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Mars mission team prepares for its toughest challenge

Scientists are readying the Tianwen 1 lander for touchdown on the red planet. **Zhao Lei** reports.

As Beijing's residents bask among the spring blossoms, engineers and technicians in the capital's northwestern suburbs are busily preparing for a challenging maneuver involving a spacecraft hundreds of millions of kilometers from Earth.

The team members — spacecraft control professionals at the Beijing Aerospace Control Center are making all-out efforts to ensure that Tianwen 1, China's first independent interplanetary mission, will soon safely land a rover on Mars to conduct scientific tests.

The rover was recently named Zhurong after an ancient god of fire.

"The next step will be the entry, descent and landing procedures, which will be the most challenging and risky parts of the entire mission," Cui Xiaofeng, chief controller of the mission at the center, told China Daily in an exclusive interview this month.

From February, the center's engineers and technicians have been working to a tight schedule to ensure that everything will be perfect before the landing is attempted, he said.

"Since the spacecraft started orbiting Mars and conducting extensive examinations of the prespecified landing area in late February, it has generated a huge amount of data and images," Cui said.

"That's producing a heavy workload for my team members, who are responsible for making detailed arrangements for the investigative operations and conducting high-precision orbital control maneuvers. Furthermore, they are tasked with processing the data and giving the findings to scientists for analysis and research."

In addition, the controllers will continue working to improve the procedures for the entry, descent and landing maneuvers until the moment they actually occur.

"Even though the procedures were basically worked out months ago, our people need to keep simulating as many scenarios as possible and optimizing plans for the upcoming maneuvers," Cui said, adding that the team is racing to complete its tasks.

"Compared with landing on the moon, touching down on Mars is more demanding and complex as a result of the planet's unique atmospheric conditions and other uncertainties. That's why scientists call the process 'Seven Minutes of Terror,'" the chief controller said. "The team is doing its best to make it a success."

Ultimate goal

The Tianwen 1 probe, named after an ancient Chinese poem, consists of two major sections — an orbiter and a landing capsule.

It was launched by a Long March 5 heavy-lift carrier rocket on July 23 from the Wenchang Space Launch Center in the southernmost island province of Hainan. As such, it kicked off China's planetary exploration program.

The mission's ultimate goal is to land a rover next month or in June in the southern region of Utopia Planitia — a vast plain within Utopia, the largest recognized impact basin in the solar system — to conduct scientific surveys.

If the robotic mission succeeds, Chinese scientists will get their first opportunity to closely observe Mars, which was first recorded in the country on one bone inscriptions in about 1300 BC.

In ancient China, the reddish celestial sphere was known as Yinghuo, or "flickering flame," a name derived from ancient astronomers' observations that it moved like a capricious light in the night sky.

Tianwen 1 is currently held in a parking orbit about 280 kilometers above Mars and it circles the planet every two days. The probe is now more than 280 million km from Earth.

Crucial tasks

The Beijing Aerospace Control Center is China's top body for controlling and tracking deep-space missions.

It was established in 1996 to serve the country's manned space program and has taken part in all 11 crewed space flights and lunar expeditions.

The center's Mars mission control



Spacecraft control specialists at the Beijing Aerospace Control Center monitor the operations of the Tianwen 1 Mars probe in this undated photo. PROVIDED TO CHINA DAILY

team was formed in early 2018 and most of the members are ages 30 to 40. Since the first day, the team members knew they would be facing a large number of difficulties and challenges because Tianwen 1 would be China's first attempt to send a spacecraft to the red planet.

"The mission is highly sophisticated and has many differences from the country's previous space projects."

"We were supposed to have a short period of time to ready ourselves for the mission, which required a lot of planning, design and calculations," Jin Wenma, a senior deep-space control expert, said.

"The probe will have traveled more than 1,200 times the distance between Earth and the moon. We can't allow even a tiny error if we want to safely land the rover on the area chosen by the scientists."

