ReadWorks®

ARTICLE-A-DAY™

Space and Space Travel

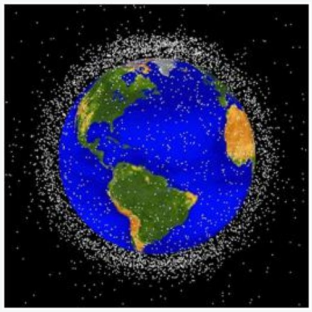
6 Articles

Check articles you have read:

- [ ] Space Junk
  464 words
- [ ] NJ Physics Professor Has the "Right Stuff"
  1178 words
- [ ] Will Human Life on Earth Come to an End?
  1518 words
- [ ] Crash Test
  993 words
- [ ] "Seven Minutes of Terror," Eight Years of Ingenuity
  1193 words
- [ ] The Most Expensive House in the Universe
  757 words

Space Junk

By Josh Adler



Many people know that trash is a big problem on planet Earth. What many people don't know is that trash has become a problem in outer space too. Years of space exploration have left tons of "space junk" in orbit around the planet.

According to *BBC News*, there are more than 22,000 pieces of junk in space around the earth. And these are just the items that we can see from the surface of the earth by telescopes or radars. There are also millions of smaller pieces of junk that we can't see.

Objects, like bits of old space rockets or satellites, move around the planet at very high speeds, so fast that even a very small piece can break important satellites or become dangerous to people, particularly astronauts. If the tiniest piece of junk crashed into a spacecraft, it could damage the vehicle. That's because the faster an object moves, the greater the impact if the object collides with something else.

To make things worse, when two objects in space collide, the two objects break into many smaller pieces. This happened in 2009 when a working United States satellite collided with a Russian satellite that was no longer functioning. The collision caused the satellites to break into more than 2,000 pieces, increasing the items of space junk.

To help minimize additional space junk, countries around the world have agreed to limit the time their space tools stay in orbit to 25 years. Each tool must be built to fall safely into the earth's atmosphere, or the mass of gases that surround the earth, after that. In the upper parts of the atmosphere, it will burn up.

Many scientists are also proposing different ways to clean up space junk. In England a metal harpoon is being tested that can be fired into space trash, grip the trash, and then pull the space junk into the earth's atmosphere where it would burn up.

The Germans have been planning a space mission with robots that would collect pieces of space trash and bring them back to Earth so that they can be safely destroyed.

In 2007 the Chinese tried to blow up one of its older satellites with a missile. Unfortunately, the explosion only created thousands of smaller pieces, adding junk in space!

"In our opinion the problem is very challenging, and it's quite urgent as well," said Marco Castronuovo, an Italian Space Agency researcher who is working to solve the problem. One reason that it's urgent is that countries are sending more and more objects into space. Many of these objects are tools that help people use their cell phones or computers.

"The time to act is now; as we go farther in time we will need to remove more and more fragments," he says.

NJ Physics Professor Has the "Right Stuff"

By Valorie Sands

In 2005, Dr. Greg Olsen became the third person ever to travel into outer space as a private citizen. Unlike NASA astronauts who earn a generous salary, he bought his own ticket into space. He paid about $20 million for the trip, a ten-day orbit aboard the Expedition 11 Russian Soyuz rocket, which docked at the International Space Station. He also took responsibility for his own training. The space flight was the achievement of a lifetime for the New Jersey entrepreneur and college physics professor.

Olsen's fascination with outer space and astronomy began when he was still a boy. He was born in 1945, years before space travel was close to becoming a reality. In fact, space exploration did not really heat up until the post-WWII rivalry known as the Cold War between Russia and the U.S. Both countries fought to win the race to space.

The Race to Space

In 1957, the Soviet Union took the lead when it sent Sputnik, the world's first artificial satellite, into space. But by 1962, U.S. President John F. Kennedy made it clear that the nation would not take a backseat to Russia. “We choose to go to the moon in this decade... because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win,” said Kennedy.

