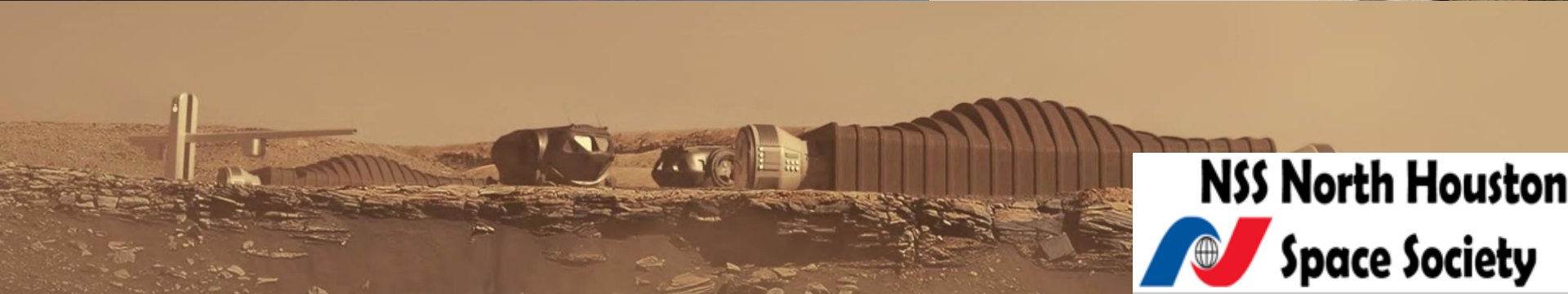
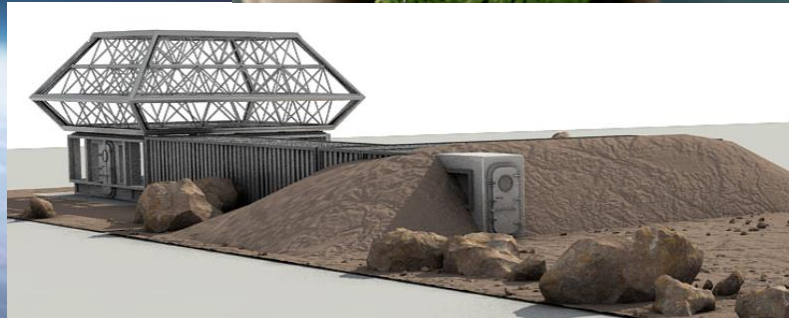


# Monthly Space News

Greg Stanley

Oct. 2, 2021



# Low Earth Orbit (LEO) news

- All-private space tourism reaches LEO
- Some interesting recent experiments carried in cargo to the ISS (Space Station)



Image credit: NASA

# Serious space tourism: Inspiration4

- Fully commercial 3-day spaceflight on modified SpaceX Crew Dragon capsule
  - First all-private orbital mission (4 private citizens, no government astronauts)
  - Higher orbit (364 miles) than ISS – higher than any person has flown in two decades
  - Fully automated, but crew trained for 6 months to handle emergencies
  - Fundraising effort for St. Jude Children’s Research Hospital by billionaire Jared Isaacman
  - Services were purchased *from* NASA for communications, training, etc. (Not for ISS)
  - Future improvements
    - Wi-Fi from Starlink
    - Better toilet



- Consistent with new NASA expectations
  - Commercial interests to run all low earth orbit operations (including space stations)
  - NASA will purchase services as necessary and focus on deep space

# Experiments recently carried to ISS

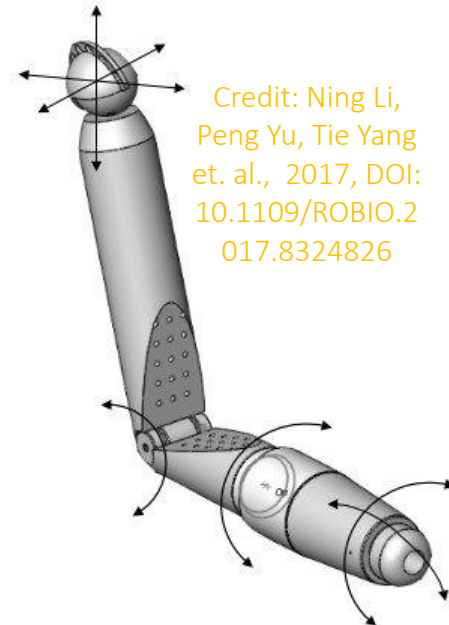
- 3D printing using simulated lunar regolith
  - Leading to habitat construction
- Small (1 meter) GITAI robot arm designed for space
  - Japanese startup company with an ambitious goal
    - Do all the work in space after the launch companies get us there!
  - 8 degrees of freedom + whatever is in the attached hand
  - Demo tasks like assembly and cabling in space
  - Mostly autonomous tests, some remote operation
  - Run inside Bishop airlock, by Nanoracks ground control



