Improving shoes, showers, 3-D printing: Research launching to the space station

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Airbus workers unpack the Bartolomeo platform at NASA's Kennedy Space Center in Florida in preparation for its launch to the International Space Station. The platform, manufactured by Airbus Defence and Space, hosts multiple external payloads in low-Earth orbit. Credit: NASA

A variety of science investigations, along with supplies and equipment, launch to the International Space Station on the 20th SpaceX commercial resupply services mission. The Dragon cargo spacecraft is scheduled to leave Earth March 6 from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida. Its cargo includes research on particle foam manufacturing, water droplet formation, the human intestine and other cutting-edge investigations.

The space station, now in its 20th year of continuous human presence, provides opportunities for research by government agencies, private industry, and academic and research institutions. Such research supports Artemis, NASA's missions to the Moon and Mars, and leads to new technologies, medical treatments and products that improve life on Earth.

High-tech shoes from space

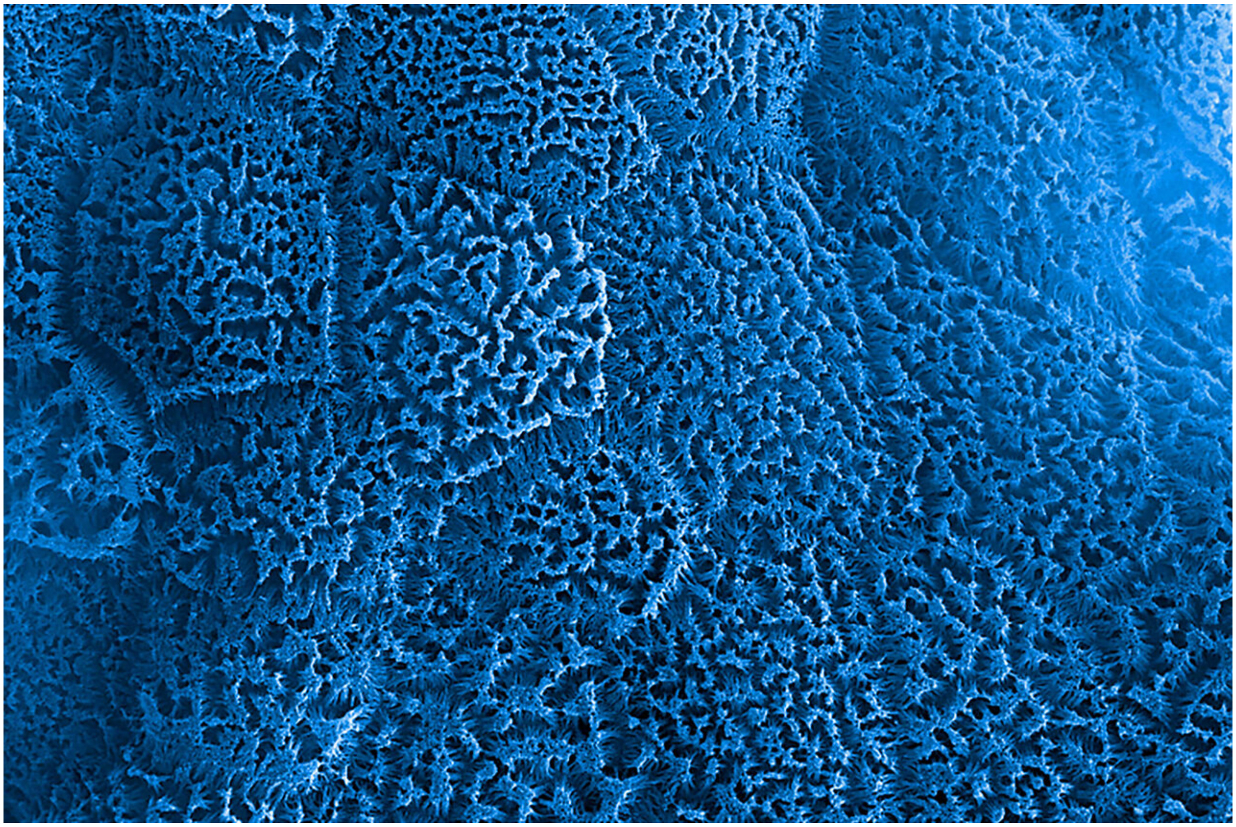
Particle foam molding is a manufacturing process that blows thousands of pellets into a mold where they fuse together. The shoe company Adidas uses this process to make performance midsoles, the layer between the sole of a shoe and the insole under your foot, for its products. The BOOST Orbital Operations on Spheroid Tesellation (Adidas BOOST) investigation looks at how multiple types of pellets behave in this molding process. Using one type of pellet creates a foam with the same properties throughout the sole component. Using multiple pellet types can allow engineers to change mechanical properties and optimize shoe performance and comfort. Removing gravity from the process enables a closer look at pellet motion and location during the process.

