2F - All Systems Go- NASA- Based Motivating Speech Activities

Are you puzzled about motivating challenging middle school boys and other clients? This program will discuss NASA's amazing educational materials for teachers and how to adapt them for speech activities at preschool, school age, middle school, high school and adult levels.

Speech pathologist, Marlene Schoenberg, will share her firsthand experience visiting NASA's Mission Control and studying clear pragmatics used to talk to astronauts in space. Problem-solving games (based on “The Martian”) will provide new ideas for conversations with older students. As we discuss science materials for speech activities, we will collaborate on expanding ways to teach such

**After this session, the participant will be able to:**

1. Review resources available for teachers through the NASA website.
2. Brainstorm on creating motivating games for students at different levels.
3. Create problem-solving scenarios for discussion with middle school and high school students to practice speech sound carry over in an exciting context.
4. Combine vocabulary development and polysyllabic word pronunciation for science-related words to carryover into classroom curriculum.
5. Explore NASA phrases to increase better pragmatics, goal setting collaboration and self-esteem in students.

**Marlene Schoenberg, Director of Speech/Language Pathology, Ethnic Communication Arts**

Marlene Schoenberg, Ed.M. CCC/SP is the program director at Ethnic Communication Arts, a multicultural speech/language consulting firm in St. Paul. She has worked with both adults and children at St. Paul Rehab Center and St. John's Hospital and provided home speech therapy for adults for Health East and for children through Kidspeak. Her master's degree in Communication Disorders is from Boston University and she taught at Inver Hills and Century Colleges. She recently presented at NASA in Houston.
Distance to the Moon
Students calculate the distance between scale models of Earth and the moon.

Fermi Telescope Teacher Resources
Use online activities, downloadable lesson plans, educator guides and other educational resources to teach about black holes and the Fermi Gamma-Ray Telescope.

Field Trip to the Moon Informal Educator Guide
The Field Trip to the Moon Educator Guide calls for participants to use inquiry-based learning and team-building to develop an understanding of complex systems as they work in teams to design a self-sufficient lunar station.

Field Trip to the Moon: LRO/ILCROSS Edition Informal Educator Guide
This edition of the Field Trip to the Moon guide includes hands-on activities related to two of NASA's precursor missions.
Field Trip to the Moon Informal Educator Guide

Product Type: Educator Guide
Audience: Educators, Informal Education
Grade Levels: 3-8
Publication Year: 2007
Product Number: EG-2007-09-121-MSFC
Subjects: Earth Science, General Science, Life Science, Space Science, Technology

After watching the Field Trip to the Moon DVD, participants continue their lunar exploration with workshop activities that investigate the moon’s habitability and sustainable resources. These activities culminate with plans for the design and creation of a lunar station. Working in groups, each team receives one of six topics to investigate: ecosystem, geology, habitat, engineering, navigation or medical.

Field Trip to the Moon Informal Educator Guide [5MB PDF file]

Watch the introduction to the Field Trip to the Moon DVD.

Related materials:
Field Trip to the Moon Companion Guide
Field Trip to the Moon: LRO/LCROSS Edition Informal Educator Guide
Field Trip to the Moon Educator Guide

> Budgets, Strategic Plans and Accountability Reports
> No Fear Act
> Information-Dissemination Policies and Inventories
> Freedom of Information Act
> Privacy Policy, Accessibility and Other Notices
> NASA Advisory Council
> Aerospace Safety Advisory Panel
> Inspector General Hotline
> Office of the Inspector General
> NASA Communications Policy
> Contact NASA
> Site Map
> BusinessU
> USA.gov
> Open Gov
> NASA
> Help and FAQ

Page Last Updated: December 10th, 2014
Page Editor: Flint Wild
NASA Official: Brian Dunbar
humans' return to the moon. Topics include lunar landforms and spacecraft design.

Genesis: Science Modules
The Genesis mission provides educational modules and classroom materials for educators teaching grades K-12. Topics include chemistry, solar system origins and more.

Heat and Temperature From the Cosmic Classroom
This module introduces the concepts of heat and temperature, heat transfer, and detection.

High Energy Astrophysics Science Archive Research Center
HEASARC is a multimission, astronomy archive for the X-ray and gamma-ray wave bands. The education pages have lesson plans, classroom activities, images and background material.

IMAGE Education Center Archive of Classroom Activities
Browse an archive of more than 100 teacher-tested lesson plans about solar events, Earth's magnet field, and space weather.