Credit: GITAI

- Bionic human arm for comparison (7 degrees of freedom):

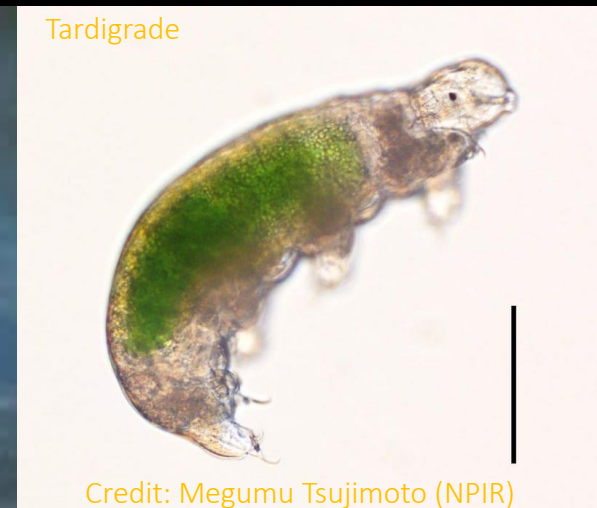
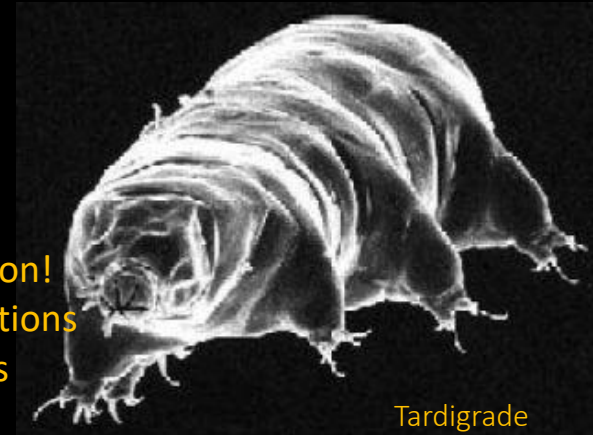
- Metal corrosion in space
- New CO2 scrubber technology (1 year test)
- Better heat dissipation for spacecraft
  - Heat shield tests in garbage when Cygnus cargo ship is filled with garbage and discarded in 3 months



Credit: Ning Li, Peng Yu, Tie Yang et. al., 2017, DOI: 10.1109/ROBIO.2017.8324826

# ISS biological experiments

- New automated labs reduce workload
- Biological studies in microgravity/high radiation
  - Effects on human muscle growth/loss
  - Effects on bone tissue growth (prevent spaceflight bone loss)
  - Plant germination and growth (for agriculture in space)
  - Effects on squid (microbes for immune system/digestion)
  - Effects on tardigrades
    - Can survive 30 years without food or water!
    - We already knew tardigrades can survive outer space, despite low temperature, low pressure, low gravity, lack of O<sub>2</sub>, and high radiation!
    - Watch adaptation and gene activation in tardigrades over 4 generations
    - May learn ways to protect food, medicine, & people from extremes
  - Effects on brine shrimp, ants, slime molds



# Lunar-related news: Continuing Artemis HLS saga

- Artemis: “Back to the Moon to stay”
  - American boots on the ground in 2024
  - Includes HLS (Human Landing System)
  - HLS awarded to SpaceX using Starship
  - HLS derailed by lawsuit from Blue Origin
  
- NASA threw a bone to losers in HLS competition
  - \$146 M to the 3 teams originally competing for HLS
  - “Appendix N” pays for studies for landings after Artemis 3
    - Concepts, risks, etc.



