MIMICKING MARS

NASA teams will simulate a mission to Mars in the Crew Health and Performance Exploration Analog program, which operates out of a habitat built at Johnson Space Center in Houston. There will be three such missions, each involving a handful of crew members living and working in the habitat for a year. BILL STAFFORD NASA

NASA has begun a series of simulations to see what could go wrong on a mission and how a crew could handle it

Matt Alderton Special to USA TODAY

The premise of "Stars on Mars" was absurd. ● The reality TV show that aired this summer on Fox featured 12 celebrities-turned-"astronauts" living on Mars — or, rather, a makeshift version of the Red Planet that producers built in the desert in South Australia. ● In each hour-long installment, host William Shatner gave a new mission to contestants like former cycling champion Lance Armstrong, Olympic figure skater Adam Rippon, "Modern Family" actress Ariel Winter and Super Bowl-winning running back Marshawn Lynch, who must live together in a habitat and work together to overcome fabricated challenges like food shortages, communication delays and meteor showers. ● At the end of each episode, the group deemed one individual not "mission critical" and sent them home. ● The last celebrity standing was named "the brightest star in the galaxy." (Spoiler: Rippon won.)

And yet, the concept was not as far-fetched as it seemed. On June 25, just three weeks after Fox aired the first episode of "Stars on Mars,"NASA began the first of three planned missions in its Crew Health and Performance Exploration Analog (CHAPEA) program. The program's purpose: Simulating life on Mars so NASA can anticipate and come up with solutions for challenges that might arise when it eventually sends astronauts to the planet for real-life missions.

"We've created a 1,700-square-foot habitat with a 1,200-square-foot area outside of that habitat," says CHAPEA co-investigator Suzanne Bell, lead for NASA's Behavioral Health and Performance Laboratory at Johnson Space Center. "We're simulating a surface habitat from Mars, as well as the Martian landscape, and we're putting four-person crews there in isolation for 378 days to collect … human health and performance data under Mars-realistic conditions."

In other words, NASA is producing its own version of "Stars on Mars," except it revolves around science instead of celebrities and research instead of ratings. The lessons learned during each simulated year-long stay will move NASA a step closer to its most ambitious objective ever — putting humans on the surface of another planet for the first time.

●●●→

“If you want to help astronauts maintain their health, do you choose to send more variety in food or more variety in exercise equipment? There’s always risk and resource trades going on, so we want to understand what needs to be prioritized.”

Suzanne Bell
CHAPEA co-investigator

The CHAPEA habitat includes separate working and living spaces. Participants will have tasks similar to what astronauts will be required to do on Mars, including meal prep, maintenance work, scientific experiments, exercise, personal hygiene and sleep.
BILL STAFFORD/NASA

Red Planet rehearsal

NASA could launch its first crewed mission to Mars by the late 2030s or early 2040s. There are three main reasons to go to Mars, explains Michelle Courtney, lead for crew support systems integration for the Mars Architecture Team within NASA’s Exploration Systems Development Mission Directorate.

First and foremost is scientific discovery. Second is building and flexing America’s innovation muscles. And third is the simple fact that it’s inspiring.

“Mars is a perfect place to go because it’s a very close, habitable planet,” Courtney says. “There’s a lot we can discover there in terms of science and geology, and trying to get there helps us drive development of new technologies that can enable us to travel even further into our solar system. We have to learn about propulsion systems and energy generation and life support and health countermeasures so that we can actually get crews there to explore.”

Although the potential fruits of a Mars mission are exciting, harvesting them won’t be easy. NASA has therefore developed a list of 63 “Moon to Mars” objectives that serve as a blueprint for sustained human presence and exploration throughout the solar system. Spanning four broad areas — science; transportation and habitation; lunar and Martian infrastructure; and operations — it’s a checklist for what NASA needs to learn and accomplish in order to successfully execute its Mars ambitions.

“We’re able to use those guiding objectives to understand what capabilities we need on Mars, and what we can do on Earth to develop those capabilities,” says Nicole Piontek, Courtney’s deputy.

Because they offer a way to safely test hypotheses without endangering crew members, ground-based analogs are a critical part of NASA’s strategy.