Imagine Mars Project
The Imagine Mars Project is a hands-on, STEM-based project that asks students to imagine and design a community on Mars, then express their ideas through the arts and humanities while integrating 21st Century skills.

Imagine the Universe: Educators' Corner
Download lesson plans, posters and activity booklets to teach students about the electromagnetic spectrum, stars and objects outside the solar system.
One-Year Crew (/content/one-year-crew/index.html)

March 1, 2016
RELEASE 16-023

NASA Astronaut Scott Kelly Returns Safely to Earth after One-Year Mission

NASA astronaut and Expedition 46 Commander Scott Kelly and his Russian counterpart Mikhail Korienko enjoy the cold fresh air back on Earth after their historic International Space Station.

Credits: NASA TV

NASA astronaut and Expedition 46 Commander Scott Kelly and his Russian counterpart Mikhail Korienko returned to Earth Tuesday after a historic 340-day mission aboard the International Space Station. They landed in Kazakhstan at 11:26 p.m. EST (10:26 a.m. March 2 Kazakhstan time).

Joining their return trip aboard a Soyuz TMA-18M spacecraft was Sergey Volkov, also of the Russian space agency Roscosmos, who arrived on the station Sept. 4, 2015. The crew touched down southeast of the remote town of Dzhezkazgan.

“Scott Kelly’s one-year mission aboard the International Space Station has helped to advance deep space exploration and America’s Journey to Mars,” said NASA Administrator Charles Bolden. “Scott has become the first American astronaut to spend a year in space, and in so doing, helped us take one giant leap toward putting boots on Mars.”

During the record-setting One-Year mission (http://www.nasa.gov
(from!l), the station crew conducted almost 400 investigations to advance NASA's mission and benefit all of humanity (http://www.nasa.gov/press-release/nasa-book-shows-how-space-station-research-offers-benefits-for-humanity-0). Kelly and Kornienko specifically participated in a number of studies to inform NASA's Journey to Mars (http://www.nasa.gov/eye on Mars), including research into how the human body adjusts to weightlessness, isolation, radiation and the stress of long-duration spaceflight. Kelly's identical twin brother, former NASA astronaut Mark Kelly, participated in parallel twin studies (http://www.nasa.gov/twins-study/) on Earth to help scientists compare the effects of space on the body and mind down to the cellular level.

One particular research project examined fluid shifts (http://www.nasa.gov/content/fluid-shifts-study-advances-journey-to-mars) that occur when bodily fluids move into the upper body during weightlessness. These shifts may be associated with visual changes and a possible increase in intracranial pressure (http://www.nasa.gov/content/t-s-all-in-your-head-nasa-investigates-techniques-for-measuring-intracranial-pressure-u), which are significant challenges that must be understood before humans expand exploration beyond Earth's orbit. The study uses the Russian Chibis (http://www.nasa.gov/sites/default/files/thumbnails/image/jsc2015e046469_alt.jpg) device to draw fluids back into the legs while the subject's eyes are measured to track any changes. NASA and Roscosmos already are looking at continuing the Fluid Shifts investigation with future space station crews.

The crew took advantage of the unique vantage point of the space station, with an orbital path that covers more than 90 percent of Earth's population, to monitor and capture images (http://www.nasa.gov/content/one-year-crew-image-gallery) of our planet. They also welcomed the arrival of a new instrument to study the signature of dark matter (http://www.nasa.gov/mission_pages /station/research/news/calte/r) and conducted technology demonstrations that continue to drive innovation, including a test of network capabilities for operating swarms of spacecraft (http://www.nasa.gov/feature/nasa-small-satellites-to-demonstrate-swarm-communications-and-autonomy).

Kelly and Kornienko saw the arrival of six resupply spacecraft during their mission. Kelly was involved in the robotic capture of two NASA-contracted cargo flights — SpaceX's Dragon during the company's sixth commercial resupply mission and Orbital ATK's Cygnus during the company's fourth commercial resupply mission. A Japanese cargo craft and three Russian resupply ships also delivered several tons of supplies to the station.

Kelly ventured outside the confines of the space station for three spacewalks during his mission. The first included a variety of station upgrade tasks, including routing cables to prepare for new docking ports for U.S. commercial crew spacecraft (http://www.nasa.gov/commercialcrew). On a second spacewalk, he assisted in the successful reconfiguration of an ammonia cooling system and restoration of the station to full solar power-generating capability. The third spacewalk was to restore functionality to the station's Mobile Transporter system.

