Automated Reconfigurable Mission Adaptive Digital Assembly Systems **(ARMADAS)**

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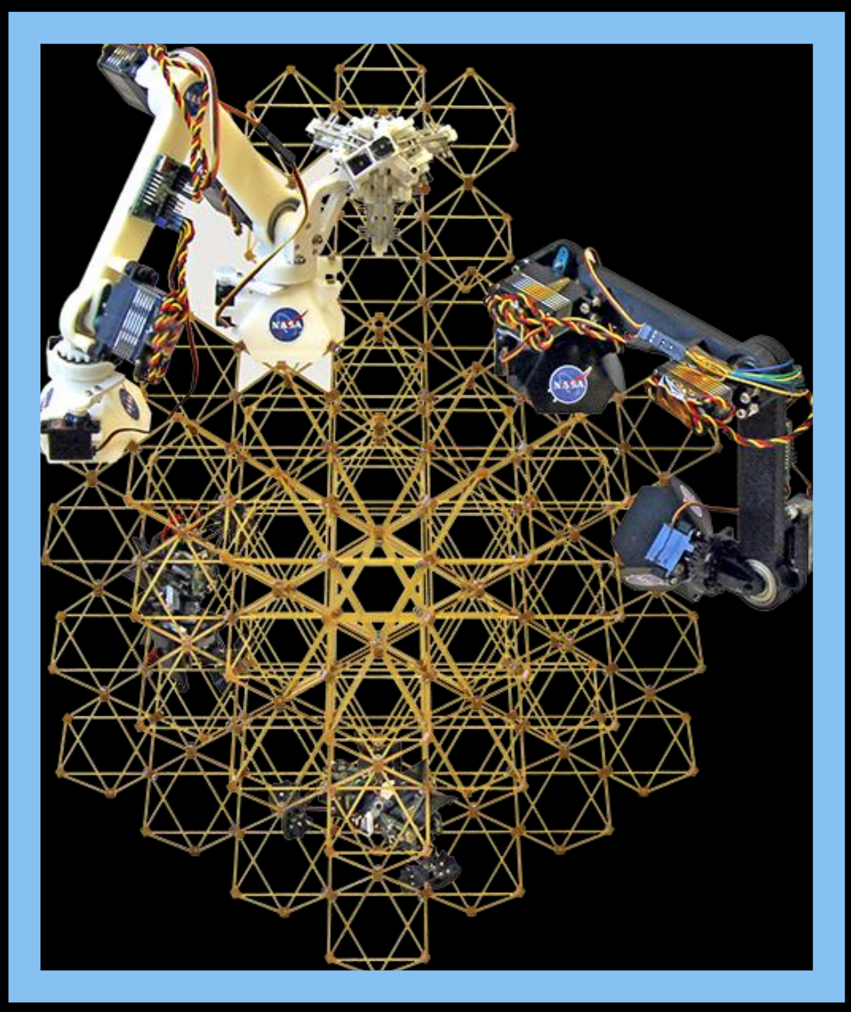
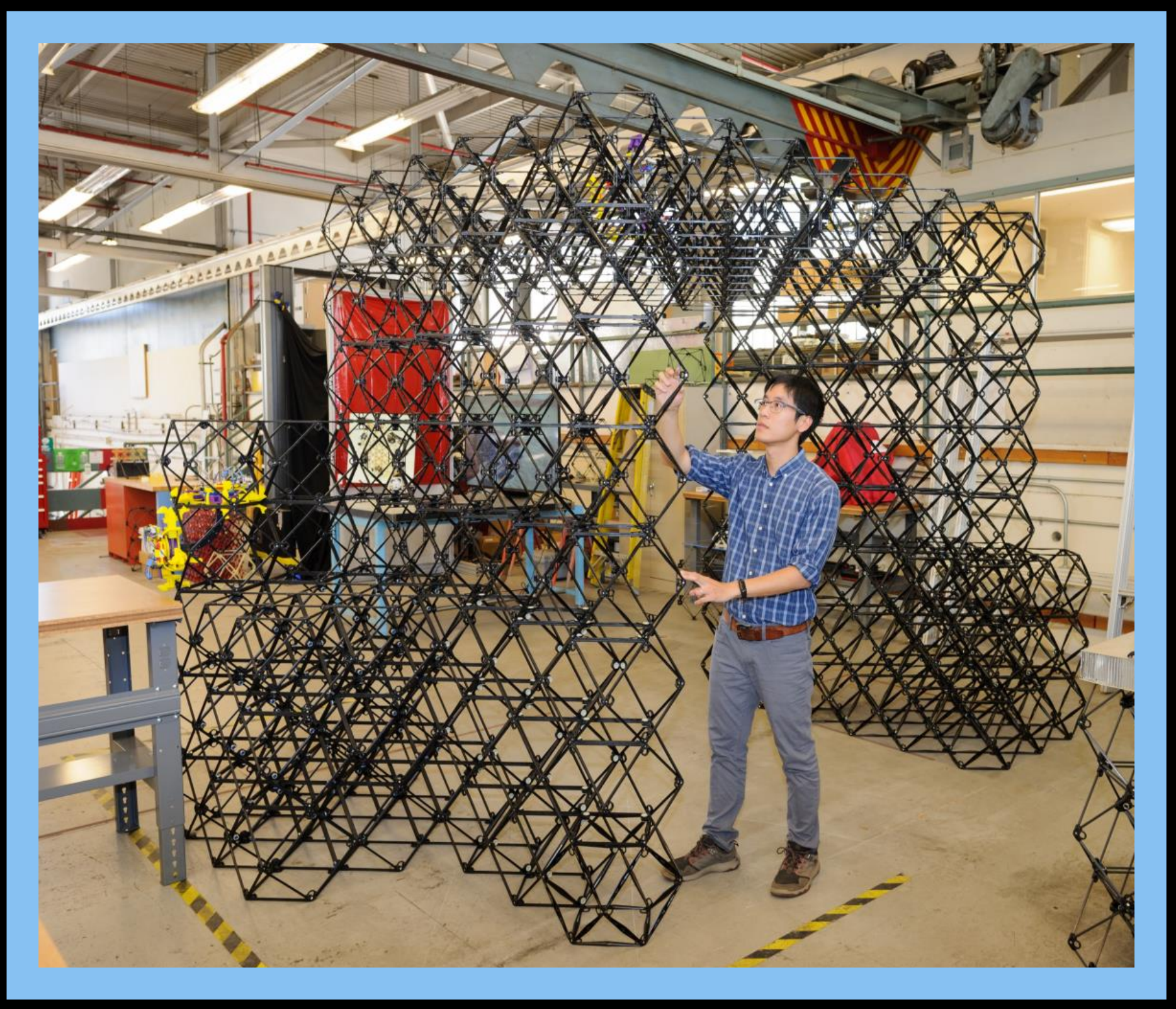
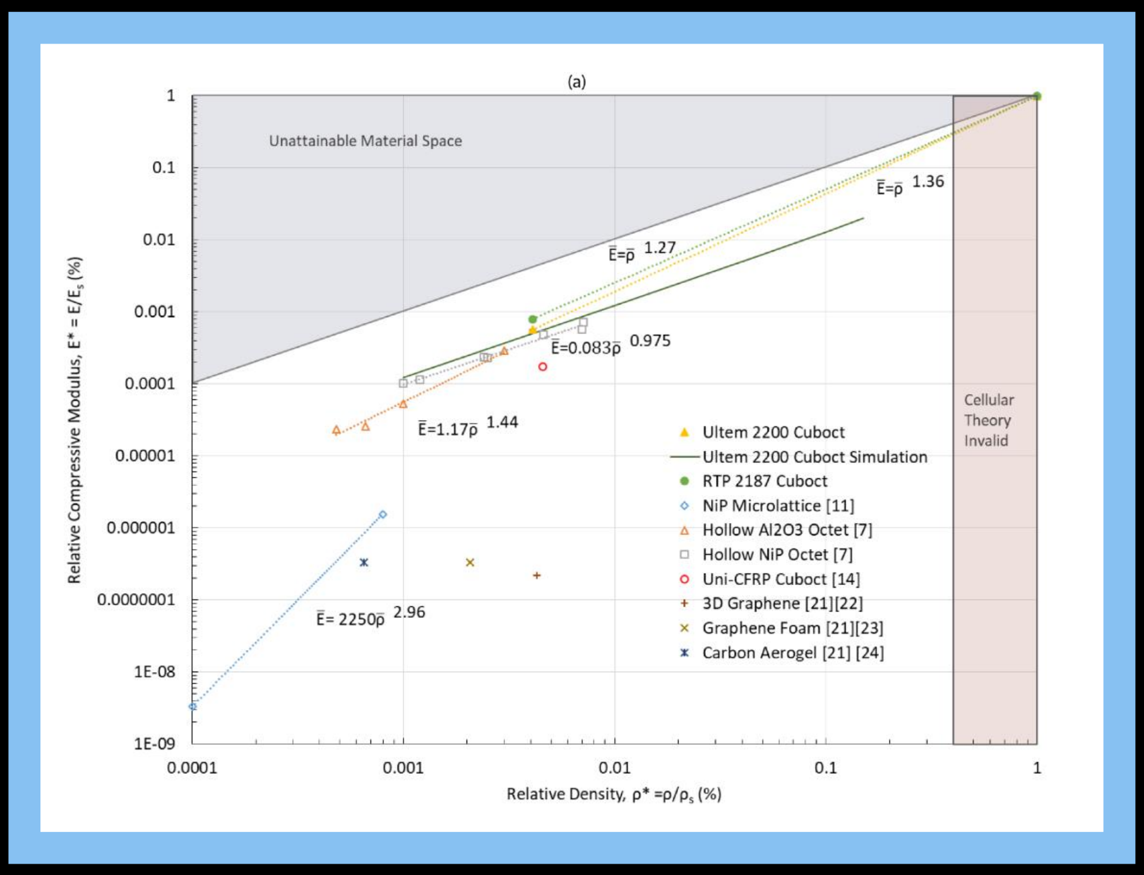
Autonomous Lunar Infrastructure

