

Crisis in Peru

Political upheaval, protests leave at least 17 dead

WORLD, PAGE 10



Online retail diversifies in pandemic

BUSINESS, PAGE 14

Future of soccer

French children dream of following in Mbappe's footsteps SPORTS, PAGE 19



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Left: A screen at the Jiuquan Satellite Launch Center shows the six astronauts aboard the Chinese Space Station on Nov. 30. **WANG JIANGBO / FOR CHINA DAILY** **Above:** A rocket carrying Shenzhou XV lifts off from the Jiuquan Satellite Launch Center in Northwest China on Nov. 29. **KONG FANGZHOU / FOR CHINA DAILY**

SPACE SECTOR SET TO ROCKET INTO FUTURE

State players and private firms prepare to lift nation to stellar success. **Zhao Lei** reports.

Chen Li, who owns a restaurant in Longlou, a coastal township in China's southernmost province of Hainan, said he is grateful to the country's space industry because it has boosted business at his eatery in recent years.

"So many people came to Longlou before the launch of the Wentian space lab. There was a mountain of people, a sea of people! A lot of tourists came to my restaurant to get a taste of Wenchang chicken," the 62-year-old said, referring to a renowned local delicacy.

He said he opened his first restaurant in 1992, but it wasn't until 2016 that business began to flourish thanks to the space launch missions that started being carried out that year at the Wenchang Space Launch Center in Longlou, China's youngest space base and the only one on the coast.

"Since the first launch at the center (in June 2016), the number of tourists has risen every year and my business has continued to bloom. Many tourists have told me they come here to watch the splendid scenes of a rocket being launched, and to spend some days visiting the local scenery," he said.

He added that before the Wentian mission, he had never seen so many travelers in Longlou.

"I think at least 100,000 people flooded in before the launch. Rooms at all of the inns, hostels and hotels that I know of had been booked up many days before the scheduled date of the flight. I hired part-time waiters and prepared more food for the hordes of tourists," he said.

According to the township government, more than 500,000 tourists were in Longlou on July 24 to see the launch of Wentian, and Chen said he owes a debt of

gratitude to the nation's space endeavors.

"Because of the space program, my business is now 10 times busier than it was in the years before the launch missions came here. Without them, our lives could never have been as good as they are now," he said, adding that he sets off fireworks in front of his restaurant each time a carrier rocket is launched from the Wenchang center.

In addition, many local people who worked elsewhere have returned to Longlou to start their own businesses, hoping to reap the rewards of the opportunities brought about by the space sector, he said.

According to local authorities, there are now nearly 1,000 stores and hospitality-related businesses in Longlou — four times the number before 2016. By the end of last year, the average annual income in the town had reached 19,179 yuan (\$2,720) per capita, which is 40 percent higher than in 2016.

Ambitious programs

In addition to their increased wealth, Chen and his fellow residents have witnessed a line of ambitious programs — including the country's permanent space station project — that have made China a rising space power.

All three major components of the Tiangong space station, now orbiting 400 kilometers above the Earth, were carried into space by a Long March 5B heavy-lift rocket model launched from Wenchang.

The first and most important part of the Tiangong station — the Tianhe core module — was launched in April last year, marking the beginning of a historic project that had been advocated by the nation's scientists since the 1980s.

Tianhe is 16.6 meters long and has a

diameter of 4.2 meters. At 22.5 metric tons, the craft's weight is equal to that of 15 standard-size automobiles combined.

The module is bigger and heavier than any Chinese spacecraft launched before it. Inside the craft, the astronauts have about 50 cubic meters in which to live and work, much more than the room available in any previous Chinese manned spacecraft. There are separate quarters for working, sleeping, personal hygiene, dining, healthcare and exercise.

The module also has appliances such as an air conditioner and a microwave oven, a refrigerator, a water dispenser and a treadmill.

In late July, Tiangong's first lab module, named Wentian, was launched to connect with the Tianhe section. Weighing 23 tons and 17.9 meters long, Wentian contains eight scientific cabinets. They are mainly used to serve biological and life science studies, and can also support research on the growth, aging and genetic traits of plants, animals and microbes in the space environment.

The exterior of the module has 22 extravehicular payload adapters capable of carrying the scientific equipment needed for experiments that require exposure to space, cosmic rays, vacuum and solar winds.

In addition to its scientific functions, Wentian serves as a backup control station to the Tianhe core module in case of emergency or malfunction. It has all the same flight control devices as those in the core module so the entire Tiangong station can be operated via Wentian if necessary.

The craft also has three separate sleeping quarters and an independent section for personal hygiene. They can be used in emergencies or for handovers by two crews.

In late October, the second lab module — named Mengtian — was hauled into space by a Long March 5B rocket to dock

Big numbers

323

The number of launches conducted by the country's space program since the 10th National Congress of the Communist Party of China in November 2012, accounting for 64 percent of all Chinese rocket flights. In the past decade, the country has completed five lunar exploration missions and five manned space flights.

500

Estimated number of Chinese satellites operating in Earth's orbit

22

The different types of carrier rockets in service in China, 16 of which are members of the Long March family.

4

The number of Chinese probes that have landed on other bodies in the solar system: three on the moon and one on Mars (FIGURES AS OF MONDAY)

with the Tianhe. The addition of Mengtian marked the end of the on-orbit assembly process for the Tiangong station.

Mengtian, the world's largest single-body spacecraft now in active service, contains 13 scientific cabinets used for microgravity studies and experiments in fluid physics, materials science, combustion science and fundamental physics. It also carries 37 extravehicular payload adapters capable of bearing scientific experiments that need to be exposed to cosmic rays, vacuums and solar winds.

