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Living and Working in Space

The more we know about the universe, the more we learn about ourselves. Every NASA mission embodies the spirit of discovery. The following information will provide a glimpse of how astronauts live their daily lives while learning about the unknown.

Health and Hygiene

Zero gravity and a sunrise every 90 minutes can disrupt an astronaut's health, both physically and mentally. The crew must combat motion sickness, claustrophobia and homesickness every day. They also must be prepared for any medical emergencies that may arise.

Astronaut Peggy A. Whitson, Expedition 5 flight engineer, cuts Cosmonaut Sergei Y. Treschev's hair in the Zvezda Service Module on the International Space Station. Treschev holds a vacuum device the crew has fashioned to catch freshly cut hair, which is floating freely.

Astronauts don't have to worry about germs like on Earth; the only germs aboard the space shuttle or the International Space Station are the ones they take with them. But that doesn't mean they won't get sick. Zero gravity causes the fluids in your body to rise to your head, which feels like a constant head cold.

Astronauts are required to exercise two hours per day, using the treadmill or stationary bicycle, to avoid the bone and muscle deterioration that occurs in zero gravity. Without this exercise, astronauts would be unable to walk or stand up when they return to Earth after months of floating in space.

Astronaut N. Jan Davis spends a moment of her off-duty time aboard the Space Shuttle Discovery *brushing her hair. Davis, payload commander, never strayed far from the payload operations checklist, seen attached to the nearby middeck wall.*

The crew typically gets eight hours of sleep time after a 16-hour mission day. Just like on Earth, astronauts can have dreams and snore. The excitement and anxiety of being in space, motion sickness and noise from the station or other crew members can disrupt sleeping patterns. Each astronaut gets a sleep mask and ear plugs to block out noise and light.

Astronauts take sponge baths daily, using two washcloths, one for washing and one for rinsing, and use rinseless shampoo to wash their hair. Water and soapsuds stick to the skin in weightless conditions, and excess water is suctioned into the wastewater tank. Toothpaste can be swallowed or sucked out, like in the dentist's office.

The air quality on the shuttle and the station is vital to the astronauts. Without oxygen, the crew would get fatigued, black out and die. The Environmental Control and Life Support System (ECLSS) aboard the station creates oxygen using electrolysis. This

process uses solar-panel-generated electricity to split water into hydrogen gas and oxygen gas, just like photosynthesis occurs on Earth. The hydrogen is then vented into space.

The ECLSS must also remove the ammonia, acetone and carbon dioxide gases, produced by the astronauts, as well as any gases produced by the experiments. NASA scientists are currently working on a plant-based system to replace the mechanical process.

Water is constantly recycled aboard the station. A Russian-built water processor takes the humidity and condensation from the air and turns it into drinking and bathing water.

Housing

The space shuttle has three decks: the flight deck, the middeck (living quarters) and the life support and housekeeping deck. The middeck is four meters long and 2.7-3.7 meters wide. The crew eats, sleeps, bathes and plays here. The area has a toilet, a washbasin, a galley with an oven, lockers, bunk beds and the airlock that leads to the cargo bay.

On the space station, the crew members have a little more space, even though most of it is taken up by experiments. The Zvezda Service Module is the primary living quarters for the astronauts and houses the galley, refrigerator/freezer, exercise equipment, sleeping cabin, toilet, washbasin and a kitchen table.

Using the bathroom without gravity is a different experience. The toilet aboard the space station doesn't require flushing because it has fans that suck air and urine through the funnel and hose into the wastewater tank.

Astronaut C. Michael Foale, Expedition 8 mission commander and NASA ISS science officer, floats in front of the galley in the Zvezda Service Module on the International Space Station as he fills a Crew Healthcare System Water Microbiology in-flight analysis bag from the potable water dispenser.

The toilet is composed of the toilet bowl and the urine funnel (gray tube). The astronauts position themselves on the toilet seat using leg-restraints and thigh-bars. The toilet works like a vacuum cleaner with fans that suck air and waste into the commode. Each astronaut has a personal urinal funnel, which has to be attached to the hose's adapter. Fans suck air and urine through the funnel and hose into the wastewater tank; no flushing is needed.

Food containers are disposable and eating utensils and trays are cleaned using moist sanitizing towelettes, eliminating the need for a dishwasher or kitchen sink. The galley is a modular unit that heats and rehydrates food and beverages.

Astronaut Edward T. Lu, Expedition 7 NASA ISS science officer and flight engineer, eats a meal in the Zvezda Service Module on the International Space Station.