Including crewmate Gennady Padalka, with whom Kelly and Kornienko launched on March 27, 2015, 13 astronauts and cosmonauts representing seven different nations (the United States, Russia, Italy, Japan, Denmark, Kazakhstan and England) lived aboard the space station during the yearlong mission.

With the end of this mission, Kelly now has spent 520 days in space, the most among U.S. astronauts. Kornienko has accumulated 516 days across two flights, and Volkov has 548 days on three flights.

Expedition 47 continues operating the station, with NASA astronaut Tim Kopra in command. Kopra, Tim Peake of ESA (European Space Agency) and Yuri Malenchenko of Roscosmos will operate the station until the arrival of three new crew members in about two weeks. NASA astronaut Jeff Williams and Russian cosmonauts Alexey Ovchinin and Oleg Skripochka are scheduled to launch from Baikonur, Kazakhstan, on March 18.

The International Space Station is a convergence of science, technology and human innovation that enables us to demonstrate new technologies and make research breakthroughs not possible on Earth. It has been continuously occupied since November 2000 and, since then, has been visited by more than 200 people and a variety of international and commercial spacecraft. The space station remains the springboard to NASA's next giant leap in exploration, including future missions to an asteroid and Mars.

For more information about the one-year mission, visit:

http://www.nasa.gov/oneyear (http://www.nasa.gov/oneyear)

For more information about the International Space Station and its crews, visit:

http://www.nasa.gov/station (http://www.nasa.gov/station)

-end-

3/23/2016 7:38 AM
1. What will the astronaut take on his Space Trip?

Toothbrush or dental floss?
Screw driver or Glue?
Broom or dustpan?
Trapeze or backpack?
Mousetrap or hairspray?
Cloth laundry bag or plastic?
Brother or his sister?
Comb or a hairbrush?
An Apron or a helmet?
A flare or slippers?
A whistle or a glow stick?
What will the astronaut eat on the Space Station?

1. White bread or brown bread?
2. A grapefruit or bran for breakfast?
3. A soft drink or a cold drink of water?
4. Green beans or grapes with lunch?
5. Grilled cheese or waffles and applesauce for lunch?
6. Sloppy joes or apple pie?
7. Freeze pops or fruit for dessert?
8. Cookie crumbs or cream cheese and crackers?
9. Brussels sprouts or cauliflower?
10. Crunchy chips or tater tots with dinner?

Marlene Schoenberg, Ed.M. ccc/sp
Speech/Language Pathologist
Ethnic Communication Arts
ethcom@winternet.com
MAE C. JEMISON (M.D.)
NASA ASTRONAUT (FORMER)

PERSONAL DATA: Born October 17, 1956, in Decatur, Alabama, but considers Chicago, Illinois, to be her hometown. Recreational interests include traveling, graphic arts, photography, sewing, skiing, collecting African Art, languages (Russian, Swahili, Japanese), weight training, has an extensive dance and exercise background and is an avid reader. Her parents, Charlie & Dorothy Jemison, reside in Chicago.

EDUCATION: Graduated from Morgan Park High School, Chicago, Illinois, in 1973; received a bachelor of science degree in chemical engineering (and fulfilled the requirements for a B.A. in African and Afro-American Studies) from Stanford University in 1977, and a doctorate degree in medicine from Cornell University in 1981.

ORGANIZATIONS: Member, American Chemical Society, Association for the Advancement of Science, Association of Space Explorers. Honorary Member, Alpha Kappa Alpha Sorority. Board Member, World Sickle Cell Foundation, American Express Geography Competition. Honorary Board Member, Center for the Prevention of Childhood Malnutrition. Clinical Teaching Associate, University of Texas Medical Center.


EXPERIENCE: Dr. Jemison has a background in both engineering and medical research. She has worked in the areas of computer programming, printed wiring board materials, nuclear magnetic resonance spectroscopy, computer magnetic disc production, and reproductive biology.

Dr. Jemison completed her internship at Los Angeles County/USC Medical Center in July 1982 and worked as a General Practitioner with INA/Ross Loos Medical Group in Los Angeles until December 1982.

From January 1983 through June 1985, Dr. Jemison was the Area Peace Corps Medical Officer for Sierra Leone and Liberia in West Africa. Her task of managing the health care delivery system for U.S. Peace Corps and U.S. Embassy personnel included provision of medical care, supervision of the pharmacy and laboratory, medical administrative issues, and supervision of medical staff. She developed curriculum and taught volunteer personal health training, wrote manuals for self-care, developed and implemented guidelines for public health/safety issues for volunteer job placement and training sites. Dr. Jemison developed and participated in research projects on Hepatitis B vaccine, schistosomiasis and rabies in conjunction with the National Institute of Health and the Center for Disease Control.

