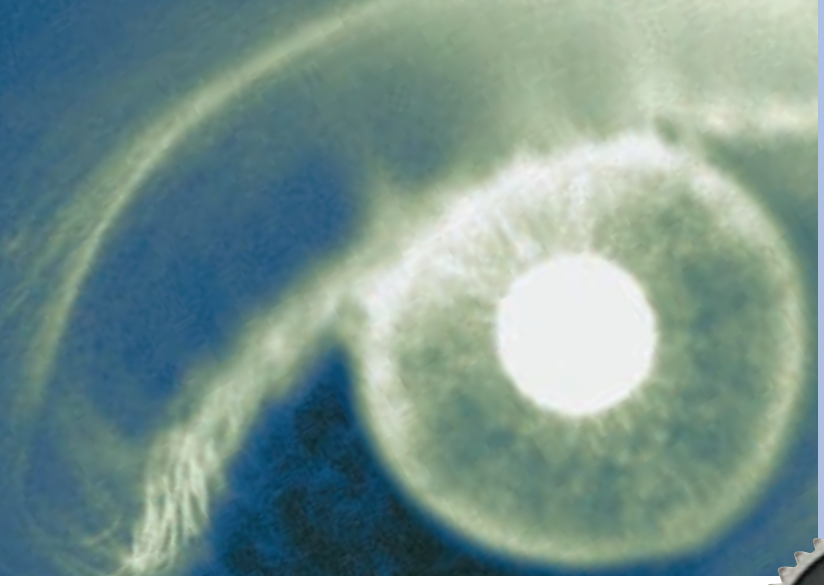

achieving a vision

Advanced Human Support Technology

JOHNSON SPACE CENTER
Space & Life Sciences Directorate

SPACE & LIFE SCIENCES DI

Earth may have its boundaries, but the potential of advanced human support research makes the future of our space program limitless.

life into space

To capitalize on the tremendous resources and opportunities presented by the space frontier, we must first protect life from the hostile environment beyond Earth's surface. Extreme cold, a nearly perfect vacuum, cosmic radiation, reduced gravity, and the threat of collision with other space objects make technology — advanced technology — a prerequisite for survival. The farther we venture from Earth, the more advanced, self-reliant, autonomous, and dependable our technology needs to be. The Space and Life Sciences Directorate at NASA's Johnson Space Center (JSC) in Houston, Texas leads this Nation's efforts to develop the expertise and capability to support our astronauts in space. The Directorate manages NASA's Advanced Human Support Technology (AHST) program, a program that integrates work performed at JSC, at other NASA centers, and by our academic and industrial affiliates. The AHST program is a research and development effort that encompasses Advanced Life Support, Advanced Extravehicular Activity Systems, Advanced Environmental Monitoring & Control, and Space Human Factors Engineering. This brochure is one in a series that explores NASA's multilateral activities in the space and life sciences.

advanced life support

The farther we venture from Earth, the greater challenge we face in acquiring a continual supply of air, food, and water. For future space travelers, resupply from Earth will be an impossibility; instead, they will need to stow an initial supply of resources from Earth, recycle these resources as efficiently as possible, and supplement their stores with food grown on board and elements derived from the space or planetary environments. A life support system that continually reuses the elements of its environment without resupply is called a closed-loop system. The Advanced Life Support program aims to develop safe, efficient, and effective closed-loop life support systems for space travel.

Future human bases elsewhere in the solar system will need to rely upon local resources for power, fuel, and even building materials. Concepts for Martian bases, such as the one pictured here, exploit this concept, which is known as in situ *resource utilization.*

Interplanetary travel and excursions on the Moon, Mars, and asteroids will require habitats with highly efficient recycling technologies. Traditional physical and chemical means of recycling air and water will work in concert with biological elements to form a complete environment

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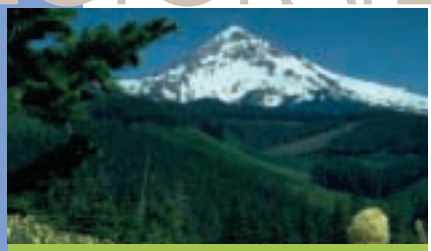