When asked why he loved space travel, Dr. Olsen talked about his professional crewmates, NASA

astronaut Bill McArthur and Russian cosmonaut Valery Tokarev. "For the same reason they love it -- to be weightless, to see the awesome sight of Earth from space," he said.

Spaceflight Training School

Going to space school for the Expedition 11 spaceflight "was also like being a college student again," said Dr. Olsen. That is, except for some of the training, which involved zero gravity flights and spins around in a centrifuge of up to 8 Gs acceleration (eight times Earth's gravitational pull). However, most of Dr. Olsen's training was spent in classrooms and in flight simulators. He was expected to know his way around the Soyuz vehicle, the space station, and to help with day-to-day routines. Yet neither NASA nor the Russians assigned him to heavy-duty responsibilities during the space flight.

According to Olsen, the most physically challenging part of the training was the water-landing exercise to practice "splash down." This is a demanding and dangerous method of landing a spacecraft by parachute into a body of water. To prepare for the grueling task, Olsen and his crewmates wore wet suits and other protective survival gear. During just two hours of practice, he sweated off more than three pounds from his 170-pound frame.

Learning Russian

Despite demanding tests of endurance, Olsen described the physical training as the easiest part of preparation for the experience. He said that for him the hardest part "was trying to learn Russian. I love Russians and the Russian culture... but I've never been good at languages since I was a young person."

Dr. Olsen learned Russian well enough to succeed in bonding well with his Russian crewmate and training personnel. "I'm just in awe of them," he said. "When I watched them operate the Soyuz spacecraft and the simulators, they seemed to know every nut and bolt on the vehicle. I just tried to soak up the knowledge."

Overcoming fear was no problem for Dr. Olsen. He was "very, very confident" about space travel aboard the Russian Soyuz vehicle. "It has a great safety record, and I have no qualms about doing this whatsoever." The main goal of the Soyuz mission was to switch crews, and to replace

emergency capsules that must always be attached to the space station in case of an emergency escape.

A Smooth Launch

Olsen's launch from the Cosmodrome, a space launch facility in Kazakhstan, went smoothly. He reported that one of the most unforgettable highlights of his ten-day trip was the lift-off experience during takeoff. He was also awed by the sight of Earth passing by in the rocket's window and the memorable feeling of floating around the space station.

Radio Broadcast from Space

A licensed ham radio operator, Dr. Olsen spoke to New Jersey students from space via a ham radio. In the first of three broadcasts from the International Space Station (ISS) Olsen said, "Welcome to space. It's really nice here. It's nice and roomy."

"In some ways it's like camping out, because we have no running water, no sinks, and we kind of have to fend for ourselves for food," said Dr. Olsen. He reported that the professional astronauts had made him feel welcome aboard the space station.

Olsen expressed appreciation to many of his teachers, colleagues, and family in his space broadcast. He thanked his professors at Fairleigh Dickenson University in Teaneck, New Jersey, where he earned a Master's Degree in Physics. He also thanked engineering students and former classmates at the University of Virginia, the school where he earned his doctorate. It was with their support that he was able to first build a spectrometer that became the basis for his New Jersey company, Sensors Unlimited. Spectrometers are sophisticated space age tools that use light to help astronomers and astronauts collect information. Using a spectrometer, astronauts can calculate the temperature of an object in space, learn which direction it's moving, calculate its speed and weight, and find out what it is made of.

Scientific Studies from Space

Olsen had planned to take an infrared spectrometer built by his Princeton, New Jersey firm with him on his space trip. However, it failed to pass through U.S. Export Customs, so the project had to

be shelved. Instead, he conducted three medical experiments designed to study the human body's reaction to the absence of gravity. He also conducted studies on bacteria growth in zero gravity, and on how spaceflight affects the lower back and inner ear. He contributed his scientific findings to the European Space Agency.