"We needed to develop plans and technologies for major steps in the mission, including the Mars orbital insertion, the entry-descent-landing operation, long-distance tracking and communication, and the rover's movements on the Martian soil."

Thanks to the center's hard-working engineers and technicians, Tianwen 1 has smoothly completed all of its maneuvers ahead of the final

landing. During the probe's seven-month voyage to Mars, the controllers assisted the spacecraft in carrying out four midcourse corrections and a deep-space orbital maneuver to ensure it was always precisely aimed at the planet.

They also performed comprehensive examinations of the probe's components to check they were working correctly.

Yu Tianyi, a senior control specialist, said the center's workers are expecting a successful touchdown, but after the landing they will also face many challenges.

For example, communicating with the semi-autonomous rover and manipulating its operations on the planet's surface will pose tremendous challenges.

"Driving a Martian rover will be very different to controlling a lunar buggy due to a number of factors: the much greater distance [between the two planets]; the more complicated environment; and the effect of the Martian atmosphere," Yu said.

"Compared with our experience of operating lunar vehicles, we will have more difficulties in establishing and maintaining communications with the Martian rover. We will have a very short time every day when we will be able to contact it, so the num-

ber of signals and data we will be able to upload and download will be very limited. That will require us to make the best use of the precious transmission period every day and make sure our commands are succinct and precise."

Liu Shaoran, a deputy chief controller of Tianwen 1, said the team members have fulfilled their duties and commitments to the mission. Many have sacrificed much in the service of their country and its space endeavors, he said.

"For instance, Liu Xiaohui, a young woman in my team, postponed her wedding ceremony in her hometown two months in the past year so her work would not be affected," Liu Shaoran said.

"Before the third planned ceremony, everything was ready in her hometown and her family members and friends had been informed about the occasion, but she eventually called off her trip because she believed her work was more important than personal issues."

"No one persuaded or forced her to do that, it was simply her own decision."

Eventually, Liu Xiaohui and her husband used a video link to hold a "tele-wedding ceremony" attended by their relatives and friends in her hometown, he said.

Even though Liu Xiaohui is now expecting her first child, she continues to work as hard as ever, Liu Shaoran added.

Wang Cheng, another deputy chief controller, said Run Dong, a young man in his team, has spent almost all his time working at his post as a mission planner since he joined the center several years ago.

Dong's schedule leaves little time for family life. "However, he has rarely told anyone about his devotion and the sacrifices made in his private life," Wang said.

"I understand him. There are many people like him in this building who are doers rather than talkers. They are working hard for our nation."

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Zhurong on course for historic journey

By ZHAO LEI

If it touches down safely on the red planet and works as planned, the Tianwen 1 rover will be the sixth such vehicle deployed on Mars, following five predecessors launched by the United States.

If the semi-autonomous craft functions efficiently, it will work for at least three months and undertake comprehensive surveys of the planet.

The rover, recently named Zhurong after an ancient god of fire, is 1.85 meters high and weighs about 240 kilograms.

It has six wheels and four solar panels, and can move at 200 meters an hour on the Martian surface. It carries six scientific instruments, including a multispectral camera, a meteorological sensor and ground-penetrating radar.

The center hopes Zhurong to obtain information about a wide range of topics, such as the composition of the planet's surface, the geological structure, climate and environment.

Tianwen 1, China's first independent Mars mission, began in July when the probe of the same name was launched from the Wenchang Space Launch Center in Hainan province.

As it was loaded with fuel, the probe weighed more than 5 metric tons when it was launched, but its weight gradually decreased as the spacecraft burned the propellants during its flight.

It traveled more than 470 million kilometers before entering a Martian orbit on Feb 10, when it was 193 million km from Earth.

Because the two bodies keep moving on their own orbits, a Mars-bound spacecraft must fly in a carefully designed curved trajectory to catch up with the red planet. Depending on the launch time, the probe can travel 400 million km from Earth.

On Feb 24, Tianwen 1 entered a preset parking orbit.