As we venture farther from Earth's surface, the technology required to keep us alive becomes increasingly complex. Climbers conquering Everest's peak must have protection from cold and carry their own food and oxygen. Likewise, International Space Station astronauts will need technology to sustain themselves in the harsh orbital environment. To an even greater degree than mountain climbers or space station crew, humans en route to Mars or asteroids will require new food production technologies; state-of-the art, human-machine interfaces; and automated, intelligent computer systems to monitor and control the spacecraft environment.

with little dependence on external resources. Specially engineered microorganisms will degrade waste products harmful to humans and provide usable substances such as nitrogen and oxygen. Plants will serve multiple functions, converting carbon dioxide into oxygen, recycling selected wastes as fertilizers, and supplying food for the crew. This complete approach to closed-loop life support, using what are known as "bioregenerative systems", reproduces, on a small scale, what our planet has done for billions of years — support life through a complex interaction of physical, chemical, and biological processes.

Getting Down to Earth

NASA purification technology that removes harmful microorganisms provides safe, drinkable, reclaimed water on board spacecraft. NASA recycling technology is also used to purify water in developing areas or in areas where natural disaster has contaminated the water supply with harmful bacteria.

extravehicular activity systems

When space crews venture outside their spacecraft, they carry a fully independent life support system with them. For a limited period of time, a space suit must provide all the life support systems necessary to sustain an astronaut in space or on a planetary surface. Designers of space suits for long-duration space flight face a number of unique challenges now being addressed by NASA's program in Advanced Extravehicular Activity (EVA) Systems.

Today's EVA systems are not suited for long-duration and planetary space travel for a variety of reasons. One drawback of current EVA systems is that they are too heavy and bulky to use in a gravity environment. Habitat construction and other surface operations will require EVA systems with a greater degree of mobility, dexterity, and length of use than are currently provided. Perhaps most significantly, space suits of the future should require less maintenance and yield an even higher degree of reliability than current space suits.

Tomorrow's space suits will require greater dexterity, ease-of-use, and lower maintenance than the suits used on the Shuttle and Station today.

Getting Down to Earth

Everyday, our Nation's firefighters use a technology initially developed for NASA. During lunar excursions, astronauts required a portable life support system that gave rise to the Improved Firefighters' Breathing System, an apparatus that protects the wearer's lungs from the damaging effects of smoke and heat.

NASA engineers will combine advances in environmental monitoring and life support systems with miniature technologies, exceptionally lightweight metal alloys, and other advanced materials to create singularly streamlined suit structures that will give astronauts the freedom of movement to complete such tasks as sample collection, geological surveying, and habitat maintenance.

environmental monitoring and control

Technologies such as the electronic nose use the natural world as a model of structure, function, and integration. The electronic nose is designed to detect minute changes in cabin air quality, much like the sensitive nose of a dog. As small as the microchip pictured here, the "e-nose" is an unobtrusive means to monitor the spacecraft environment.

The Advanced Environmental Monitoring and Control program will provide breakthrough technologies that will revolutionize how spacecraft environments are monitored and controlled. Advances are now being made in the field of nanotechnology — miniaturization of devices to a molecular scale — that will provide future spacecraft with integrated networks of sensors to assess the spacecraft environment. These sensors will result in automated adjustment of environmental parameters, eliminating the need for crew intervention. NASA officials are looking into the use of hybrid organisms that consist of genetically engineered biological components linked to nonbiological systems. Examples of hybrids include biological cells and computer chips fused to detect radiation (biochips), genetically engineered beetles for carrying sensors, and root-like plants that creep into surface cracks and pores to act as sealant.[1]

Spacecraft of the future will carry astronauts far from home. They will need efficient recycling technologies and sensitive environmental monitoring techniques to provide a safe and comfortable journey.

space human factors engineering

Advanced computing capabilities will make spacecraft of the future more "user-friendly" for astronauts as they travel months, even years, from home. Innovative human-machine interfaces, next-generation display technologies, and autonomous maintenance capabilities will free up astronaut time for scientific pursuits.

As our space missions become more frequent, involve travel farther from home, and last for longer periods of time, the already heavy demands placed on astronauts will increase accordingly. The Space Human Factors Engineering program is working to ensure that crews of the future will enjoy a comfortable and secure spacecraft environment. Researchers are applying their knowledge about the ways in which humans interact with their surroundings to spacecraft design, mission planning, and support from ground personnel.