On return to the United States, Dr. Jemison joined CIGNA Health Plans of California in October 1985 and was working as a General Practitioner and attending graduate engineering classes in Los Angeles when selected to the astronaut program.

NASA EXPERIENCE: Dr. Jemison was selected for the astronaut program in June 1987. Her technical assignments since then have included: launch support activities at the Kennedy Space Center in Florida; verification of Shuttle computer software in the Shuttle Avionics Integration Laboratory (SAIL); Science Support Group activities.

Dr. Jemison was the science mission specialist on STS-47 Spacelab-J (September 12-20, 1992). STS-47 was a cooperative
mission between the United States and Japan. The eight-day mission was accomplished in 127 orbits of the Earth, and included 44 Japanese and U.S. life science and materials processing experiments. Dr. Jemison was a co-investigator on the bone cell research experiment flown on the mission. The *Endeavour* and her crew launched from and returned to the Kennedy Space Center in Florida. In completing her first space flight, Dr. Jemison logged 190 hours, 30 minutes, 23 seconds in space.

Dr. Jemison left NASA in March 1993.

MARCH 1993

This is the only version available from NASA. Updates must be sought direct from the above named individual.
KAREN L. NYBERG (PH.D.)
NASA ASTRONAUT

Pronunciation: CARE-in NIGH-burg

PERSONAL DATA: Born on October 7, 1969. Her hometown is Vining, Minnesota. Married. One child. Recreational interests include running, sewing, drawing and painting, backpacking, piano, and spending time with her family. Dr. Nyberg’s parents, Kenneth and Phyllis Nyberg, still reside in Vining.


SPECIAL HONORS/AWARDS: University of North Dakota Sioux Award (2009), University of Texas Outstanding Young Engineering Graduate Award (2009); University of Texas Outstanding Young Mechanical Engineer Award (2008), University of North Dakota Young Alumni Achievement Award (2004); Space Act Award (1993); NASA JSC Patent Application Award (1993); NASA Tech Briefs Award (1993); NASA JSC Cooperative Education Special Achievement Award (1994), Joyce Medalson Society of Women Engineers Award (1993-94); D.J. Robertson Award of Academic Achievement (1992); University of North Dakota School of Engineering and Mines Meritorious Service Award (1991-1992). Recipient of numerous scholarships and other awards.

EXPERIENCE: Graduate research was completed at The University of Texas at Austin BioHeat Transfer Laboratory where she investigated human thermoregulation and experimental metabolic testing and control, specifically related to the control of thermal neutrality in space suits.

NASA EXPERIENCE: Co-op at Johnson Space Center from 1991-1995, working in a variety of areas. She received a patent for work done in 1991 on Robot Friendly Probe and Socket Assembly. In 1998, on completing her doctorate, she accepted a position with the Crew and Thermal Systems Division, working as an Environmental Control Systems Engineer.

Selected as a mission specialist by NASA in July 2000, Dr. Nyberg reported for training in August 2000. Following the completion of two years of training and evaluation, she was assigned technical duties in the Astronaut Office Station Operations branch where she served as Crew Support astronaut for the Expedition 6 crew during their six-month mission aboard the International Space Station. Dr. Nyberg has since served in the Space Shuttle branch, the Exploration branch, and as Chief of the Robotics branch. She completed her first spaceflight in 2008 on STS-124, and logged more than 13 days in space. Dr. Nyberg is currently serving as a flight engineer aboard the station for Expedition 36.

SPACE FLIGHT EXPERIENCE: STS-124 Discovery (May 31 to June 14, 2008) was the 123rd space shuttle flight, and the 26th shuttle flight to the International Space Station. STS-124 was launched from the Kennedy Space Center, Florida, and docked with the space station on June 2 to deliver the Japanese Experiment Module-Pressurized Module (JEM-PM) and the Japanese Remote Manipulator System. STS-124 shuttle astronauts delivered the 37-foot (11-meter) Kibo lab, added its rooftop storage room and conducted three spacewalks to maintain the station and to prime the new Japanese module’s robotic arm for work during nine days docked at the orbiting laboratory. STS-124 also delivered a new station crew member, Expedition 17 Flight Engineer Greg Chamitoff. He replaced Expedition 16 Flight Engineer Garrett Reisman, who returned to Earth with the STS-124 crew. The STS-124 mission was completed in 218 orbits, traveling 5,735.643 miles in 13 days, 18 hours, 13 minutes and 7 seconds.

