New Mars rover has a human approach

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This artist concept shows NASA's Mars Science Laboratory Curiosity rover in 2011. NASA's Mars rover, nicknamed Curiosity, is zeroing in on its August landing on the Red Planet and aims to touch down closer than expected to its mountain target, the US space agency said Monday.

In a matter of days, a geologist unlike any on Earth will venture into alien territory. It has six legs and one arm. Instead of feet, it rides around on metal wheels as thin as cardboard. Its brain is in its belly, where it also digests and analyzes the remains of Martian rocks. It eats plutonium for breakfast.

Despite its resemblance to a one-armed, 1-ton praying mantis, Curiosity is the most advanced machine ever sent to another planet. If all goes according to plan, the rover will touch down on Mars on Aug. 5 and begin rolling along the surface a few days later.

Curiosity will be the eyes and ears for an international team of about 350 earthbound scientists. The rover's goal is to climb a 3-mile-tall mountain

and gather evidence that could resolve a long-standing mystery: Was there life on Mars in its warmer, wetter past - and could it sustain life today?

The rover's suite of 10 primary instruments was designed with these questions in mind. It can shoot lasers at rocks to see what they're made of. It can record hours of high-quality color video of the Martian landscape and relay the footage back to Earth. It can even drill into stone to look for specific organic compounds thought to be necessary for life to begin.

"It is a mind-blowing machine," said Michael Watkins, a mission project engineer at the Jet Propulsion Laboratory in La Canada Flintridge, where Curiosity was designed and built.

"We're really talking about, effectively, a field geologist/astrobiologist remotely operating on Mars," said Jeff Simmonds, the science payload manager for the mission.

Mars Science Laboratory, as this machine is officially known, is the product of more than seven years of work by hundreds of scientists and engineers.

At first glance, Curiosity - so named by a sixth-grade girl from Kansas who won an essay contest - doesn't appear to be made in the image of a geologist.

But closer inspection reveals that it has its own versions of the basic human senses and the tools a geologist would take into the field, including a rock hammer, a hand lens and several sets of "eyes." There are also a few fancy gadgets that, on Earth, would be confined to a lab.

Curiosity bears only the slightest resemblance to its ancestor Sojourner,

the 23-pound rover that was the first to scoot around the dusty planet in 1997. Where Sojourner traveled just 325 feet or so and never ventured more than 40 feet away from its base station, Curiosity may travel more than 12 miles as it makes its way into the middle of Gale Crater and climbs Mount Sharp, sampling many layers of rock over the course of a Martian year (687 Earth days).

Size matters. The nearly 2,000-pound Curiosity also dwarfs the roughly 400-pound Mars Exploration Rovers, Spirit and Opportunity, which landed on the Red Planet in 2004. Although the twin rovers theoretically could surpass Curiosity's top speed of about 150 yards per hour, the new machine will be able to take on much rougher terrain.

"We're so much bigger that a really dangerous obstacle for MER is pretty much something that we can just drive right over," Simmonds said.

Spirit and Opportunity were simpler because their mission was more straightforward: Find evidence of water on Mars. Now that they've done so, the next set of questions is more complicated - and so is the rover.

Curiosity is an impressive machine. It stands about 7 feet tall, 9 feet wide and 10 feet long. Its body is bedecked with cameras, and thick wires snake around its metal shell. Its long arm grips a fistful of tools: a scooper to collect soil samples, a drill to bore into stone, a specialized lens to peer at microscopic structures and a "tongue" of sorts that can press against rock to taste the chemicals within.

Because Curiosity will be using high-powered instruments - and often more than one simultaneously - it cannot get by on solar power, as its rover predecessors did. Instead, it will feed on nuclear energy, using heat generated by the decay of radioactive plutonium to keep 110 watts constantly flowing to its battery.

In spite of its size, everything on board the rover has been pared down to its most minimalist version, to make it as light as possible.

As with a human geologist, the rover makes good use of its eyes. A pair of color cameras mounted on the mast - the head and neck of Curiosity's bug-like body - will record three-dimensional color images and video of the Martian terrain, to be transmitted back to Earth. One camera system will scan far-off terrain while the other will focus on closer ground, observing the landscape, rocks, soils and perhaps signs of frost.

And just as a geologist might use a trusty hand lens to get a closer look at a bit of rock or soil, so will Curiosity. The rover's 1.5-inch-wide hand-lens imager sits on the end of its long arm, able to snap photos of features in rocks that are only 12.5 microns big. This camera will also shine ultraviolet light on rocks to detect carbonate and other mineral sediments whose presence would hint that water may have flowed in the area.

Where a human geologist would pull out a rock hammer to break off a sample for analysis, Curiosity will use a drill. But because it can't bring its samples to a laboratory on Earth, Curiosity also contains a lab inside its body.

"We take as much of our lab with us in the rover as we possibly can," Simmonds said.

After the rover's arm drills into a rock, it will drop the collected powder into its belly, where two instruments will digest the samples and analyze their composition.

One device combines three tools: a mass spectrometer that uses magnetic fields to separate ionized elements according to their mass; a gas chromatograph to sort chemicals based on how quickly they vaporize

when heated; and a laser spectrometer to determine which chemicals are present by shooting jets of light at the pulverized rock and examining the fingerprint of the light that shines back. Scientists hope to find carbon, nitrogen, hydrogen and oxygen - elements thought to be essential for life.

The other lab device will use X-rays in two ways: It will shoot rays at the samples to see what electromagnetic fingerprints they produce, and it will bounce rays off the samples to produce recognizable patterns of light and shadows. Those tests will help identify the minerals in the Martian rocks, including those that are likely to house organic compounds.

"For geologists, our currency is minerals," said Matt Golombek, a JPL scientist who works with the still-functioning Opportunity rover. "If we can identify the minerals, we can tell what kind of rock it is and how it formed."

Curiosity can also examine minerals from as far as 23 feet away by shooting a laser and analyzing the light signature of the dust that is kicked up. If the zapped rock turns out to be a dud, the rover can simply move on.

That's important because, for all its advances, Curiosity moves with painstaking slowness. The most basic tasks - like identifying a distant target, maneuvering the robot arm so that its instruments are precisely positioned to examine a rock and then finally taking a sample - can take days, Simmonds said.

In a nod to the long-term goal of sending people to Mars, Curiosity will measure the neutrons, gamma rays, energetic ions and other particles that bombard the planet and might pose a safety hazard for future astronauts who venture to the Red Planet.

In the meantime, scientists will have to put their faith in a machine that's millions of miles away, said Rob Manning, the mission's chief engineer.

"We need to trust that it's doing its job," he said.