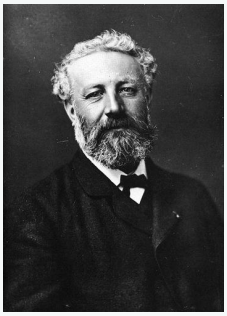
The Journey Home

During Olsen's return trip to Earth, there were pressurization problems aboard the Soyuz TMA-6 spacecraft carrying him and his crew home. Overcoming the difficulties at undocking and during the descent tested the astronauts' skill, emotional strength and mental capability. In fact, at a press conference, a Russian News Agency announced that it had been a fairly serious situation. Fortunately, disaster was avoided because the Expedition 11's astronauts all kept their cool and monitored the glitch very closely during re-entry. All three space travelers wore Russian-built Sokol spacesuits, a standard precaution, for an extra layer of protection, according to Olsen.

"At no time was there panic or alarm, or anything of that sort," said Olsen about the pressurization problems during re-entry. He added that at one point during the descent, he needed to add more oxygen into the Soyuz cabin. "We had practiced this many times during simulation practice, and I thought everyone handled it like pros." Ten days after liftoff, the Soyuz crew landed safely back on Earth, in a desert in Kazakhstan.

Will Human Life on Earth Come to an End?

By ReadWorks



Photograph of Jules Verne

In 1993 science-fiction writer Kim Stanley Robinson published *Red Mars*, the first of his Mars trilogy. *Red Mars* is set in the year 2026. At the beginning of the novel, the spacecraft Ares departs. Aboard the Ares, the space colonists are bound for Mars.

The voyage to Mars is portentous. On Earth, corporations are coming to dominate global governance. Nation states still fly their flags, but they owe their allegiance to the transnational corporations. The "trans-nats," as the transnational corporations are called, are the real agents of the global economy. They have the power and ability to extract natural resources from the earth. The increasing competition among trans-nats and growing human population means more and more resources are being removed. This situation threatens the feasibility of life on the planet.

Robinson played out this idea over the course of three books. By the end of *Red Mars*, a world war has erupted on Earth. The second book in the trilogy, *Green Mars*, documents the terraforming of the red planet. (Terraforming is a science-fiction term for adapting another planet or moon into a planet that can sustain life in the same way Earth can. This process involves creating an appropriate biosphere, atmosphere, and surface topography on the new celestial body.) The third book in the trilogy, *Blue Mars*, picks up at the stage when the terraforming has allowed for water to exist on Mars. Life on Mars is now truly possible. By the end of the book series, humanity has acquired the skills and technology to spread its civilization throughout the solar system.

Robinson is an American writer. The Mars trilogy is his best-known work. Robinson is also an active outdoorsman. Themes of ecological sustainability run throughout his work, as do questions of social

justice. He has won numerous awards within the science-fiction community. Fans of Robinson's, and especially the Mars trilogy, have long been waiting for a film adaptation of the series.

Robinson's idea of moving human civilization to Mars is creative. Still, the idea of the imperative for space colonization has been around for centuries. As long as man has been able to imagine a frontier, he has wanted to conquer it. This is no less true for the space outside our planet.

The German astronomer and mathematician Johannes Kepler discovered the laws of planetary motion in the 17th century. (Kepler was the first person to calculate the orbit of Mars.) Kepler exchanged letters with his Italian colleague Galileo Galilei. In a letter dated from 1610, Johannes Kepler wrote to Galileo: "As soon as somebody demonstrates the art of flying, settlers from our species of man will not be lacking. Given ships or sails adapted to the breezes of heaven, there will be those who will not shrink from even that vast expanse."

Kepler was, of course, correct. As soon as men could get off the earth, they did. For Kepler, the obstacle was only technological. Indeed, it took a long time to master the technology. The technological discoveries were aided by men of both science and letters.

Jules Verne, considered to be the father of the science-fiction genre, predicted a human voyage to the moon in his 1865 novel, *From the Earth to the Moon*. For the story, Verne calculated many of the details of rocket propulsion, a technology that was in its infancy in 1865. What is remarkable to many contemporary scientists is the accuracy with which Verne computed his rocket's mechanics. He also placed the rocket's point of departure in Florida, and very near the site of the Kennedy Space Center.