Expedition 35/36 to the International Space Station - On May 28, 2013, Dr. Nyberg launched aboard the Soyuz TMA-09M from the Baikonur Cosmodrome in Kazakhstan to the International Space Station along with Russian cosmonaut Fyodor Yurchikhin and European Space Agency (ESA) astronaut Luca Parmitano. They are the only the second crew ever to dock to the space station the same day they left Earth. They were welcomed aboard by Expedition 35 Commander Pavel Vinogradov and Flight Engineers Alexander Misurkin of Roscosmos and NASA astronaut Chris Cassidy.
Nine Real NASA Technologies in 'The Martian'

Mars has held a central place in human imagination and culture for millennia. Ancients marveled at its red color and the brightness that waxed and waned in cycles over the years. Early observations through telescopes led some to speculate that the planet was covered with canals that its inhabitants used for transportation and commerce. In “The War of the Worlds”, the writer H.G. Wells posited a Martian culture that would attempt to conquer Earth. In 1938, Orson Welles panicked listeners who thought they were listening to a news broadcast rather than his radio adaptation of Wells’s novel.

The real story of humans and Mars is a little more prosaic but no less fascinating. Telescopes turned the bright red dot in the sky into a fuzzy, mottled disk that gave rise to those daydreams of canals. Just 50 years ago, the first photograph of Mars (http://www.nasa.gov/feature/celebrating-50-years-of-exploring-the-red-planet) from a passing spacecraft appeared to show a hazy atmosphere. Now decades of exploration on the planet itself has shown it to be a world that once had open water (http://www.nasa.gov/vision/universe/solarsystem/opportunity_water.html), an essential ingredient for life.

The fascination hasn’t waned, even in the Internet Age. A former computer programmer named Andy Weir, who enjoyed writing for its own sake and posted fiction to his blog, started a serial about a NASA astronaut stranded on Mars. The popularity ultimately led him to turn it into a successful novel, “The Martian”, which has been made into a movie that will be released in October 2015.

“The Martian” merges the fictional and factual narratives about Mars, building upon the work NASA and others have done exploring Mars and moving it forward into the 2030s, when NASA astronaut:
are regularly traveling to Mars and living on the surface to explore. Although the action takes place in the future, NASA is already developing many of the technologies that appear in the film.

Habitat

On the surface of Mars, Watney spends a significant amount of time in the habitation module -- the Hab -- his home away from home. Future astronauts who land on Mars will need such a home to avoid spending their Martian sols lying on the dust in a spacesuit.


Show only Left

Left: An artificial living habitat (Hab) is necessary to facilitate human exploration of the planet Mars in "The Martian." Right: The NASA's Johnson Space Center.

Credits: Twentieth Century Fox/NASA

HERA is a self-contained environment that simulates a deep-space habit. The two-story habitat is complete with living quarters, workspaces, a hygiene module and a simulated airlock. Within the module, test subjects conduct operational tasks, complete payload objectives and live together for 14 days (soon planned to increase to up to 60 days), simulating future missions.
In the isolated environment. Astronauts have used the facility to simulate ISS missions. These research analogs provide valuable data in factors, behavioral health and countermeasures to help further NASA’s understanding on how to conduct deep space operations.

Plant Farm

Today, astronauts on the international Space Station have an abundance of food delivered to them by cargo resupply vehicles, including some from commercial industries (http://www.nasa.gov/mission_pages/station/structure/launch/overview.html). On Mars, humans would not be able to rely on resupply missions from Earth – even with express delivery they would take at least nine months. For humans to survive on Mars, they will need a continuous source of food. They will need to grow crops.

Show only Left

Left: In a scene from "The Martian," astronaut Mark Watney employs some ingenious methods to plant crops on Mars. Right: Regrown from the Veggie experiment while on board the International Space Station.

Credits: Peter Mountain/NASA

Watney turns the Hab into a self-sustaining farm in "The Martian," making potatoes the first Martian staple. Today, in low-Earth orbit, lettuce is the most abundant crop in space. Aboard the
International Space Station, Veggie (http://www.nasa.gov/content/veggie-plant-growth-system-used-on-international-space-station) is a deployable fresh-food production system. Using red, and green lights, Veggie helps plants grow in pillows, small bags with a wicking surface containing media and fertilizer, to be harvested by astronauts. In 2014, astronauts used the system to grow “Outrdegeous” red romaine lettuce and just recently sampled this space-grown (http://www.nasa.gov/mission_pages/station/research/news/meals_ready_to_eat)crop for the first time. This is a huge step in space farming (http://www.nasa.gov/feature/space-farming-yields-a-crop-of-benefits-for-earth), and NASA is looking to expand the amount and type of crops to help meet the nutritional needs of future astronauts on Mars.