Results of this investigation could demonstrate the benefits of microgravity research for manufacturing methods, contributing to increased commercial use of the space station. New processes for particle foam molding could benefit a variety of other industries, including packaging and cushioning materials.

New facility outside the space station

The Bartolomeo facility, created by ESA (European Space Agency) and Airbus, attaches to the exterior of the European Columbus Module. Designed to provide new scientific opportunities on the outside of the space station for commercial and institutional users, the facility offers unobstructed views both toward Earth and into space. Experiments hosted in Bartolomeo receive comprehensive mission services, including technical support in preparing the payload, launch and installation, operations and data transfer and optional return to Earth. Potential applications include Earth observation, robotics, material science and astrophysics.

Airbus is collaborating with the United Nations Office of Outer Space Affairs to offer UN Member States the opportunity to fly a payload on Bartolomeo. Developing countries are particularly encouraged to participate, and the mission is devoted to addressing the UN's Sustainable Development Goals. Bartolomeo is named for the younger brother of Christopher Columbus.



Human intestine cells forming microvilli inside Emulate's Intestine-Chip. Credit: Emulate

Conserving water in the shower

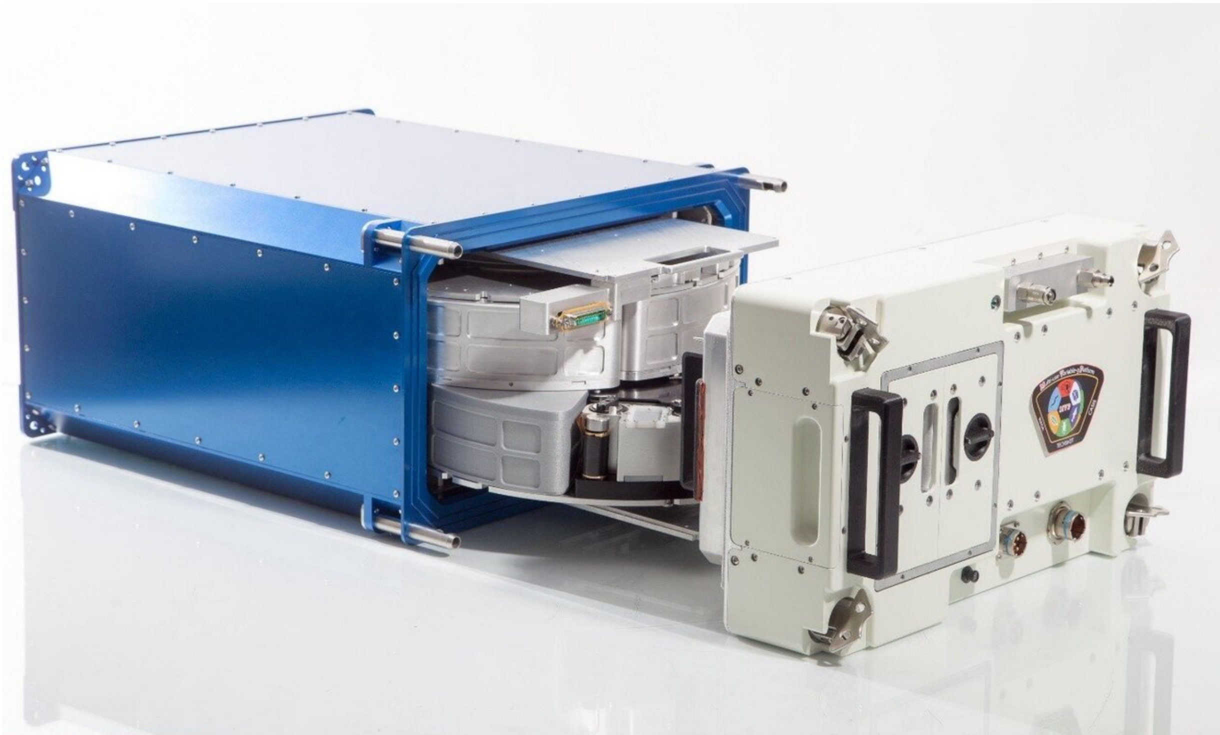
Droplet Formation Studies in Microgravity (Droplet Formation Study) evaluates water droplet formation and water flow of Delta Faucet's H2Okinetic showerhead technology. Reduced flow rates in shower devices conserve water, but also can reduce their effectiveness. That can cause people to take longer showers, undermining the goal of using less water. Gravity's full effects on the formation of water droplets are unknown, and research in microgravity could help improve the technology, creating better performance and improved user experience while conserving water and energy.