“CHAPEA is really necessary because there are so many facets of crew health and performance that we need to study … so that we can be successful sending humans to Mars,” Courtney says.

Thanks to the Apollo program and the International Space Station, NASA already knows a lot about humans in space. But Mars will be different.

“On the International Space Station, there are regular resupplies and the crew changes out periodically,” Bell says. The station’s proximity to Earth allows the crew to communicate easily with loved ones, receive care packages from home and even request favorite foods when supplies are replenished.

“Mars is going to be a completely different scenario,” Bell says. “There will be a much smaller transit vehicle to get there, for example. Food will have to be pre-positioned, there will be limited if any resupply, and there will be very little or no abort capabilities. So it’s going to be the same crew of four together for a 2.5-year period.”

In light of those circumstances, CHAPEA is focused on learning how humans interact with systems, how they work together as teams and how they deal with environmental stressors that might affect mission success, including resource limitations, isolation and equipment failure, just to name a few.

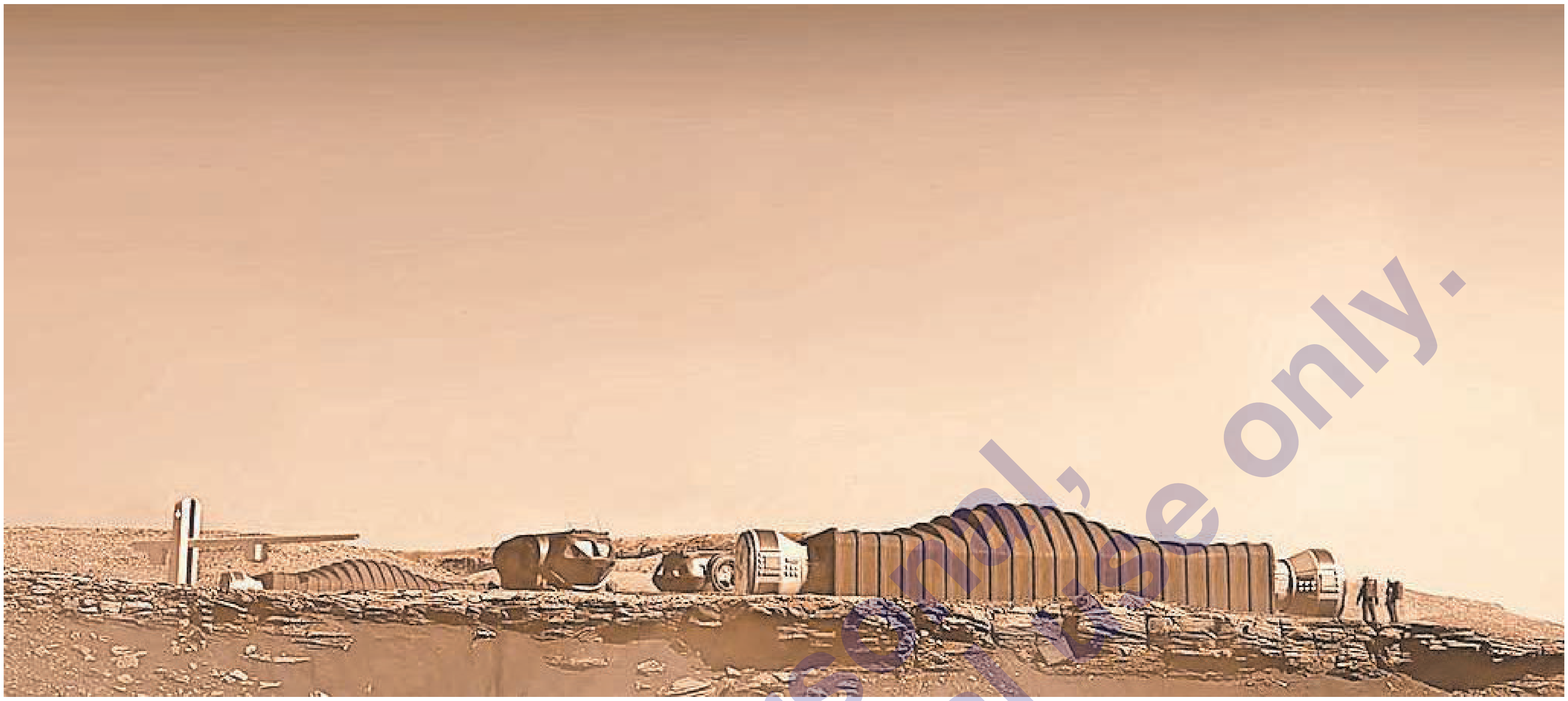
To that end, the crews participating in each of CHAPEA’s three analogs will spend their days engaged in a variety of activities designed to mirror those that humans will have to do on Mars, including crop growth, meal preparation and consumption, exercise, communications, personal hygiene, maintenance work, science work and sleep. Crew members will even take simulated spacewalks using treadmills and virtual reality.

