# In-Space Manufacturing (ISM)



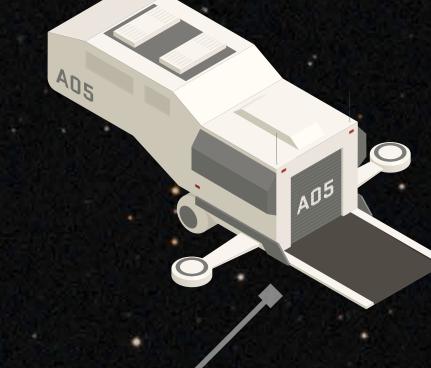
# 1: Launch / Re-supply

Equipment launched from Earth. Raw materials & consumables from:

- 1) Earth
- 2) recycling
- 3) Moon
- 4) asteroids

### Space Resources Transport

Momentus, TransAstra, Orbit Fab



### Space Debris Recycling

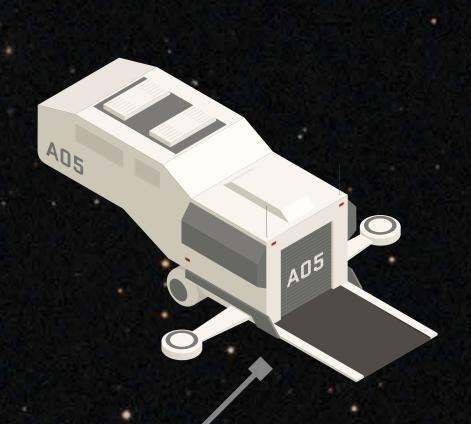
Made in Space, CisLunar Industries, Orbit Recycling, Tethers Unlimited

### Re-Supply Vechicles (1-way)

Cygnus, Progress, HTV, Tianzhou

### Re-Supply Vechicles (2-way)

Dragon, Starship, Starliner, Dream Chaser, Sojuz



# 2: On-Orbit Manufacturing

Using microgravity environment to manufacture new products and materials, on or nearby:

- 1) space stations (multi-use or dedicated)
- 2) free-flying spacecraft (multi-use or dedicated)



# Microgravity End-to-End Services

Nanoracks, Ice Cubes, Bartolomeo, Space Tango, yuri

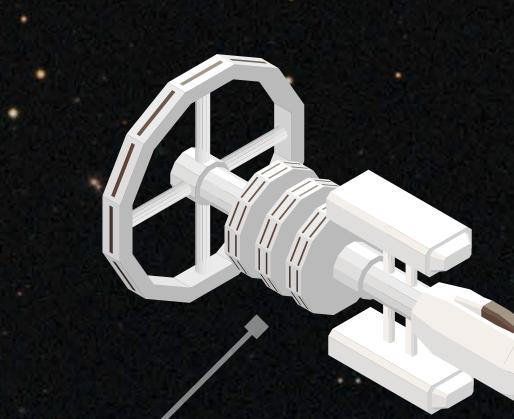
Dedicated Space Factories



In-Space Construction/Assembly Made in Space, Tethers Unlimited, Orbital Assembly, Arkisys, Momentus

# 3: Use in Orbit / Re-Entry

1) Large-scale space structures, solar power stations, space food etc will remain for use in space. The more accurate term for this activity can be in-space construction or in-space assembly. 2) Re-entry capsule (can be same) to bring samples and products to Earth, which will likely be the largest market for many materials.



### Large-Scale Space Structures

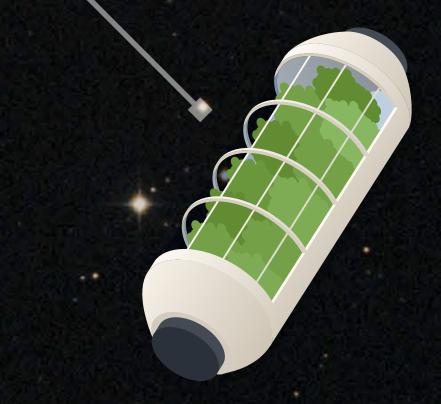
Made in Space, Tethers Unlimited, Orbital Assembly, Momentus, Skycorp, United Space Structures

> Space Food Nanoracks



# Re-Entry Capsules (1-way)

SpaceWorks, JAXA



### Space Vechicles (2-way)



1) Launch orbital factory to the ISS or commercial space station. As preparation or everything at the same time. 1a) Re-supply raw materials & consumables (optional). 2) Use the mostly automated orbital factory and help of

(commercial) astronauts to manufacture the material or product in microgravity.

3) Use (the same) space capsule to return the products.

# Path 2: Dedicated Free-Flyers

1) Launch reusable spacecraft or space capsule (e.g. Cargo Dragon) with raw materials, consumables and fully automated manufacturing apparatus included. 2) Use the free-flying spacecraft as a microgravity environment for in-space manufacturing.

3) Enter atmosphere & retrieve the (reusable) capsule.

Dedicated Free-Flyers

Dragon, Space Tango, Space Forge,

Space Rider, Dream Chaser, Arkisys

**Space Stations** 

Commercial Space Stations

Axiom, Nanoracks, Orion Span,

Orbital Assembly

ISS, Gateway, Tiangong

## Dragon, Starliner, Dream Chaser,

Space Tango, Space Rider, Sojuz

## Space Station > Free-Flyer

- Regular Dragon, Starliner, Starship etc flights.
- Most not that time sensitive if extra 1-2 months.
- Quantinities will likely be small for the near future.
- Multi-use and more consumables due to resupply.
- More electrical power thanks to larger solar arrays.
- Fast 24/7 telecommunications and mission control.
- Capsule retrival (tracking, legal, transport) handled.
- Lower costs all around to help with ISM economics.

# Free-Flyer > Space Station

- Re-usable satellites or solo capsules are flexible.
- Independence if aiming for full vertical integration.
- Full use of payload capacity and 100% automation.

Spaceships (2-way)

factoriesinspace.com Erik Kulu, 2021-04-04