Technical details aside, thus far, the impetus for space exploration had been romantic. It was Verne's literary successor, H. G. Wells, who imagined a more pressing need for getting man off the planet. In a lecture at the Royal Institute of London in 1902, the author prophesied a need for man to leave the earth:

It is conceivable that some great unexpected mass of matter should presently rush upon us out of space, whirl sun and planets aside like dead leaves before the breeze, and collide with, and utterly destroy every spark of life upon this earth. It is conceivable, too, that some pestilence may presently appear, some new disease that will destroy not 10 or 15 or 20 percent of the earth's inhabitants as pestilences have done in the past, but 100 percent, and so, end our race. And finally

there is the reasonable certainty that this sun of ours must someday radiate itself toward extinction.

The threats of asteroids or plagues were theoretical. Wells could imagine the end of the earth, but he did not believe it would occur. Instead he imagined life would extend into the cosmos. In *The Outline of History* (1920) he writes that "Life, forever dying to be born afresh, forever young and eager, will presently stand upon this earth as upon a footstool, and stretch out its realm among the stars."

In the 20th century, writers, scientists, and philosophers started to advocate space colonization for ecological and political reasons. This new call for space colonization envisions scenarios in which the human population has made life on Earth unfeasible. The argument starts from the supposition that resources on Earth are scarce. Population pressure will inevitably strain these resources. What's more, the competition for some of these resources—energy, water, food—will lead to global conflict. (As we have seen, Robinson's Mars trilogy picks up this theme.)

It is in this sense that the imperative for space colonization becomes more urgent. No longer is it a romantic quest for human fulfillment. Instead it is a matter of survival for both the planet and humankind. This belief is not limited to the dreams of science-fiction writers.

Krafft Arnold Ehricke was a rocket propulsion engineer and the designer of the D-1 Centaur rocket stage. Ehricke defined something called the "extraterrestrial imperative." In his view, it is the responsibility of humanity to colonize space in order to guarantee the survival of the species. Ehricke wasn't exactly an environmentalist, but he did define the extraterrestrial imperative in ecological terms:

One of the most thoughtless statements, parroted ad nauseam ever since rational concern for our environment exploded into an emotional syndrome, calls man the only animal that soils its own nest. Every animal soils its nest with the products of its metabolism if unable to move away. Space technology gives us for the first time, the freedom to leave our nest at least for certain functions, in order not to soil it.

Similarly, Isaac Asimov, a giant of 20th century science-fiction, explored the idea in a speech at Rutgers University in the 1980s. He said that for those who view industrialization and its attendant pollution and degradation as the source of the planet's problems, the only solution at present is to give up industrialization. Asimov explained:

> This is something that we can't do; we have the tiger by the tail. We have 4.5 billion people on Earth. We can't support that many unless we're industrialized and technologically advanced. So, the idea is not to get rid of industrialization, but to move it somewhere else. If we can move it a few thousand miles into space, we still have it, but not on Earth. Earth can then become a world of parks, farms and wilderness without giving up the benefits of industrialization.

Since Asimov gave that speech at Rutgers, the world population has grown from 4.5 billion people to closer to 7 billion.

One of the most famous and respected scientists of the present day is Stephen Hawking. The theoretical physicist gave the idea of space colonization a boost in 2012. At a publicized lecture, Hawking pleaded for interplanetary travel. "I don't think we will survive another thousand years without escaping beyond our fragile planet," he said.

Hawking used the word “survive” and gave his estimate of a timeline, thus making the idea of space colonization sound urgent. This is a subject the physicist has given prior consideration. In a 2010 video, Hawking spoke at greater length on the subject. "Our population and our use of the finite resources of Planet Earth are growing exponentially, along with our technical ability to change the environment for good or ill. But our genetic code still carries the selfish and aggressive instincts that were of survival advantage in the past. It will be difficult enough to avoid disaster in the next hundred years, let alone the next thousand or million. Our only chance of long-term survival is not to remain inward looking on Planet Earth, but to spread out into space."