# Mars-related news

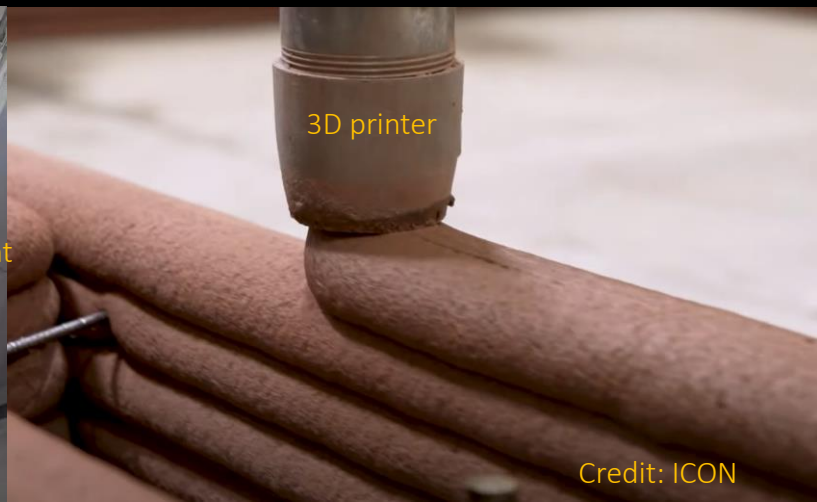
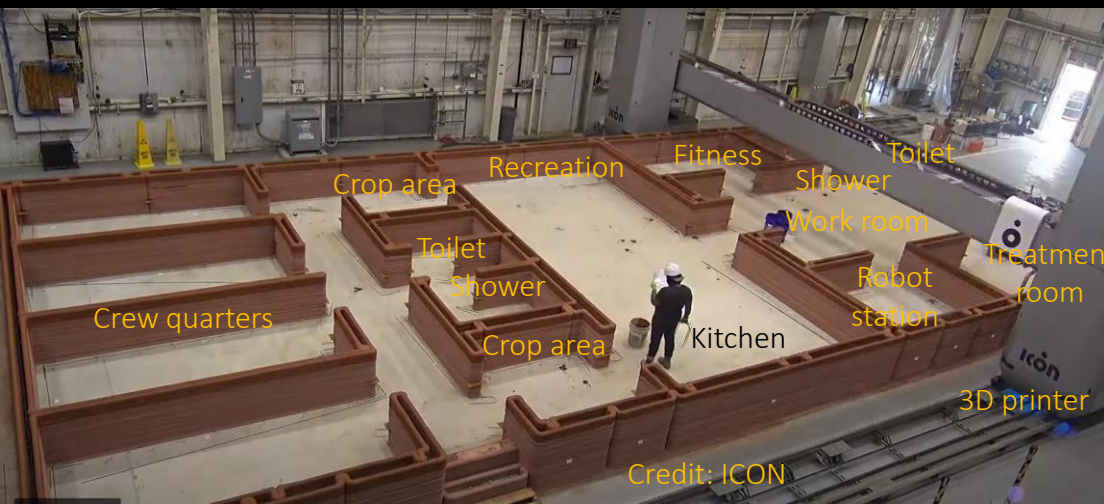
- You just missed signing up for NASA's latest simulated Mars habitat ("Analog")
- Other past and future Mars habitat analogs



# NASA simulated Mars mission: CHAPEA “Crew Health And Performance Exploration Analog”

Mars Dune Alpha Conceptual Render: Visualization on Mars. Credit: ICON

- Simulated Mars habitat (“analog”) at JSC
  - 1,700 sq.ft. 3D printed module by ICON, designed by BIG
  - Printer extrudes Lavacrete (Portland cement + lava) using H2O. Mars application should melt local regolith
- Each of 3 missions will have 4 crew members, starting in Fall 2022
  - Applications for crew for the first 1 year mission just closed Sept 17
  - Future missions in 2024 and 2025
- Testing physical operations, human behavior, food systems
  - Simulated resource limitations, equipment failure, communication delays, etc.
  - Simulated spacewalks using Virtual Reality



# Some other Moon/Mars “analog”, mostly on hold

- Mars Society

- MDRS: Mars Desert Research Station (Utah)
- Arctic Research Station (northern Canada) (to 2017)

- NASA HI-SEAS (Mauna Loa, Hawaii)

- Hawaii Space Exploration Analog and Simulation
- Was for Mars, will do lunar station simulation

- NEK facility/SIRIUS missions (Moscow)

- Can be sealed airtight/pressurized, unlike most others
- Russia’s Mars500 project (2007-2011)
- Last mission 2019, more planned

