INTERNATIONAL SPACE STATION

BENEFITS for Humanity

2022
**SCIENTIFIC BENEFITS**

The International Space Station is a robust scientific laboratory with dozens of research facilities, capabilities for autonomous research and monitoring, and an array of tools and observational instruments. At any one time, this microgravity lab hosts hundreds of investigations spanning every major scientific discipline from physics to microbiology.

A study analyzing the behavior of fluid during boiling in microgravity was conducted. This experiment, known as the Multiscale Boiling Investigation (RUBI), involved a very different type of bubble formation than on Earth. Boiling in microgravity takes place in slow motion and produces larger bubbles, allowing scientists to observe and measure effects that are too fast and too small on Earth and providing a more comprehensive understanding of heat transfer during boiling. This information could be applied to creating electronics such as laptops more efficiently.

**EXPLORATION BENEFITS**

The International Space Station is the ideal test bed for demonstrating and improving technologies needed to explore farther into space and to stay there longer. New power generation, air and water recycling, carbon dioxide removal, communications, and computing systems are among the exploration-enabling technologies being tested and proven on the station. Researchers also study how humans adapt to and work in space, grow plants in microgravity, and more.

Aging-like changes, including arterial thickening and stiffening, accelerate in many station crew members. The Canadian Space Agency (CSA) Vascular, Vascular Echo, and Vascular Aging experiments study these changes. Results could help researchers to develop effective countermeasures to maintain astronaut health on future long-duration missions.

Studies employing NASA's Veggie Production System help researchers identify the best methods for growing crops in space, providing fresh food security for future missions to the Moon and Mars. On Earth, the same principles can be applied to improve food production in remote environments.

**ECONOMIC BENEFITS**

The International Space Station nurtures a growing commercial space economy that includes commercial research, satellite services, and in-space manufacturing. Many of the tools and processes developed for use in space have launched new and thriving businesses on the ground, while growing participation of private entities in supporting station activities is helping to bring more commercial players into the space marketplace.

Using a magnetic field on the space station, the bioprinter also created thyroid gland tissue spheroids. This effort is part of the initiative to test the viability of commercial manufacturing of organs in orbit.

Researchers believe that optical fibers used for ultra-high-speed broadband communications and remote sensing could exhibit far superior qualities when produced in microgravity. Several studies, including the ISS National Laboratory-sponsored Optical Fiber Production in Microgravity, are putting this theory to the test, seeing whether low-Earth orbit can become the commercial manufacturing location of these fibers.

**SOCIEtal BENEFITS**

In addition to scientific discovery and exploration technologies, the International Space Station provides a unique vantage point at the edge of Earth’s atmosphere for monitoring climate change and provides benefits on Earth through spinoff technologies and inspiring future generations.

The Twins Study compared NASA astronaut Scott Kelly to his twin on Earth during a nearly year-long mission on the orbiter laboratory in order to examine fluid shifts in the body, changes in the structure of the eye, and other physical responses to long-term space flight.

Exploiter (NICER), a telescope helping unravel the mysteries of our universe, are also being used to reduce the size and complexity of computed tomography (CT) scanners. This technology could lead to CT scans that expose patients to less radiation and expand capabilities for remote doctors.

Millions of students around the world have participated in station downlinks and STEM programs, including Amateur Radio on the International Space Station (ARISS) events, Sally Ride EarthKam, StoryTime from Space, and numerous plant growth experiments. These programs help inspire the next generation of scientists.

A series of protein crystal growth (PCG) studies from the Japan Aerospace Exploration Agency (JAXA) have provided the precise structures of many proteins and could result in development of drugs to treat breast cancer, gum disease, and muscular dystrophy. A study of the protein structure associated with Duchenne Muscular Dystrophy (DMD) in particular has led to clinical trials of a drug that may slow the progression of DMD by half, potentially doubling the lifespan of many patients.
On November 2, 2020, the International Space Station entered its third decade of human-tended operation and science. The first decade of station was the decade of construction; the second decade, moving from initial research to full utilization. We are now in the decade of results.

During the past twenty years, the space station evolved from an outpost on the edge of space into a highly capable microgravity laboratory. Now results are compounding, new benefits are materializing, and the third decade is building on this previous work.

This orbiting laboratory enables researchers from around the world to take advantage of microgravity, exposure to space, and a unique perspective on Earth to conduct groundbreaking experiments through an environment made accessible by the space station. Although the International Space Station is a partnership between many nations, each with distinct goals, every partner shares a unified goal: to use this amazing laboratory for the betterment of humanity. With more than 20 years of experiments now conducted on the station, more breakthroughs are materializing than ever before.

Benefits for Humanity 2022 highlights the diversification of benefits stemming from microgravity research—for society, science, exploration, and the economy. This edition focuses on new areas of scientific study, future technologies for the exploration of the Moon and Mars, lives saved, and numerous companies and jobs created.

The International Space Station advances scientific understanding of our planet, improves human health, develops advanced technologies, and provides a space platform that inspires and educates the leaders of tomorrow—a legacy and influence that will be felt for decades to come.

For more information on the International Space Station Benefits for Humanity publication, including where to find the full publication, go to: https://www.nasa.gov/stationbenefits

The International Space Station Benefits for Humanity 2022 is a product of the International Space Station Program Science Forum (PSF), which includes the National Aeronautics and Space Administration (NASA), Canadian Space Agency (CSA), European Space Agency (ESA), Japan Aerospace Exploration Agency (JAXA), State Space Corporation ROSCOSMOS (ROSCOSMOS), and the Italian Space Agency (ASI).