The spacecraft has been programmed to maintain that position for about three months to ensure the selected touchdown site before releasing its landing capsule to descend through the atmosphere.

The capsule is expected to land sometime next month or in June, and after several days of preparations it will place a rover on the soil.

By the time of the touchdown, Mars will be about 318 million km from Earth, according to the mission planners.

If Tianwen 1 can fulfill its objectives — orbiting the planet to make comprehensive observations, landing on the surface and deploying a rover to conduct tests — it will become the first Mars expedition to accomplish all three goals with one probe.

The most recent rover to operate on Mars was Perseverance of the US, which started operations in the Jezero Crater on Feb 19 (Beijing time).

Tianwen 1 is the world's 46th Mars exploration mission since October 1966, when the former Soviet Union launched the first Mars-bound spacecraft. Only 19 of those missions have been successful.

Tianwen, meaning "the quest for heavenly truth," is an epic work by Qu Yuan, a renowned poet from the Chu Kingdom who lived during the Warring States Period (475-221 BC).

The China National Space Administration said that naming the mission after the poem was intended to illustrate China's determination to explore deep space and also foster a love of science in the nation's young people.

For the second step in the country's Mars' exploration program, a larger probe will set off for the planet, sometime around 2026, to take samples and return them to Earth, officials said.



People watch the Tianwen 1 probe being launched by a Long March 5 heavy-lift carrier rocket from the Wenchang Space Launch Center in the southernmost island province of Hainan on July 23. PROVIDED TO CHINA DAILY

TALKING POINT

Tongue-tied, but totally in control



Zhao Lei

I like watching the promotional videos released by SpaceX because their blend of spectacular scenes and good soundtracks is always inspiring and brings emotional satisfaction.

By comparison, promotional videos created by China's space authorities and contractors are nowhere

near as exciting and attractive, if I may say so. They don't tell their story well, often look prosaic and always use the same music for the soundtrack.

That description can also be applied to the nation's space workers, such as the spacecraft control specialists I interviewed at the Beijing Aerospace Control Center in a northwestern suburb of the capital.

They are brilliant at their jobs, but they always appear a little tongue-tied when I ask them to share their own stories with me.

Wang Cheng, a senior engineer with the center's Tianwen 1 mission team, had his last stem surgery in November. The doctors told him that his condition had partly been caused

by working long hours, and they urged him not to overtax himself.

However, after he was discharged from the hospital, Wang quickly returned to his job and resumed a punishing schedule, working day and night until the condition reemerged and forced him to see a doctor again.

I learned this from Wang's colleague Liu Shaoran, a senior controller who has been involved with the Tianwen 1 mission since the launch of the probe in July.

Wang, who was sitting next to Liu, told me, "This is not worth writing about."

Liu responded, "We all understand that health is the foundation of one's life and work, but when my colleagues are faced with such impor-

tant tasks, they put considerations about their own health aside and devote themselves to their work."

"In fact, many private companies have contacted our professionals, offering much higher salaries, but we have all declined the offers. Because they are convinced that what they are doing here is worth it, and also because they want to be part of the motherland's space exploration efforts."

He added that a lot of people at the center have made sacrifices in their private lives to aid their work, but they would never tell a reporter like me about those things.

"Just like many other people striving for our space program, they are the reason China's space industry has achieved so much and has risen so rapidly in the global space sector," he said.

I can testify to the truth of his

words, having witnessed the country's lunar exploration efforts which landed a rover on the far side of the moon — something no other nation has accomplished. They also brought samples of lunar soil back to Earth 44 years after the last moon rocks returned from the silver sphere.

I have also navigated the construction of a global navigation satellite network that has ended China's reliance on foreign systems.

Now, I am looking forward to watching the launch of a colossal rocket that will place the core capsule of China's space station in orbit many hundreds of kilometers above the Earth.

So, though Wang, Liu and their colleagues may not be good storytellers, they will always be remembered and thanked for the pride and glory they have created for China and its people.