Lockers house the astronauts' personal belongings, including personal hygiene items, clothing, books, CDs and anything else they brought for the trip.

Sleeping can be a problem when you are weightless. Astronauts must strap themselves down when they sleep to avoid bumping into things. Station and shuttle crews have sleeping bags that can be attached to a seat or the wall. On the shuttle, there are four sleep sacks. Other crew members can sleep in the commander's seat or the pilot's seat or can attach themselves to the wall.

Astronaut Paul W. Richards, STS-102 mission specialist, is pictured in the Zvezda Service Module in front of one of the sleep stations.

Instead of sleep sacks, there are two crew cabins aboard the station, each accommodating one person. When there is a third crew member and the commander allows everyone to sleep at one time, the astronauts can sleep anywhere in the station, as long as they attach their sleeping bags to something.

Communication

When astronauts need to phone home from the space station, they use the Softphone via a laptop computer. The system uses Internet Protocol (IP) information packets to route the signals and, when connected, astronauts can use the computer keypad to dial any number and call anyone they wish. They speak through a headset with a microphone. The distance can mean there is a time lag of up to one second in conversations. Standard IP phone systems would disconnect with such a delay, so the Softphone the astronauts use is

Cosmonaut Yuri I. Malenchenko, Expedition 7 mission commander, uses a communication system in the Zvezda Service Module on the International Space Station.

modified for the station. Astronaut television interviews show that same one-second lag. Other inconveniences may include lack of service due to the satellite being out of range or the station blocking the signal. A new digital tool called the Orbital Communications Adapter allows high-speed data transfers and carries voice and video signals, allowing astronauts to send e-mails to coworkers and family.

When astronauts and cosmonauts leave Earth, they also have amateur, or HAM, radio as a constant companion. Since its first flight in 1983, HAM radio has flown on more than two dozen shuttle missions. Dozens of astronauts have used the Space Shuttle Amateur Radio Experiment, or SAREX, to talk to thousands of kids in school and to their families on Earth while they were in orbit. They have pioneered space radio experimentation, including television, text messaging and voice communication. The Russians had a similar program for the cosmonauts aboard the Russian space station Mir. When U.S. astronauts were aboard Mir in preparation for the long missions on the station, they used amateur radio for communication, including emergency messaging while Mir was in distress.

Working

Space shuttle and space station crews put in a lot of overtime when they are in space. The average workday for an astronaut in space is 16 hours, and they are on call 24 hours a day.

The shuttle crew's activities include conducting experiments, assembling the station and maintaining the shuttle while in space. The shuttle crews also conduct missions that involve the release, capture or repair of satellites. The shuttle's average flight time is two and a half weeks, a short time in comparison to the six to nine months Expedition crews spend on the station.

The station crew's main purpose is to conduct research, take part in medical experiments and maintain the station. Each Expedition crew has its hands full with new and continuing experiments in two labs: the U.S. Destiny Laboratory Module and the Zvezda Service Module. Two other experiment modules will be added: the Japanese Experiment Module and the European Columbus Laboratory Module. Each lab module houses several experiments researching bioastronautics, spaceflight, physical and Earth sciences, space biology and space product development.

Astronauts also conduct ongoing experiments on themselves. Monitoring the stresses of extended microgravity and its effects, the station crews will help predict and prevent any adverse, long-term effects that would harm future crews on deep space missions to Mars and beyond.

Maintaining the station is a full-time job in itself. The crew is constantly checking the station systems, cleaning air filters and updating computer equipment to keep it in good condition. The crew also has to be ready for emergency repairs, spacewalks and trash duty.

Astronaut Edward T. Lu, Expedition 7 NASA ISS science officer and flight engineer, performs routine maintenance on an extravehicular mobility unit spacesuit in the Quest airlock on the International Space Station.

