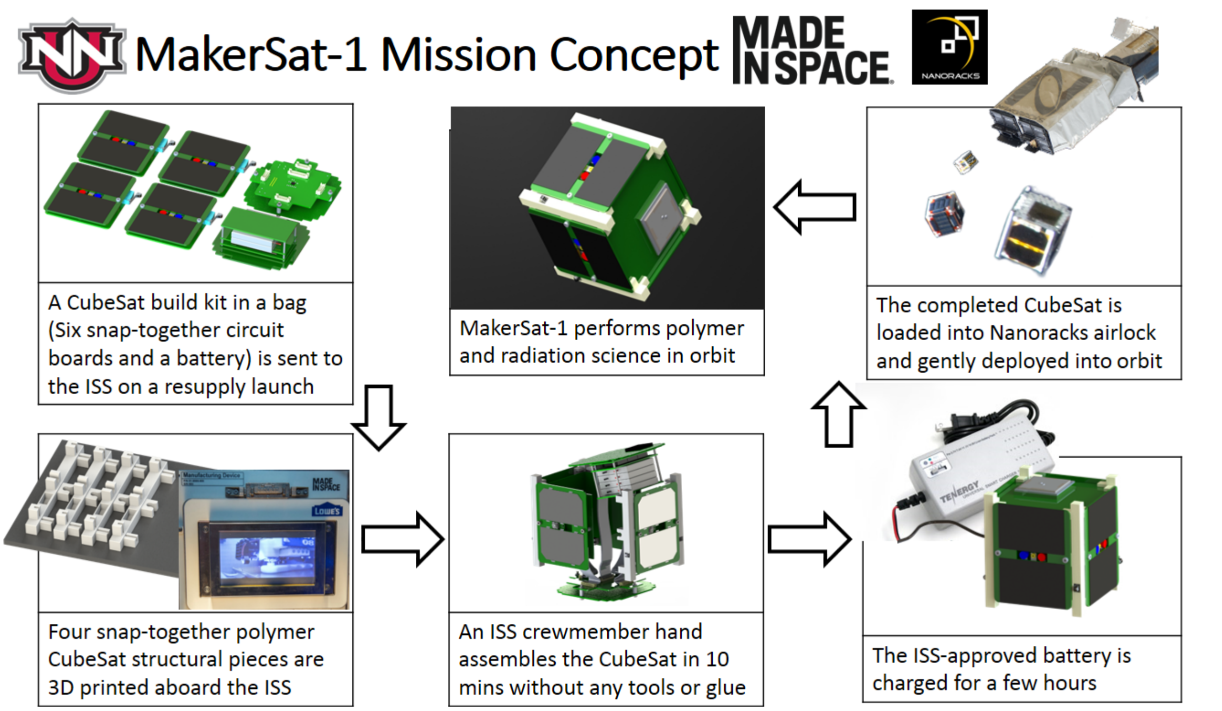
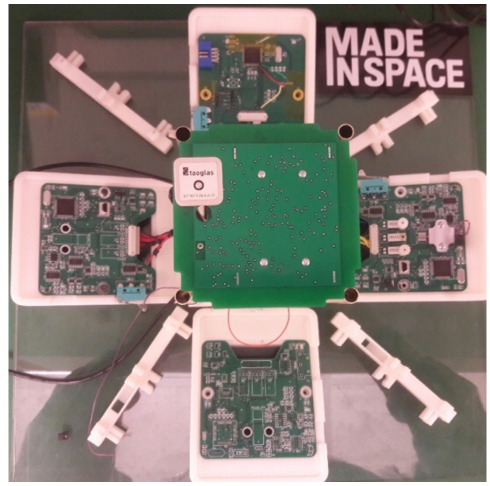


Mission Purpose:

MakerSat-1 is a technology proof-of-concept mission to demonstrate microgravity additive manufacturing, assembly, and deployment of a CubeSat from the International Space Station.