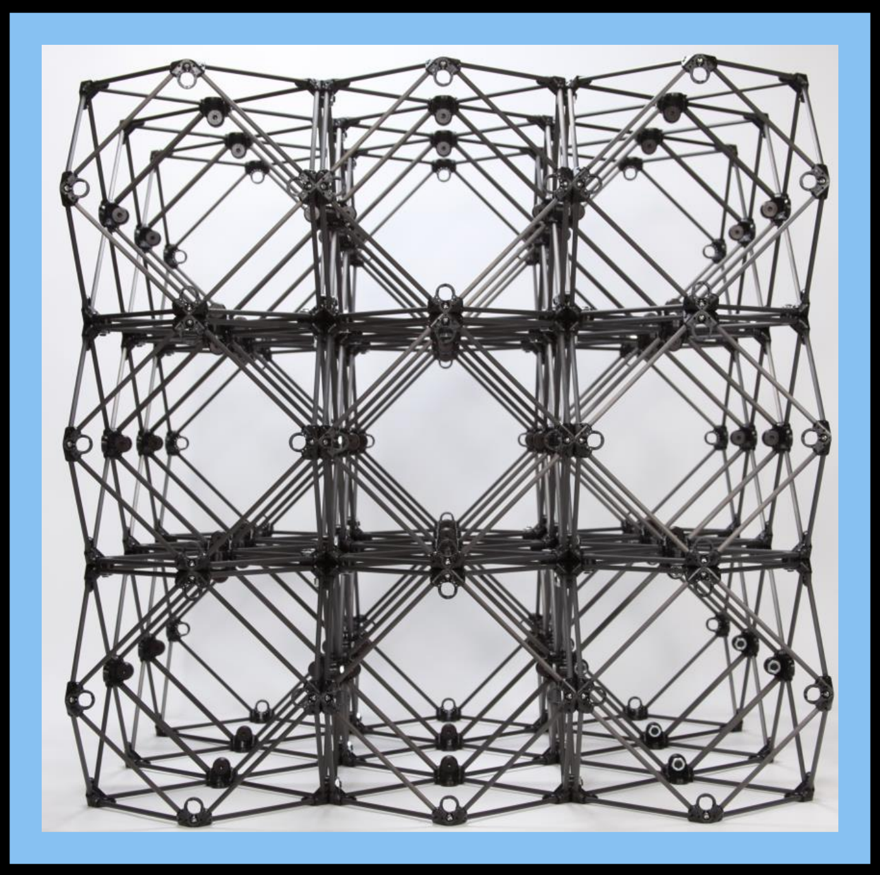
To meet the needs of future deep space exploration, NASA is interested in large-scale hardware systems in the agency's thrust areas of solar power, communications, habitats and science interests. Scalable in-space assembly of physical systems is critical to massless exploration and in-space reliance goals. The ARMADAS project demonstrates autonomous assembly of digital materials and structures. This provides automation technologies with potential for meeting long duration and deep space infrastructure needs, such as construction and maintenance of long duration spaceport, surface infrastructure, and habitat scale systems. Project demonstrations to date include a system that can fit into a small satellite-sized payload, which automatically assembles into primary structures, such as a small habitat module or array/antenna, using onboard robotic assemblers.