- China’s “Mars Camp” (Gobi desert)

- 1734 acres, including a tourism center, near Jinchang
- Tourism, will eventually do some astronaut training

- China’s Mars Village (Tibet plateau) (Tourism)

- Some other past/current projects

- Biosphere 2. Focus: ultimate sustainability/biology
- D-Mars, MELISSA (ESA), HERA, HMP, LSSIF, Lunar Palace 1, Lunaris, NEEMO



# Future Mars habitat analogs

- Mars Science City (Dubai, 2022-2024)
  - Had been delayed by land acquisition issues
  - Now moving ahead
  - Tourist/research split is unclear
- SAM: Space Analog for the Moon and Mars (University of Arizona)
  - Sealed habitat for 1-4 people and plants, in construction, not fully funded yet
  - Starts with refurbished 480 m<sup>3</sup> Biosphere 2 test module (near Tucson, AZ)
  - Adds adjacent workshop, living quarters, kitchen, common area, airlock, ½ acre yard, 30 ft. synthetic lava tube, gravity offset rig to simulate low G, pressure suits, simulated regolith, CO2 scrubber, ...
  - Studying a realistic transformation from mechanical life support to more biology
    - Greenhouse, farming, transforming regolith to soil, recycling air, water, food, waste management
  - Computer models will be developed in publicly-available SIMOC (free on the web)



# How many launches since the last meeting (Sept 4)?

*This includes failed launches only if they lift off the launch pad and only includes launches that attempt going into orbit*



SpaceX Starlink launch from Vandenberg Space Force Base, on Falcon 9, long exposure photo. Credit: SpaceX

# Launches since last meeting (Sept 4, 2021)

 Sept 6 – Long March 4C – Earth observation satellite

 Sept 9 – Long March 3B – TV broadcasting satellite

 Sept 9 – Soyuz 2-1v – Classified military satellite

 Sept 13 – Falcon 9 – 51 Starlink (internet) satellites (now 1520 total)

 Sept 14 – Soyuz – 34 OneWeb internet service satellites (now 322 total)

 Sept 15 – Falcon 9 – Inspiration4 (first all-private orbital tour)

 Sept 20 – Long March 7 – Resupply ship to dock with Chinese space station

 Sept 27 – Kuaizhou 1A – Earth observation satellite

 Sept 27 – Long March 3B – Classified satellite (FAIL)

 Sept 27 – Atlas 5 – Landsat 9 Earth observation satellite, 4 small rideshares

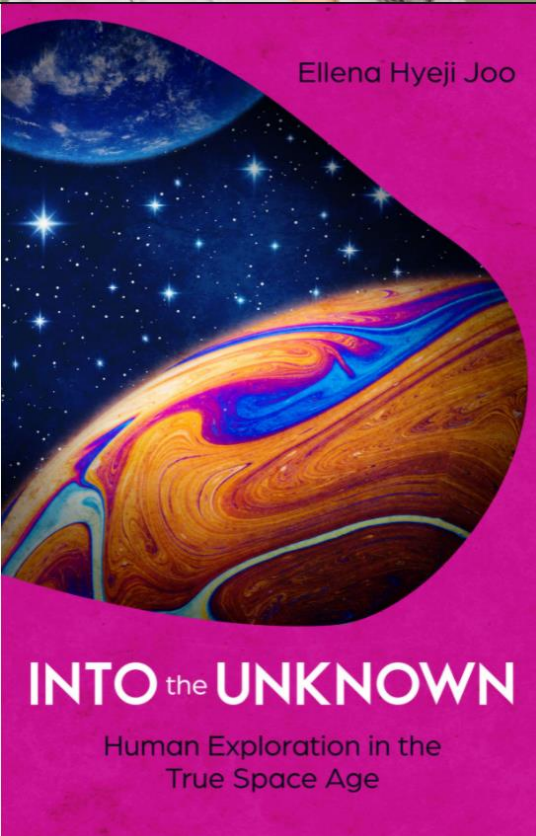
Discussion & questions?



# Featured speaker: Ellena Hyeji Joo



- TOPIC: Into the unknown: human exploration in the true space age
- Thoughts on humanity's long range future in space, our values, what happens when we meet aliens, and how to prepare for that



- Grew up in 4 different countries, fluent in 5 languages
- BS in Foreign Service in International Politics (Georgetown University)