3D printing in space?

One of the most interesting things about CHAPEA is the habitat in which the analogs are taking place, known as Mars Dune Alpha.

Located in a large building at Johnson Space Center in Houston, Mars Dune Alpha features four private crew quarters on one end of the habitat and dedicated workstations, medical stations and food-growing stations on the opposite end, with shared living spaces in between. According to fabricator ICON, each area features a unique experience — including different ceiling heights — to avoid spatial monotony and crew member fatigue when spending long periods indoors. For the same reason, there’s a mix of fixed and movable furniture so crew members can reorganize the habitat according to their daily needs, and customizable lighting, temperature and sound controls to help them regulate their circadian rhythms and optimize

•••→



The CHAPEA habitat goes by the name "Mars Dune Alpha." This artist's rendering shows what the facility might look like if it were actually on Mars. ICON/NASA

their overall well-being.

"Outside the habitat is a sandbox that simulates the Martian landscape, which crew members access by going through an airlock," Bell says. "Only the four crew members can go in that sandbox. It's completely closed off to anything else."

The habitat itself was constructed from Lavacrete — ICON's proprietary concrete mix — using 3D printing.

"The concept behind 3D printing is that it's a really novel approach to *in situ* resource utilization," Courtney explains. Future astronauts might travel with 3D printers and use Martian soil to create cement for use in additive manufacturing, thereby reducing missions' cost and mass so that precious payloads could be devoted to food and supplies instead of building materials. "Essentially: How could we use resources on other planetary bodies so that we don't have to send them all the way from Earth?"

Turning observations into insights

CHAPEA's first analog will conclude in 2024. After that, there will be two more analogs with new crew members in 2025 and 2026, respectively.

"When you design something, you're not designing it for just one specific person or one specific group of people," Courtney says. "You need to collect multiple data points. Humans are diverse, so we need to study a diverse astronaut population to be able to understand what makes sense to design into our missions."

A deep bench of experts — including specialists in behavioral health, nutrition, food sciences and kinesiology — helped NASA design CHAPEA, and will help it mine the data it collects for best practices that it eventually will use to design an actual Mars habitat.

Crews on Mars will have to be together for a *long* time — perhaps 2½ years — so the habitat includes individual living quarters, allowing for a little bit of privacy and solitude when needed. BILL STAFFORD/NASA

"For example, there always will be limited payloads. So if you want to help astronauts maintain their health, do you choose to send more variety in food or more variety in exercise equipment?" Bell says. "There's always risk and resource trades going on, so we want to understand what needs to be prioritized."

Ultimately, the goal isn't just getting astronauts to Mars. Also, it's getting them home.

"A mission to Mars is going to be a really long-duration mission, and there are lots of challenges associated with it," Courtney says. "So we have to not only send crew, but also return them safely."

Mars Sample Return

The Mars Sample Return Program — a joint venture of NASA and the European Space Agency — will revolutionize our understanding of Mars by bringing back rock samples being carefully selected and collected by NASA's Perseverance rover. A final mission concept is still being developed, but it would include sending a lander to Mars to retrieve those samples. The lander would then lift off from the planet and rendezvous with another craft that would take the rocks to Earth. Current planning envisions the mission launching around 2028, with the samples getting to Earth in the mid-2030s.

— NASA