MakerSat-1 is the first spacecraft explicitly designed to be 3D-printed aboard the ISS, easily and safely snap-assembled by the astronaut crew in only 5 minutes without tools or fasteners, and then gently deployed directly into orbit from the ISS. Its structural frame was 3D-printed in August 2017, using the Additive Manufacturing Facility (AMF) printer aboard the ISS. Six circuit boards/batteries are being sent to ISS on a July 2019 re-supply flight to permit the crew to finish snap-together assembly, and battery charging. MakerSat-1 will be launched on a SpaceX Falcon 9 vehicle where it will be transported onto the ISS. It will then be deployed from the SEOPS deployment system onboard the Cygnus spacecraft hatchdoor which will be released from the ISS.



MakerSat-1 utilizes four 3D printed frame rails that slide and snap securely together with six solar panel circuit board assemblies (shown above) and an ISS-approved LiPo battery.

Primary Mission Data:

Spacecraft structural 3D polymers in the extreme environment of orbit will be exposed to outgassing in vacuum, extreme temperatures, ultraviolet and ionizing radiation, monoatomic oxygen plasma erosion, and even micrometeorites. All of these environmental conditions tend to erode the mass and strength of these plastics at varying rates, depending on their material properties.

Therefore, MakerSat-1 has a polymer mass loss experiment to determine whether Nylon, ABS, PLA, or PEI/PC Ultem is the most robust material with which to 3D print spacecraft. Small half gram samples of these plastics are mounted on the end of vibrating piezoelectric microcantilevers, whose natural frequencies will be continuously measured for the entire mission lifetime to detect milligram-level mass losses of these plastics caused by the harsh orbital environment.

These four plastic samples and a non-eroding brass control sample are directly exposed to the space environment through a window in the satellite exterior. These cantilevers are excited by a small vibration motor over a range of frequencies from 40-100Hz, to allow precise measurement of their natural resonant frequencies. Significant mass loss degradation is expected for ABS and PLA, with much less expected for Nylon and PEI Ultem.

<u>By studying the real-time degradation of 3D printed polymer structures in space, we will allow good material choices to be made for future 3D printed spacecraft and large space structures, such as those planned for the “Archinaut” orbiting robotic 3D printer and assembler.</u>

<u>Data will be collected over the entire orbital life of the spacecraft.</u>

Auxilliary Mission:

The EyeStar Simplex radio on MakerSat-1 was previously successfully operated on four previous cubesats: MakerSat-0 Nov. 2017, TSAT, and Globalstar Experiment and Risk Reduction Satellites (GEARRS1 and GEARRS2). GEARRS1 was deployed from the ISS and verified the Globalstar CDMA protocol. GEARRS2 was launched in 2015 into a 350 by 700 km orbit and the Simplex communication operated well for 9 months.

The initial orbital results from the recently FCC-licensed and launched MakerSat-0 Globalstar radio (with integrated transmit killswitch and identical to the MakerSat-1 radio for which licensing is currently being sought) show that more research and learning about this radio comm technique for future cubesats is still needed.

Comms:
The 1U MakerSat-1 cubesat has been designed with a similar communication system to previously successful GlobalStar-enabled cubesat missions. It has a low-power 1.6GHz bent-pipe downlink via the GlobalStar constellation to their ground stations around the world.

It also has a 2.4GHz uplink receiver that is only used to receive a potential kill command from the US-based (Indiana) NearSpaceLaunch (NSL) ground station, should the FCC request to shut the satellite's 1.6GHz transmitter off.

The downlink 1.6GHz frequency is proprietary to Globalstar around the world. The transmitter is interlocked with an earth horizon detector, so that it is only able to transmit upward toward the GlobalStar constellation when its horizon detector sees no earth image in its view.

Restated, the transmitter will only transmit upward away from earth toward the GlobalStar constellation. Also, the kill command will only be transmitted from earth to satellite upon FCC request and only over the Indiana NSL ground station.