Water Recovery

There are no lakes, river or oceans on the surface of Mars, and sending water from Earth would take more than nine months. Astronauts on Mars must be able to create their own water supply. The Ares 3 crew does not waste a drop on Mars with their water reclaimer, and Watney needs to use his ingenuity to come up with some peculiar ways to stay hydrated and ensure his survival on the Red Planet.

On the International Space Station, no drop of sweat, tears, or even urine goes to waste. The Environmental Control and Life Support System recovers and recycles water from everywhere: urine, hand washing, oral hygiene, and other sources. Through the Water Recovery System (WRS), water is reclaimed and filtered, ready for consumption. One astronaut simply put it, “Yesterday’s coffee turns into tomorrow’s coffee.”

Liquid presents some tricky problems (https://www.youtube.com/watch?v=3lwy8xxJxKo) in space. The WRS and related systems have to account for the fact that liquids behave very differently in a microgravity environment. The part of the WRS that processes urine must use a centrifuge for distillation, since gases and liquids do not separate like they do on Earth.

NASA is continuing to develop new technologies for water recovery. Research is being conducted to advance the disposable multifiltration beds (the filters that remove inorganic and non-volatile organic contaminants) to be a more permanent component to the system. Brine water recovery would reclaim every drop of the water from the “bottoms product” leftover from urine distillation. For future human-exploration missions, crews would be less dependent on any resupply of spare parts or extra water from Earth.
The technology behind this system has been brought down to Earth to provide clean drinking water (http://www.nasa.gov/content/benefits-for-humanity-water-for-the-world) to remote locations and places devastated with natural disasters.

Oxygen Generation

Food, water, shelter: three essentials for survival on Earth. But there’s a fourth we don’t think about much, because it’s freely available: oxygen. On Mars, Watney can’t just step outside for a breath of fresh air. To survive, he has to carry his own supply of oxygen everywhere he goes. But first he has to make it. In his Hab he uses the “oxygenerator,” a system that generates oxygen using the carbon dioxide from the MAV (Mars Ascent Vehicle) fuel generator.

On the International Space Station, the astronauts and cosmonauts have the Oxygen Generation System, which reprocesses the atmosphere of the spacecraft to continuously provide breathable air efficiently and sustainably. The system produces oxygen through a process called electrolysis, which splits water molecules into their component oxygen and hydrogen atoms. The oxygen is released into the atmosphere, while the hydrogen is either discarded into space or fed into the Sabatier System (http://www.nasa.gov/mission_pages/station/research/news/sabatier.html), which creates water from the remaining byproducts in the station’s atmosphere.
Oxygen is produced at a more substantial rate through a partially closed-loop system that improves the efficiency of how the water and oxygen are used. NASA is working to recover even more (http://www.nasa.gov/press/2014/october/nasa-selects-advanced-oxygen-recovery-proposals-for-spacecraft-missions/) from byproducts in the atmosphere to prepare for the journey to Mars.

**Mars Spacesuit**

The Martian surface is not very welcoming for humans. The atmosphere is cold and there is barely any breathable air. An astronaut exploring the surface must wear a spacesuit (http://www.nasa.gov/suitup) to survive outside of a habitat while collecting samples and maintaining systems.

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Left: Actor Matt Damon plays NASA astronaut Marc Watney in “The Martian.” Right: NASA invited the public to vote on three concepts in NASA’s advanced suit development program.

*Credits: Giles Keyte/NASA*

Mark Watney spends large portions of his Martian sols (a sol is a Martian day) working in a spacesuit. He ends up having to perform some long treks on the surface, so his suit has to be flexible, comfortable, and reliable.

NASA is currently developing the technologies to build a spacesuit that would be used on Mars.
Engineers consider everything from traversing the Martian landscape to picking up rock samples.

One of the challenges of walking on Mars will be dealing with dust. The red soil on Mars could affect the astronauts and systems inside a spacecraft if tracked in after a spacewalk. To counter this, new spacesuit designs feature a suitport on the back, so astronauts can quickly hop in from inside a spacecraft while the suit stays outside, keeping it clean indoors.

Rover

Once humans land on the surface of Mars, they must stay there for more than a year, while the planets move into a position that will minimize the length of their trip home. This allows the astronauts plenty of time to conduct experiments and explore the surrounding area, but they won’t want to be limited to how far they can go on foot. Astronauts will have to use robust, reliable and versatile rovers to travel farther.