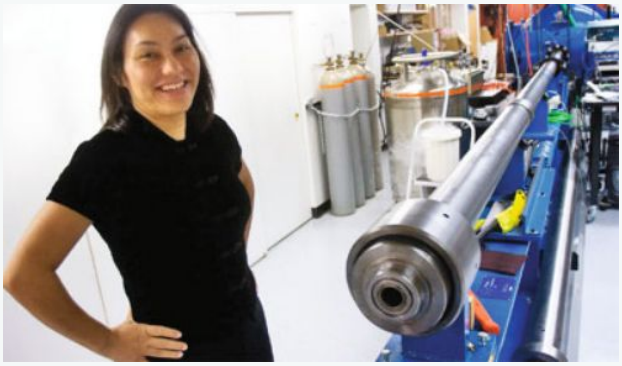
Despite the endorsement of one of humankind’s smartest minds, space colonization might sound like the stuff of fiction. But remember: the idea of space travel was just a fantasy in H. G. Wells’s time. One hundred years later, it became reality. Who can say how far away we are from space colonization and life on Mars? Should the time be calculated in years? In gallons of water? In acres of farmland?

Crash Test

By Kirsten Weir

Sarah Stewart smashes things to learn how our solar system evolved.

From behind the safety of a steel door and a concrete block wall, Sarah Stewart presses a button that fires her big gun. In the next room, the 6-meter- (20-foot-) long blaster shoots a metal disk into a block of ice at 2.6 kilometers per second—more than 5,800 miles per hour. Stewart hears a thud and a clanging sound. The light fixtures overhead sway. Impact!



Courtesy Harvard University

Sarah Stewart fires this 6-meter-long gun in her lab to simulate the effects of cosmic collisions.

Stewart routinely smashes chunks of ice with speeding projectiles to find out how collisions in space have shaped our solar system. She is a professor of planetary science at Harvard University.

"The sad thing is, we spend weeks setting up an experiment," she says. "Then you hit it, and it's all blown to pieces, and we literally vacuum it up afterward." Sad, maybe, but the destruction has led to some major discoveries.

Planet Evolution

Stewart was born in Taiwan, the daughter of an American father and a Taiwanese mother. Her dad was in the Air Force, so she moved around the world as she grew up.

As a kid, Stewart loved getting lost in the pages of science-fiction novels. In college, she got hooked on astronomy and signed up to work in a lab, studying how planets form. That led to a graduate degree at the California Institute of Technology, where she began researching collisions

in space. "Coming out of high school, I would never have predicted that I'd work on planets colliding with one another," she says.

Planets are created when smaller rocks crash into one another and fuse, Stewart explains. Even after a planet has formed, it keeps getting pummeled. Most of the moons and rocky planets in the solar system are pockmarked with craters from smashups with comets and asteroids. "Collisions have occurred the whole time the solar system has been in existence," Stewart says.

The collisions leave lasting impressions. Nearly every rocky body in the solar system has an odd feature that can be explained by a crash, says Stewart. Impacts happen elsewhere in the universe too. Many *exoplanets* (planets that exist outside our solar system) are surrounded by telltale dust clouds that could have been caused only by collisions, she notes.

"If you want to understand the solar system, you want to understand impact events and what they left behind," Stewart says. "It's like a detective story."

Master Blaster

Stewart studies one particular material that's prevalent in space: "I have this special love of ice," she admits. Most of the rocky bodies in our solar system are at least partially covered in one form of ice or another.

Plain old water ice is composed of two atoms of hydrogen and one atom of oxygen—H2O. Not all water ice is created equal, however. "You can arrange the hydrogens and oxygens in different ways," Stewart says. Scientists know of at least 15 different crystal structures of frozen H2O, and more are being discovered all the time.

Water ice also mixes with other compounds, such as ammonia or methane. Those ices each have many different crystal structures too.

The impact of a collision in space can transform the crystal structure of ice. "When you take normal ice and hit it really fast with an asteroid or a comet, you can make forms of ice that last just a few seconds," says Stewart.