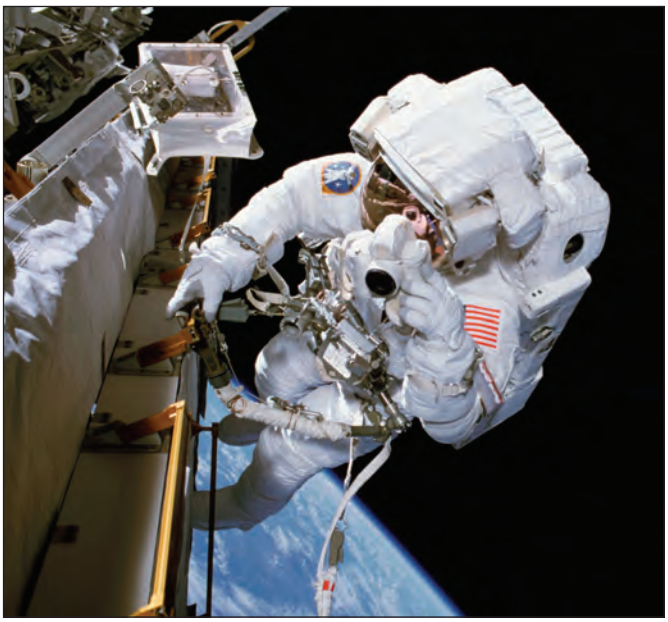
If something breaks or requires new parts on the station, the crew can't take it to a repairman or call a tow truck. The astronauts have to be ready to diagnose and repair the station at a moment's notice. Decays in the station cabin's atmospheric pressure (leaks) must be tracked down, isolated and fixed.

Communication interference or loss must be reestablished. Power must be restored, and sometimes these minor crises could call for a spacewalk.

Spacewalks require astronauts to float more than 200 miles above the Earth in pressurized suits. The station spacesuits have been modified from the shuttle's extravehicular mobility unit, allowing more movement, versatility and usage.

Before going out into space or putting on the spacesuit, the spacewalker must decompress to avoid "the bends." Decompression sickness occurs when nitrogen bubbles form in the bloodstream or tissues. Decompression consists of a 2-hour and 20-minute pre-breathe protocol involving high-intensity exercise and breathing pure oxygen. This is similar to the process scuba divers must follow after a deep sea dive.

Station astronauts begin the pre-breathe protocol by exercising vigorously on the station's cycle ergometer for 10 minutes while breathing pure oxygen via an oxygen mask. After 50 minutes of breathing pure oxygen, including the 10 minutes initially spent exercising, the pressure in the station's airlock will be lowered to 10.2 pounds per square inch (psi). During airlock depressurization, the spacewalkers will breathe pure oxygen for an additional 30 minutes. At the end of those 30 minutes, with the airlock now at 10.2 psi, the spacewalkers will put on their spacesuits. Once their spacesuits are on, the spacewalkers will breathe pure oxygen inside the suits for an additional 60 minutes before making final preparations to leave the station and begin their spacewalk. Astronauts follow a repressurization protocol after the spacewalk.



Astronaut Donald R. Pettit, Expedition 6 NASA ISS science officer, uses a camera after performing P-1 Truss launch lock releases on the International Space Station during a spacewalk.

An Astronaut's Day in Space

On weekdays, the astronauts keep busy with their daily routine of experiments, planning, meals and exercise.

A typical day is planned with Mission Control. The timeline below demonstrates the strict time schedule astronauts follow:

- An average day on the station starts with breakfast, personal hygiene, housecleaning and checking the daily schedule on a laptop computer.
- Next, blood samples are drawn for analysis later in the day and a daily conference is conducted with Mission Control to make sure everyone knows what is scheduled throughout the day.
- A routine air quality check is taken and the crew begins work on allotted experiments.
- Later, another air quality check is done and the crew hits the treadmill and exercise bike for a two-hour daily exercise regimen. The entire crew then meets for lunch in the Zvezda Service Module.
- After lunch, the crew receives a one-hour break and then it's back to work, doing routine maintenance on the station, conducting research and working on experiments.
- Afterward, the cabin's air pressure is checked and the crew does a few more laps on the treadmill.
- Next, tasks are finished, experiments cleaned and station systems checked.
- The crew then eats and has another daily planning conference to prepare for the next day.
- Finally, the crew has free time to get ready for bed and rest for the next busy day ahead.

On the weekends, the crew does housecleaning and works on the station's miscellaneous to-do list.

Exploration of Space Accelerates Innovation on Earth

The definition of living in space has changed dramatically since earlier spaceflight missions.

During the Mercury Program (1961-63), the first six astronauts in space accumulated less than 54 collective mission hours. The longest Apollo mission (Apollo 17) lasted 12 days, 13 hours and 52 minutes. The longest space shuttle mission (STS-80, 1996) lasted 17 days, 15 hours and 53 minutes. The Skylab's longest residential duration was 84 days, and the Expedition 7 crew lived on the space station for over six months.

The station has provided several insights into the effects of zero gravity on the human body, information that is vital to human spaceflight and long-term space travel.

Plans for colonization of the moon and Mars will move the duration into years and, perhaps one day, into generations.

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