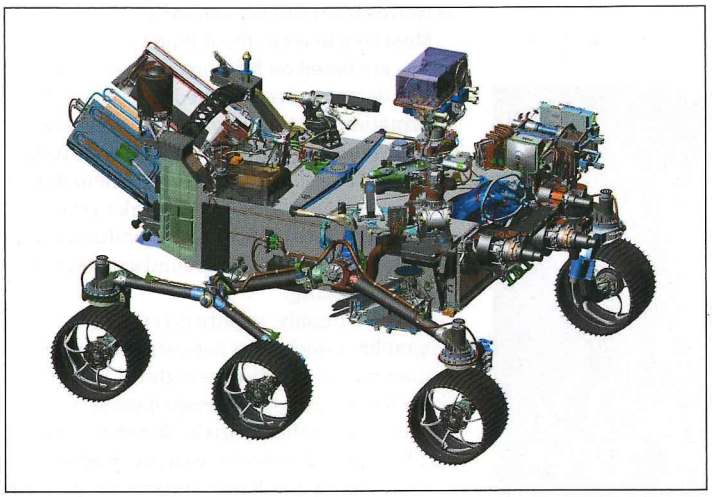
Precision Landing Will Be Key to NASA's Mars 2020 Rover



NASA/JPL-Caltech

A computer-generated rendition of NASA's Mars 2020 rover.

To scientists and engineers working on Mars rovers, a rover's entry into the Martian atmosphere and descent to its surface are known as the 7 minutes of terror. Hurtling at speeds exceeding 17,700 kilometers per hour, a rover has to put on some serious brakes if it is to land nimbly and delicately at the surface.

The process may be less terrifying during the next mission, thanks to the new Mars 2020 rover design that gives the craft more control as it lands. The NASA rover team announced plans for the craft on 1 July during a live Facebook question and answer (Q&A) session streamed from the Jet Propulsion Laboratory in Pasadena, Calif. At the Q&A, managers highlighted how new robotic features distinguish the Mars 2020 rover (named for its scheduled launch year) from past models sent to explore the Martian surface.

The new craft will look much like Curiosity, its six-wheeled, 1-ton predecessor that launched in November 2011. However, the Mars 2020 rover will have, among other features, a smarter parachute deployment system that will help it maneuver into an even tighter landing zone, a navigation system that uses pictures to guide landing, and even equipment to record ambient sound on Mars.

Equipped for a Rocky Landing

Because Curiosity relied upon velocity to activate parachute deployment and because it could not make decisions based on position, the craft opened its chute after passing below the ideal altitude. The Mars 2020 rover aims to avoid this nail-biting entry, said Allen Chen of the descent and landing team.

"By adding what's known as range trigger, we can specify where we want the parachute to open, not just at what velocity we want it to open," said Chen. In other words, certain altitudes could be programed to trigger the chute. "That shrinks our [required] landing area by nearly half."

What's more, the Mars 2020 rover will be equipped with terrain relative navigation, which uses pictures of the ground for orientation during entry and descent. The technique will help the rover avoid hazardous terrain by automatically comparing photos the rover takes of the landing zone with an onboard map generated from images previously taken by orbiting craft.

Curiosity took pictures of the surface during landing, but they were not matched to a map to facilitate better navigation. Instead, Curiosity and other previous rovers were sent to spans of flat, rock-free terrain at least 20 by 25 kilometers across to ensure that the landing location was safe. The craft then drove long distances to gather information and photograph rocky terrain.

In contrast, the range trigger and navigation system will allow the craft to maneuver into a tighter landing zone—a flat space a mere 18 by 14 kilometers across, half the prior area—surrounded by rock. Thus, after landing, the the Mars 2020 rover won't have to drive far to begin collecting samples, Chen explained.

"One of the key things for us is to land in an environment that has a lot of rocks, and rocks are challenging for landing," said project scientist Kenneth Farley from the NASA Mars Yard, a parking lot full of bedrock and red slab used to test-drive rover models. "Fortunately, we have some new capabilities with the landing system that will allow us to get into this tricky terrain."

Collecting Martian Rocks

The Mars 2020 rover will land in one of eight potential locations thought capable of once hosting microbes. Curiosity photographed areas that might have once been habitable, and using these data as well as information collected by other craft, researchers have now confirmed rock formations that appear to have been riverbeds, tsunami zones, and deltas.

In addition to taking photos, the Mars 2020 rover will collect 35 samples of rock for 7 months after arriving on the Red Planet. The rover will leave samples in designated locations for a second craft to retrieve at a later date. In contrast, Curiosity was equipped with gas analysis instruments and transmitted data about organic molecules, but no samples were returned to Earth.

NASA is currently testing the new rover's drilling tools on a variety of Earth's rock types. In addition, scientists are conducting drilling tests in a chamber that emulates Martian atmospheric pressure, which is only about 1% of that found on Earth, according to Matt Robinson of the Mars 2020 sampling and catching team. Robinson gave a live tour of the testing chamber and drilling facility during the Q&A.

The Mars 2020 rover will have a five-jointed robotic arm that can retrieve core samples for storage and transport, Robinson noted.

Searching for Water, Creating Oxygen, and More

In a press release sent after the conference, NASA announced that it will now proceed with final construction designs. Several intriguing instruments made the cut.

The Mars 2020 rover will be equipped with a ground-penetrating radar called the Radar Imager for Mars' Subsurface Experiment (RIMFAX), which will be used to search for ice and brine beneath the rover. In addition, several microphones will record Martian sound for the first time.

A device that ingests carbon dioxide from the atmosphere and produces oxygen using solid oxide electrolysis will also be included on the rover. If the device, the Mars Oxygen In Situ Resource Utilization Experiment (MOXIE), is successful, it could pave the way for instruments that allow people to breathe on Mars. The technology could also help overcome the need to transport oxygen for fuel.