To understand those fleeting, frozen forms, Stewart gets out the big gun. She fires metal disks into blocks of ice to mimic what happens when a space rock hurtles into the icy shell of a moon or a rocky planet. For fractions of a second, the block of ice experiences the extremely high pressures

and temperatures that occur during a cosmic collision.

During that split second, scientific instruments record temperature, pressure, and other variables. After the blast, Stewart collects the smashed sample to examine how it changed and pours over the data collected by the instruments. Then she plugs every detail into a computer model to help her understand how a similar impact might affect a real planet.

Mystery Solved

In 2010, Stewart's big gun helped solve a mystery—the unusual craters within craters in the ice on three of Jupiter's moons (Europa, Callisto, and Ganymede). Her experiments revealed how the odd craters formed. At the moment of impact, Stewart discovered, ordinary ice on the surface was transformed into two different phases of ice not normally seen on Earth. Although the two forms lasted for only a moment, they left their mark in the shape of a crater within a crater.

For Stewart, solving such mysteries is the best part of being a scientist. "You have this tremendous feeling of excitement," she says, "when you realize something absolutely new that nobody else in the world knows."

Crash Victims

Cosmic collisions have molded some of our solar system's rocky bodies. Here's how:

• Mercury has an unexpectedly small *mantle*. The mantle is the layer of a rocky planet that exists between the crust and the core. "One theory is that a giant impact blew off most of the mantle," says scientist Sarah Stewart.	 NASA

- Venus has a *retrograde* rotation. It spins in the opposite direction as most of the other planets rotate. (Earth turns counterclockwise; Venus turns clockwise.) A huge collision might have sent it spinning backward.

NASA

- Earth's moon formed, most scientists believe, after a Mars-sized object called Theia smashed into the young Earth. The impact ejected chucks of rock into space that gradually *accreted* (fused) to become the moon.

NASA

- Mars has a *crust* that is twice as thick at the south pole as it is at the north pole. The crust is the solid outermost layer of a rocky planet or moon. A collision may have ripped off part of the planet's northern crust.

NASA

"Seven Minutes of Terror," Eight Years of Ingenuity

By ReadWorks

"Sometimes when we look at it, it looks crazy," remarked Adam Steltzner, an engineer who works for the National Aeronautics and Space Administration—known more commonly to the world as NASA. "It is the result of reasoned engineering thought. But it still looks crazy."

In a video story entitled "Seven Minutes of Terror," Steltzner was joined on camera by an eloquent cast of entry-descent-landing engineers (or "EDL Engineers"). Working from the Jet Propulsion Laboratory (JPL) in California, their team introduced the world to one of the most daring, inventive feats of engineering the world had ever witnessed: the pinpoint landing of NASA's Curiosity rover on Mars.

The seven minutes explored in that story—and experienced by the world in early August 2012—took place after seven years of engineering, one year of space flight, and countless hours of collaboration on the perfect landing. Dubbed the Mars Science Laboratory ("MSL"), this mission brought together more than 7,000 people, working in organizations from all over the world, to accomplish its goals. MSL is one of the greatest technological accomplishments of human history.

The most impressive thing about MSL is that no mission this ambitious had ever been attempted in the past. The landing presented problems that could not be compared directly to anything done before. But thanks to the rigorous work of hundreds of engineers, NASA ended up making a new mark on Mars.

The Launch

The MSL launch took place on November 26, 2011. Blasting from the Earth at a speed of 12,582 miles per hour, the rockets that broke free of Earth's orbit and sent the Mars-bound spacecraft with the rover on its way were the most routine part of the mission. For decades NASA has specialized in space launches, drawing on some of the brightest minds on the planet to determine what it takes to bring a spacecraft to the stars.