Insight gained from this investigation also has potential applications in various uses of fluids on spacecraft, from human consumption of liquids to waste management and use of fluids for cooling and as propellants.

Studying the human intestine on a chip

Organ-Chips as a Platform for Studying Effects of Space on Human Enteric Physiology (Gut on Chip) examines the effect of microgravity and other space-related stress factors on biotechnology company Emulate's human innervated Intestine-Chip (hiIC). This Organ-Chip device enables the study of organ physiology and diseases in a laboratory setting. It allows for automated maintenance, including imaging, sampling, and storage on orbit and data downlink for molecular analysis on Earth.

A better understanding of how microgravity and other potential space travel stressors affect intestine immune cells and susceptibility to infection could help protect astronaut health on future long-term missions. It also could help identify the mechanisms that underlie development of intestinal diseases and possible targets for therapies to treat them on Earth.



The Multi-use Variable-g Platform (MVP) used for the MVP Cell-03 experiment, shown with the MVP door removed and two carousels inside. Credit: Techshot, Inc.

Toward better 3-D printing

Self-assembly and self-replication of materials and devices could enable 3-D printing of replacement parts and repair facilities on future long-duration space voyages. Better design and assembly of structures in microgravity also could benefit a variety of fields on Earth, from medicine to electronics.

The Nonequilibrium Processing of Particle Suspensions with Thermal and Electrical Field Gradients (ACE-T-Ellipsoids) experiment designs and assembles complex three-dimensional colloids—small particles suspended within a fluid—and controls density and behavior of the particles with temperature. Called self-assembled colloidal structures, these are vital to the design of advanced optical materials, but control of particle density and behavior is especially important for their use in 3-D printing. Microgravity provides insight into the relationships among particle shape, crystal symmetry, density and other characteristics.

Functional structures based on colloids could lead to new devices for chemical energy, communication, and photonics.

Growing human heart cells

Generation of Cardiomyocytes From Human Induced Pluripotent Stem Cell-derived Cardiac Progenitors Expanded in Microgravity (MVP Cell-03) examines whether microgravity increases the production of heart cells from human-induced pluripotent stem cells (hiPSCs). HiPSCs are adult cells genetically reprogrammed back into an embryonic-like pluripotent state, which means they can give rise to several different types of cells. This makes them capable of providing an unlimited source of human cells for research or therapeutic purposes. For MVP Cell-03, scientists induce the stem cells to generate heart precursor cells, then culture those cells on the space station for analysis and comparison with cultures grown on Earth.

These heart cells or cardiomyocytes (CMs) could help treat cardiac abnormalities caused by spaceflight. In addition, scientists could use them to replenish cells damaged or lost due to cardiac disease on Earth and for cell therapy, disease modeling and drug development. Human cardiac tissues damaged by disease cannot repair themselves, and loss of CMs contributes to eventual heart failure and death.

Provided by NASA