Because of these and other new designs such as thicker wheels that avoid punctures and damage, the Mars 2020 rover will weigh about 150 kilograms more than Curiosity.

By **Amy Coombs,** Editorial Intern

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Advocate of colonizing Mars is no longer an outlier

BY VICKY HALLETT

About 25 years ago, journalist Stephen Petranek worked on a story for Life magazine. The image on the cover was of a pinkish sphere on a black background. Above it were the words "Our Next Home." Just a few days before the issue was to be printed, Petranek was called in to talk to someone from corporate. The inquisitor had all of the pages of "Our Next Home" laid out in front of him, and Petranek worried that he was about to scuttle the whole thing.

Instead, he had a single question: "Could this possibly be true?"

Landing on Mars — and colonizing it — isn't merely possible. "This is going to happen," Petranek declares. And it's going to happen soon, he adds, even though most people are probably as skeptical today as that corporate guy was decades ago. Space travel has become relatively inexpensive, and companies such as Elon Musk's SpaceX are determined to make a Mars settlement a reality. With Petranek's 2015 book, "How We'll Live on Mars," his goal was to deliver a wake-up call that we're on the verge of one of the most significant events in human history.

It also turned into the basis for a script for National Geographic's "Mars," which debuted last month. (The final episode airs Dec. 19.) The miniseries blends documentary with science fiction. Interviews with experts explain present-day plans for Mars, while actors playing astronauts give viewers a sneak peek of the first manned mission to the Red Planet — which the show sets in the year 2033.

The following is based on a recent interview with Petranek; the transcript has been edited for clarity and length.

Q: What was your first reaction to this plan to adapt your book?
A: Early on, people said, "This can't just be for nerds." I thought, "Oh, no, they're going to ruin it." But they allowed me, encouraged me, to read every line of the script. They listened to me carefully about everything. It's something entertaining, and it teaches you something.

I feel the accuracy of the fictional parts [is] so high that it's not fiction. It might not be in 2033. It might be earlier. And the rocket might not look exactly like that. One thing nobody has right now is a rocket big enough to get to Mars. But when the astronauts are looking at control panels and see the amount of gravity coming into play, those numbers are calculated and real. Thrusters affecting the landing [in the first episode] — that's a scenario NASA is worried about. Those spacesuits are actually up-to-date suits being used in Houston. The helmets look like motorcycle helmets because the spacesuit has an expandable band that fills in and creates a seal.

Q: How common are inaccuracies in most science fiction movies or TV shows?
A: I think they're in almost all science fiction movies, even "The Martian," which is based on really good science. There's a lot that drives me nuts. A 300-mile-per-hour windstorm isn't going to almost kill you. In the atmosphere on Mars, it'll hardly push against you at all. [In "The Martian," the main character, played by Matt Damon, is somehow impaled by flying debris from such a storm.] But I'm very grateful for "The Martian." Before the movie, I gave a TED Talk on Mars. This talk was greeted with nice, polite applause. People were not excited. Half of the people didn't believe it could be true. Now we're getting the message across that by 2050, there might be 50,000 people on Mars.

Q: Why has going to Mars seemed so impossible to the public?
A: Part of it is because we didn't continue to be a space-exploring species after Apollo. There was no particularly good reason to go to the moon. We proved we could do it. Then we didn't do anything after that. In the 1970s, scientist Wernher von Braun was running around the halls of Congress saying, "I can get humans on Mars." For at least 30 years, we've had the technology. All we did was fly 135 space shuttle missions with nowhere to go. We built the International Space Station, but we weren't significantly exploring space. People got bored. The only time people paid attention to the space shuttle is when it killed a whole crew. It was supposed to be cheap and reusable, but it cost $1.4 billion every time it went up. We spent $150 billion. If we had one-fourth of that money, we would have had a viable outpost on Mars, and we would have had it for a while.

Q: Why is this the time to go to Mars?
A: I personally think people are beginning to think of space as not just the next big wilderness but also as an economic opportunity for humans. Now there are a lot of private rocket companies building serious rockets. It's going private quickly. Elon Musk has hired hundreds of engineers to build a satellite communication system that may include 5,000 satellites. You only need to connect to a satellite and you get broadband Internet and telephone for anyone for far less than they're paying now. Suppose he says, "I can give you that for $10 a month." There are 2 billion cellphone users on Earth, so that would be $20 billion a month to SpaceX. That's more than you need to get to Mars. I don't see anything to stop it. It's in humanity's interest to have another planet to go to.

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Q: There's disagreement about what we should do to Mars, right?
A: There are scientists who think we should treat Mars as a scientific park, so there's some controversy around terraforming [or changing the planet to be more like Earth]. But Mars is a cold, dry rock in space with almost no atmosphere. It has a lot of water in the form of ice. To say we'd go to Mars and screw it up, the way we did with Earth, is nonsense. If we can give it an atmosphere, warm it up and have flowing water on the surface and make it a far more Earthlike planet, we'd be creating a garden out of a wasteland. On Earth, we treat our water and air as waste disposal. On Mars, we will have to learn to recycle everything.

It will help us tremendously to do that on Earth, too.

Q: What do you want people to think about as they watch "Mars"?
A: It doesn't paint going to Mars as a vacation. That's an accurate portrayal. But it will actually be a cool place to live and work. Also, there are amazing things from the big thinkers [a.k.a. the real-life experts interviewed]. Many meteorites that landed on Earth originated on Mars. One-celled critters could survive that trip. So one surprise that will occur to people is that the search for life on Mars could be related to our own existence. We still have no good explanation for how and why life formed on Earth.