The Space Human Factors Engineering program aims to make the spacecraft environment as natural and functional as possible. To accomplish this, program

personnel are exploring innovative human-machine interfaces that minimize complexity and maximize efficiency. An example of this is the Wireless Augmented Reality Prototype (WARP), a head-mounted display that projects a miniaturized image directly in front of the wearer's eye. The display can be used to access information, to read the latest novel, or to receive feedback on physical parameters of the spacecraft or astronaut herself.

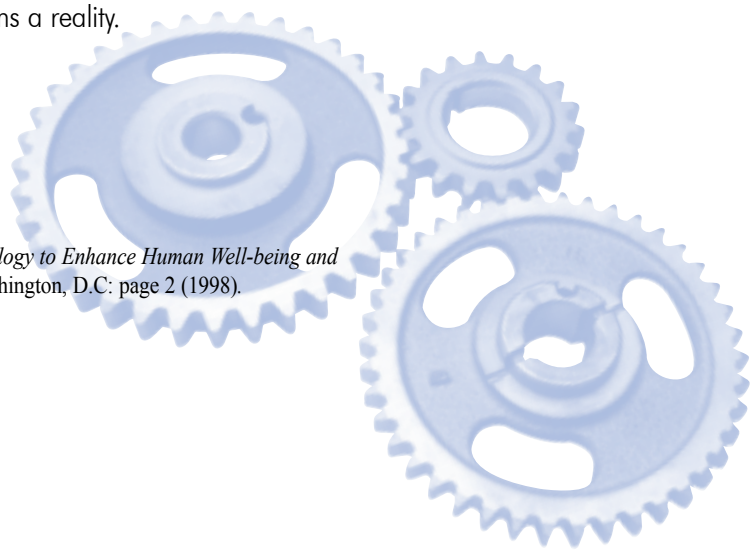
Getting Down to Earth

NASA has made great strides in wireless monitoring techniques. A wireless method originally used to monitor astronauts during space flight is now a valuable tool for hospitals to monitor patients from a central station.

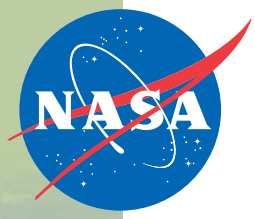
getting the research done

NASA employs a collaborative research approach, working with academic and industrial partners to capitalize on the most innovative thinking of our time. New theories and technologies are first developed through NASA's extensive ground-based research program, then thoroughly tested on the ground before being flown in space. The new International Space Station will serve as a human-tended, microgravity testbed for a variety of life support and environmental technologies. Projects ranging from individual environmental sensors to complete test habitats will be validated aboard the Station for future space missions.

Working together with our academic and industrial partners, NASA Johnson Space Center's Space and Life Sciences Directorate is making long-duration space flight safer, more comfortable, and more feasible than ever before. NASA's workforce is bringing together advances in life support, EVA systems, environmental monitoring, and human factors to make the vision of space flight more tangible. Today NASA and its partners are building the International Space Station; tomorrow we will develop commercial enterprises in Earth orbit and send travelers to Mars, to the asteroids, and beyond. Work done today in the Advanced Human Support Technology program is an integral element in making these dreams a reality.



[1]Space Studies Board, *Report of the Workshop on Biology-based Technology to Enhance Human Well-being and Function in Extended Space Exploration,* National Academy Press, Washington, D.C: page 2 (1998).



contact information

Johnson Space Center - homepage
http://www.jsc.nasa.gov/

The Office of Life and Microgravity Sciences and Applications - homepage
http://www.hq.nasa.gov/office/olmsa/

Biomedical Research and Countermeasures Program - homepage
http://www.hq.nasa.gov/office/olmsa/lifesci/biomed.htm

NASA Human Spaceflight
http://spaceflight.nasa.gov

International Space Station - science and research
http://spaceflight.nasa.gov/station/science/index.html

The International Space Station - *Research Plan* online
http://www.hq.nasa.gov/office/olmsa/ISS/cover.htm

National Space Biomedical Research Institute - homepage
http://www.nsbri.org/

Life Sciences Data Archive
http://lsda.jsc.nasa.gov

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