In "The Martian," Watney takes his rover for quite a few spins, and he even has to outfit the vehicle with some unorthodox modifications to help him survive.

On Earth today, NASA is working to prepare for every encounter with the Multi-Mission Space Exploration Vehicle (MMSEV). The MMSEV (http://www.nasa.gov/pdf/464826main_SEV_FactSheet_508.pdf) has been used in NASA’s analog mission projects (http://www.nasa.gov/pdf/541196main_Analogs_FactSheet_508.pdf) to help solve problems that the agency is aware of and to reveal some that may be hidden. The technologies are developed to be versatile enough to support missions to an asteroid, Mars, its moons and other missions in the future. NASA’s MMSEV has helped address issues like range, rapid entry/exit and radiation protection. Some versions of the vehicle have six pivoting wheels (https://www.youtube.com/watch?v=-BpXzBzKfpw) for maneuverability. In the instance of a flat tire, the vehicle simply lifts up the bad wheel and keeps on rolling.

Ion Propulsion
Slow and steady wins the race, and ion propulsion proves it. The Ares 3 crew lives and the Hermes spacecraft for months as they travel to and from the Red Planet, using ion propulsion (http://www.nasa.gov /centers/glen/about/fs21grc.html) as an efficient method of traversing through space for over 280 million miles. Ion propulsion works by electrically charging a gas such as argon or xenon and pushing out the ions at high speeds, about 200,000 mph. The spacecraft experiences a force similar to that of a gentle breeze (https://www.youtube.com /watch?v=5OFgJwdZxRc), but by continuously accelerating for several years, celestial vessels can reach phenomenal speeds. Ion propulsion also allows the spacecraft to change its orbit multiple times, then break away and head for another distant world.

This technology allows modern day spacecraft like NASA’s Dawn Spacecraft (http://www.nasa.gov/mission_pages/dawn/main/index.html) to minimize fuel consumption and perform some crazy maneuvers. Dawn has completed more than five years of continuous acceleration for a total velocity change around 25,000 mph, more than any spacecraft has accomplished on its own propulsion system. Along the way, it has paid humanity’s first visits to the dwarf planet Ceres (http://www.nasa.gov/subject/6883/ceres/) and the asteroid Vesta (http://www.nasa.gov/subject/6884/vesta/).

Solar Panels

There are no gas stations on Mars. No power plants. Virtually no wind. When it comes to human missions to the Red Planet, solar energy can get the astronauts far. The Hermes spacecraft in the book uses solar arrays for power, and Mark Watney has to use solar panels in some unconventional ways to survive on Mars.

On the International Space Station, four sets of solar arrays (http://www.nasa.gov/feature /international-space-station-solar-arrays) generate 84 to 120 kilowatts of electricity – enough to power more than 40 homes. The station doesn’t need all that power, but the redundancy helps mitigate risk in case of a failure. The solar power system aboard the space station is very reliable, and has been providing power safely to the station since its first crew in 2000.

Orion (http://www.nasa.gov/exploration/systems/orion/about/index.html), NASA’s spacecraft that will take humans farther than they’ve ever gone before, will use solar arrays for power in future
NASA Releases Plan Outlining Next Steps in the Journey to Mars

NASA is leading our nation and the world on a journey to Mars, and Thursday the agency released a detailed outline of that plan in its report, "NASA's Journey to Mars: Pioneering Next Steps in Space Exploration."

"NASA is closer to sending American astronauts to Mars than at any point in our history," said NASA Administrator Charles Bolden. "Today, we are publishing additional details about our journey to Mars plan and how we are aligning all of our work in support of this goal. In the coming weeks, I look forward to continuing to discuss the details of our plan with members of Congress, as well as our commercial and our international and partners, many of whom will be attending the International Astronautical Congress next week."

The plan can be read online at:

[http://go.nasa.gov/1VHDXxg](http://go.nasa.gov/1VHDXxg)

The journey to Mars crosses three thresholds, each with increasing challenges as humans move farther from Earth. NASA is managing these challenges by developing and demonstrating capabilities in incremental steps:

**Earth Reliant** exploration is focused on research aboard the International Space Station

From this world-class microgravity laboratory, we are testing technologies and
From this world-class microgravity laboratory, we are testing technologies and advancing human health and performance research that will enable deep space, long duration missions.