Planning the rover's trip to the red planet (Mars's nickname, due to its color)—a voyage lasting about 36 weeks at maximum cruise velocity—was also not exactly a new challenge for engineers working on the MSL mission. NASA had already landed two rovers, named "Spirit" and "Opportunity," on the surface of the red planet. Based on the principles of astronomy, the launch engineers at JPL had very precise requirements for making the journey from Earth to Mars.

The key to these requirements was an understanding of orbits. Although Mars is significantly farther from the sun than Earth, both planets orbit the same star. Their distance from each other changes during each cycle, but Earth comes into alignment with Mars once every 26 months —"lapping" it in a perpetual race around the sun. Observing this pattern, astronomers can work with engineers to pinpoint the optimal month, day, and time for a spacecraft to leave Earth on a speedy one-way trip.

Drawing on centuries of knowledge of the laws of physics, scientists designed rockets and a spacecraft to accommodate Curiosity. Years of calculation, construction, careful planning and computer modeling resulted in a vessel that cruised purposefully through space, reaching the orbit of Mars at just the right time to attempt a landing.

Through it all, the margin for error was nearly non-existent. The movement of interplanetary bodies in space is much more demanding than the movement of cars on a highway, or even airplanes in the stratosphere. Miscalculating a vector or failing to account for any aspect of the orbits could lead to a $2 billion failure.

Fortunately, NASA had taken on this challenge before. Its engineers had both the experience and the tenacity to succeed again. What came after the launch was a different story.

The Landing

Spirit and Opportunity, the two NASA rovers that landed on Mars in 2004, used a combination of parachutes, rockets, and hi-tech airbags to protect themselves. Much like launch and spaceflight, each step of the landing sequence was planned and simulated to the very last detail. Learning from a prior Mars mission, EDL engineers were able to recreate some of the same maneuvers used in that sequence.

Unfortunately, the specific requirements of MSL made it difficult to depend on past experience. While NASA had constructed the biggest supersonic parachute ever made, parachuting was far from enough. Since the atmosphere of Mars is 100 times thinner than the atmosphere of Earth, the parachute alone could not reduce the speed of descent past 200 miles per hour—a breakneck speed that would surely damage Curiosity upon landing.

Curiosity outweighed any earlier rover and contained over 150 pounds of sensitive scientific devices, so an airbag solution was ruled out. Instead, EDL engineers designed a maneuver that would allow the entry capsule to turn sharply and activate powerful rockets to finish the job. Once this maneuver was complete, the capsule could attempt a vertical landing.

Successfully executing the switch from a parachute entry to a controlled, rocket-fueled descent was a feat that could have gone wrong at any moment. Still, even this was not enough to succeed. Once the parachute was cut, and a full radar system was online to guide Curiosity to the surface, the force from the rockets could kick up so much dust that the dust itself would damage the rover.

Eternally thinking one step ahead, EDL engineers designed a device called a "sky crane" to complete the final step of the landing sequence. When the sky crane was 20 feet above Martian soil, it lowered Curiosity onto the surface with a set of cables.

Moving from 13,000 miles per hour to zero miles per hour in just seven minutes, Curiosity finally touched down. The capsule, with all rockets still firing, blasted back into the sky and crash-landed elsewhere on the planet. The landing was a success.

The Ongoing Mission

NASA states that the MSL mission "is part of NASA's Mars Exploration Program, a long-term effort of robotic exploration of the red planet." The most popular inquiry is whether Mars may have supported life at any point in its long history. The search for these signs, however, is one piece of a

much greater picture.

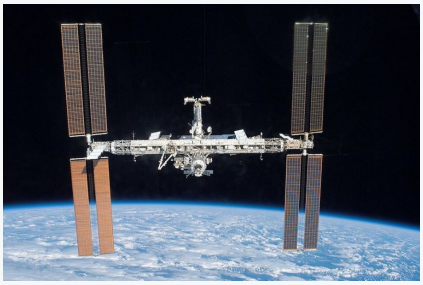
The mission has eight scientific objectives, each one broken into specific goals and all coming together to form a more detailed understanding of all things Mars. Curiosity, a rover the size of a station wagon, contains advanced instruments that help it probe, sample, record, and analyze its way through Martian terrain. NASA is preparing for the next space flight to Mars by collecting evidence on the biological, geological, chemical, and radiological profile of the red planet. Another rover mission, building on the work of Curiosity, is planned to launch in 2020.