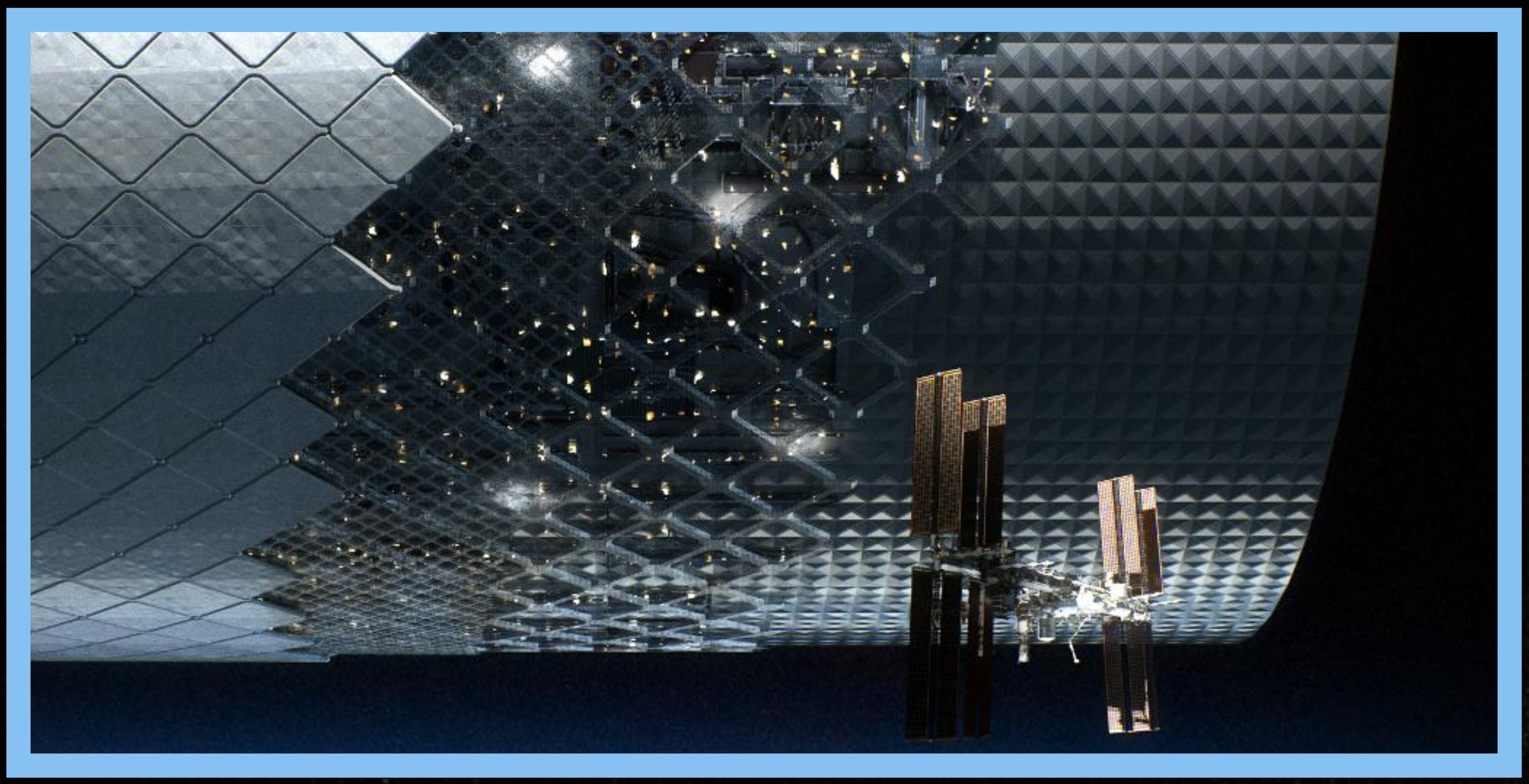
https://www.nasa.gov/directorates/spacetech/game_changing_development/projects/armadas











Discrete Programmable Metamaterials

These materials are composed of a finite set of types of modules as building blocks, with macro material properties that depend on the arrangement of these building blocks within the material. Modular and reconfigurable construction with reusability and interchangeability of components have been appreciated throughout technological history. The key philosophical idea behind discrete programmable metamaterials is that these systems can be engineered to be highly scalable and automated, through physical error correction mechanisms (similar to digital communication and computation algorithms). An example of general applications of this exponential manufacturing strategy is extremely high performing (specific strength and stiffness) ultralight lattice materials and structural systems that could find broad applications in aerospace systems.

Ultra-light Composite Materials

We show meso-scale, ultra-light (5.8 mg/cm3) fiber reinforced polymer composite lattice structures reversibly assembled from building blocks, manufactured with best-practice high-precision, high-repeatability, and high-throughput processes. Chopped glass fiber-reinforced polymer (polyetherimide) lattice materials produced with this method display absolute stiffness (8.41 MPa) and strength (19 kPa) typically associated with metallic hollow strut microlattices at similar mass density, and relative stiffness behavior exceeds all previously published examples of ultra-light materials. Additional benefits such as strain recovery, discrete damage repair with recovery of original stiffness and strength, and ease of modeling are demonstrated.

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