In the Proving Ground, NASA will learn to conduct complex operations in a deep space environment that allows crews to return to Earth in a matter of days. Primarily operating in cislunar space—the volume of space around the moon featuring multiple possible stable staging orbits for future deep space missions—NASA will advance and validate capabilities required for humans to live and work at distances much farther away from our home planet, such as at Mars.

Earth Independent activities build on what we learn on the space station and in deep space to enable human missions to the Mars vicinity, possibly to low-Mars orbit or one of the Martian moons, and eventually the Martian surface. Future Mars missions will represent a collaborative effort between NASA and its partners—a global achievement that marks a transition in humanity's expansion as we go to Mars to seek the potential for sustainable life beyond Earth.

"NASA's strategy connects near-term activities and capability development to the journey to Mars and a future with a sustainable human presence in deep space," said William Gerstenmaier, associate administrator for Human Exploration and Operations at NASA Headquarters. "This strategy charts a course toward horizon goals, while delivering near-term benefits, and defining a resilient architecture that can accommodate budgetary changes, political priorities, new scientific discoveries, technological breakthroughs, and evolving partnerships."

NASA is charting new territory, and we will adapt to new scientific discoveries and new opportunities. Our current efforts are focused on pieces of the architecture that we know are needed. In parallel, we continue to refine an evolving architecture for the capabilities that require further investigation. These efforts will define the next two decades on the journey to Mars.

**CHALLENGES FOR SPACE PIONEERS**

Living and working in space require accepting risks—and the journey to Mars is worth the risks. A new and powerful space transportation system is key to the journey, but NASA also will need to learn new ways of operating in space, based on self-reliance and increased system reliability. We will use proving ground missions to validate transportation and habitation capabilities as well as new operational approaches to stay productive in space while reducing reliance on Earth.

We identify the technological and operational challenges in three categories: transportation, sending humans and cargo through space efficiently, safely, and reliably; working in space, enabling
The Orion heat shield that flew on Exploration Flight Test 1, December 2014, arrives at Marshall Space Flight Center for machining and post-flight evaluation.
Credits: NASA

When it comes to building a spacecraft fit for a journey to Mars, improvements happen brick by brick and block by block. Orion Program leaders have decided to begin building Orion’s heat shield in blocks rather than as a monolithic structure, a move that signals the insights gained as a result of testing the design in space.

The heat shield is one of the most critical elements of Orion and protects it and the future astronauts inside from searing temperatures experienced during reentry through Earth’s atmosphere when they return home. For Exploration Mission (EM)-1, the top layer of Orion’s heat shield that is primarily responsible for helping the crew module endure reentry heat will be composed of approximately 180 blocks that can be built in stages, easing the labor-intensive manufacturing process.

“The heat shield we put to the test during Orion’s flight test last December met every expectation we had and gave us a tremendous amount of data on its thermal and mechanical performance,” said Mark Kirasich, Acting Orion Program Manager. “But the process of building the heat shield as a single piece for that flight also gave us insight into how we could improve the way we build this essential element of the spacecraft.”

Orion’s flight test, known as Exploration Flight Test-1 or EFT-1, provided an opportunity to develop confidence in the overall system and provide insight that can’t be gained from models in the laboratory. The heat shield experienced temperatures of about 4,000 degrees Fahrenheit and speeds approximately 80 percent of what it will endure when it comes back from missions near the moon, all while keeping the temperature inside the crew module in the mid-70s. Post-flight examinations of the heat shield confirmed it performed well within expected tolerances.

The heat shield was composed of a titanium skeleton and carbon fiber skin that gave the crew module its circular shape on the bottom and provided structural support, on top of which a fiberglass-phenolic honeycomb structure was placed. The honeycomb structure had 320,000 tiny cells that were individually filled by hand with an ablative material called Avcoat designed to wear away as Orion returned to Earth through the atmosphere. During the labor-intensive process, each individual cell was filled by hand as part of a serial process, cured in a large oven, X-rayed and then robotically machined to meet precise thickness requirements.

However, during the manufacture of the heat shield for Orion’s flight test, engineers determined that the strength of the Avcoat/honeycomb structure was below expectations. While analysis showed, and the flight proved, that the heat shield would work for the test, the EM-1 Orion will experience colder temperatures in space and hotter temperatures upon reentry, requiring a stronger heat shield.

Through lessons and data obtained from building and flying the heat shield, the team was able to make a design update for the Avcoat block design that will meet the EM-1 strength requirements. It is also expected to provide a cost savings and shorten the current heat shield manufacturing timeline by about two months. Engineers have now folded the update into the design review that will lock down the design for the next version.