Ultimately, scientists hope to learn enough about Mars to bring human beings to the surface for a manned research mission. Some, working with entrepreneur Elon Musk, are even devising a plan to colonize the planet by 2030. Skeptics debate whether or not such a seemingly outrageous idea could ever be made into reality.

Looking back at NASA's solutions to the great technical challenge of the Curiosity landing, it's hard to feel too skeptical about humankind's ability to reach for the stars.

The Most Expensive House in the Universe

By ReadWorks



Do you know where the most expensive house in the universe is located? Some might guess Hollywood, where some of the richest and most famous movie stars have their homes. Others might think of New York City, where a one-bedroom apartment in Manhattan can cost more than a mansion in the suburbs. But they would all be wrong, because this is a trick question. The most expensive house isn't even properly located on Earth. It's the International Space Station (ISS), which is circling in orbit above us right now. The cost to build this engineering marvel, which is roughly the size of a football field, is around 150 billion dollars.

Many different governments cooperated in order to plan and build the ISS, including the USA, Russia, Japan, Canada, and Europe. These entities decided to work together on the project only after developing plans independently for related space projects. By combining forces, they reasoned, they could split the cost of constructing a space station and also share resources while onboard the station.

The countries envisioned three important purposes for their joint project: to support scientific research, to help astronauts continue to explore space, and to educate the public. Thus, the engineering criteria for the space station had to include facilities to support each of these important missions.

Construction began in 1998, after the countries decided to band together and merge their space missions to create the ISS. Many countries used their spacecraft to deliver the parts for the ISS, little by little, into space. First came the operating systems and hardware. Then, two years later, a Russian rocket delivered the living quarters (complete with beds, toilets, and a kitchen) that would make the ISS habitable for humans. The first "residents" of the ISS—two Russian astronauts and

one American—arrived on *Expedition 1* in 2000. Over time, more space missions to the ISS added new parts to the space station, such as "docks" for incoming spacecraft that would make it easier for astronauts to come in and out of the station.

Throughout the construction of the ISS, which is partially solar-powered, engineers had to think constantly about the best way to keep the ISS running. They had to build and position the station's parts so that the space station could be powered by light from the sun. They also had to think about ways to protect it from meteoroids (including installing strong shutters on its seven windows). They installed robotic "arms" for the space station that could grab and hold both ships and astronauts securely while docking. And they had to install features that would make it easier to live for long stretches of time in space, such as exercise machines for the astronauts.

Astronauts can come and go on the ISS. They come to perform many of the experiments for which the station was designed, involving biology, physics, astronomy, and meteorology. Others test equipment to be used in missions to the moon and Mars. In a Japanese-built laboratory aboard the ISS called *Kibo* (which means "hope"), they can even grow plants and raise fish. However, most of the astronauts' space food is still delivered in sealed bags, and there isn't much variety. Thus, the crew aboard the ISS often looks forward to visiting shuttles that bring the astronauts fresh, different fruit to eat.

Life aboard the ISS has become relatively more comfortable thanks to technological improvements developed by engineers; however, it has not always been easy for the engineers back home to work on the space station. Space travel and construction of spacecraft are two of the most expensive projects a country can take on, and as the economies around the world shift, some countries have a harder time contributing financially. Sometimes, engineers from different countries will disagree about the best way to build something. And while some people on the space station project think it's a good idea to charge money to space "tourists" in order to provide more funds for the project or to charge companies a lot of money to advertise their business on the rockets that fly to the ISS, others think that these ideas do not align with the original purposes of the ISS. But the fact is, no country or individual can afford the giant price tag for this important space "house" alone, so they must keep working together. And the results—whether they include important new scientific discoveries, easier and more frequent missions to Mars, or better cultural relations between our countries—are sure to benefit us.