- Can Test Surface Habitats



### Life Sciences

- Can test plants/animals, full lifecycle, at any gravity and cosmic ray shielding level.
- Can determine suitability for settlement before sending to Mars, etc.
- Can pre-test utilization at different gravity levels, determine suitability ranges.



# Research is NOT a Substitute for Actual Settlement Work

- Need Mars Settlement to do Final Testing and Implementation
- Determines correct shielding/gravity requirements at every stage.
- Establish operating range of equipment, crew, plants, and animals.



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### Questions?

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