A major technical feature of Mengtian is that it can move scientific apparatus out of the Tiangong station without requiring any manual labor by the astronauts to conduct extravehicular experiments and bring them back again.

Moreover, the lab module is capable of sending miniature spacecraft, such as CubeSats, into orbit, the designers said.

So far, four teams of astronauts have lived and worked inside the Tiangong station, which now consists of the Tianhe core module, the Wentian and Mengtian lab capsules, the Shenzhou XV spacecraft and the Tianzhou 5 cargo ship.

The current crew — the three members of the Shenzhou XV mission — arrived at the station on Nov. 30. They are scheduled

to stay until May, when they will be relieved by the crew of Shenzhou XVI.

Serving as a national space-based platform for science and technology, Tiangong is expected to operate in orbit for more than 10 years, and will be open to astronauts from other countries in the near future, according to the China Manned Space Agency.

Starting next year, a third group of Chinese astronauts is scheduled to take part in flights, officials from the agency said. The 18 new astronauts — 17 men and one woman — are in three groups: seven spacecraft pilots, seven spacecraft engineers and four payload specialists.

They are currently undergoing systematic training at the Astronaut Center of China in Beijing before being certified for space missions. China had 21 astronauts in its first two generations. Of them, 16 took part in 10 flight missions, including the latest, Shenzhou XV.

Five members of the first generation who did not take part in any spaceflights during their service have already retired.

Commercial missions

In July, construction of a new space complex began not far from the Wenchang launch center. It aims to become China's first launch site dedicated to commercial missions.

The Hainan Commercial Space Launch Site is a joint venture between the Hainan government and three State-owned space conglomerates. It is expected to tap the growing demand for launch infrastructure from private space enterprises.

"The existing government-run launch centers are well-developed, but they are too busy to handle the growing demand from the commercial space sector, and it is not uncommon for even a government-assigned mission to wait for an arrangement at these sites," said Hu Shengrun, a senior rocket designer at the China Aerospace Science and Industry Corp.

Two private companies — i-Space and Galactic Energy, both based in Beijing — have already succeeded in conducting orbital missions in which carrier rockets have transported spacecraft into space orbit.

Meanwhile, the leader in the private rocket sphere, Galactic Energy, has conducted four successful launches using its Ceres 1 solid-propellant rocket.

According to Xia Dongkun, a vice-president at Galactic Energy, the company's engineers are producing components for several new Ceres 1 rockets, while its designers are developing the Pallas 1, a larger, reusable liquid-propellant rocket model.

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TIMELINE

1. Dec 2, 2019

The Chang'e 3 mission begins, with the aim of sending a robotic probe to the moon. After a 12-day flight, the probe lands, becoming the first Chinese spacecraft to do so and the first craft from any country to achieve the goal in nearly four decades. Yutu, the first Chinese lunar rover, begins operations. It works until July 2016.



2. Nov 2, 2016

China's largest and mightiest carrier rocket, the Long March 5, debuts at the Wenchang Space Launch Center, Hainan province, to transport a scientific-experiment satellite into space. The most technologically sophisticated rocket ever built by China, it has a lift-off weight of 869 metric tons and can carry up to 25 tons into a low-Earth orbit or 14 tons to a geosynchronous transfer orbit. The payload capacity is

about 2.5 times larger than that of any other Chinese rocket.

3. Dec 8, 2018

China's fourth lunar probe, Chang'e 4, is launched toward the far side of the moon. After a 26-day journey, the unmanned spacecraft lands in the Von Karman crater, beginning humanity's first close observation of the area. The Yutu 2 rover, the mission's core component, has worked on the moon for nearly 1,400 days and traveled nearly 1,300 meters on the lunar soil, making it the longest-working rover ever.

4. June 5, 2019

A Long March 11 solid-propellant carrier rocket is used for China's first seaborne space launch in its territorial waters. Prior to the mission, scientists had conducted more than 310 carrier rocket launches at China's four land-based space launch centers.

5. July 25, 2019

i-Space, a Beijing startup, becomes Chi-

na's first private enterprise to successfully conduct an orbital mission. The company launches its first SQX-1 carrier rocket at the Jiuquan Satellite Launch Center in Northwest China, sending two satellites and three experimental payloads into space.

6. July 31, 2020

The domestically developed Beidou Navigation Satellite System is completed, and starts providing full-scale global services. Since 2000, a total of 59 Beidou satellites, including the first four experimental ones, have been launched.



7. Nov 24, 2020

The Chang'e 5 robotic moon mission is launched from Wenchang. After landing on Dec 1, it brings 1,731 grams of lunar soil

and soil back to the Earth on Dec 17, about 44 years after the last lunar substances were returned. The 23-day mission makes China the third country to retrieve lunar samples.

8. July 23, 2020

The Tianwen 1 mission, the nation's first independent interplanetary exploration, is launched from Wenchang. The spacecraft consists of two major components — a rover named Zhurong and an unmanned orbiter. It travels more than 470 million kilometers before entering Mars' orbit in February last year. Zhurong touches down on the planet on May 15 last year and begins work on the surface a week later.

9. April 29, 2021

In-orbit construction of the Tiangong space station begins as the Tianhe core module — the first and central component

— is launched. The station has three parts: a connection section; a life-support and control section; and a resources section. So far, 12 astronauts have lived in the craft.

10. Oct 31, 2022

The Mengtian space lab module is launched from Wenchang to complete the on-orbit assembly of the Tiangong station. Mengtian, the world's largest single-body spacecraft now in active service, is about 17.9 meters long, has a diameter of 4.2 meters and weighs more than 23 tons. There are 13 science cabinets inside the craft to hold scientific equipment. It also carries 37 extravehicular payload adapters capable of carrying experiments that need to be exposed to the space environment.

