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## Chapter 14

# The Development of Space Technology in China: A Unique Way<sup>\*</sup>

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### Foreword

Over the past three decades, the Chinese economy has made eye-catching achievements. Coincidentally, the Chinese space industries have scored outstanding achievements in the past five decades, which greatly promoted the development of social progress, and brought about profound and far-reaching effects. Space technology has turned out to be one of the most important strategic fields of high technology in China.

What exactly is the key point for such achievements? It is innovation, not copying from the experience of any other countries or systems. China has integrated the general rules for economy and for space technology development with its own national characteristics by constant self-adjusting to changing conditions, thus resulting in a unique way of development in the world. The rules of space technology are universal, but different nations have surely experienced their respective characteristics in space activities and technology development.

The Chinese government and space technicians have explored a unique and successful development path for the Chinese space programs by overcoming various difficulties with great wisdom and remarkable courage, and also made

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due contributions to the space exploration of mankind and the peaceful use of outer space.

## **Achievements**

On 8 October 1956, China's first space research institution—the Fifth Research Institute of the Ministry of National Defense of China was established.

Since that day, from the development of sounding rockets to the launch of satellites and manned spacecraft, China's space endeavors have all along been devoted to independent innovation and self-reliance with Chinese characteristics. China's space technology has already ranked among the world's most advanced, which has become the embodiment of China's overall national strength and a window of prosperity.

With moderate investment and within a short period of time, China's space industry has made glorious achievements that the Chinese people have felt proud of, and that the international community has paid attention to. As an important part of world space industry, China's space activities have presented a brilliant record in world space history.

## **Launch Vehicles**

Long March 1, the first Chinese launch vehicle, was successfully launched on 24 April 1970. From October 1996 to 17 August 2011, 102 such launch vehicles were successfully launched in succession.

China's Long March launch vehicles have been developed into 14 models in four series, covering the full orbital range of near-Earth orbit (LEO), Sun-synchronous orbit (SSO), and geosynchronous transfer orbit (GTO). In the technologies for multi-satellite launching by one launch vehicle, high-power cryogenic engine, cluster launch vehicle, geostationary orbit (GEO) satellite launching, and malfunction detection, China is ranked among the world's most advanced.

From 1990 to now, China's Long March series launch vehicles have successfully performed 35 times for satellite launches for foreign countries.

## **Satellites**

China's first manmade satellite was successfully launched in 1970, and this is the first milestone of China's space activities. Until now, China has accomplished a satellite framework of 16 models for various purposes in seven series, including reentry satellite, Dongfanghong broadcast satellite, Fengyun meteoro-

logical satellite, Earth resource satellite, oceanic satellite, Beidou navigation satellite, and scientific experiment satellite. In addition, China has developed two platforms for modern small satellites.

## **Manned Spaceflight**

China initiated its manned spaceflight project in 1992, the second milestone for China's space activities. China's manned space project is of grand magnitude, demanding sophisticated technologies and systems engineering relating to a wide range of knowledge. It includes seven major systems: astronauts, space applications, monitoring and control communications, launching ground, landing site, launch vehicles, and manned spacecraft. In particular, the successful development of the launch vehicle system and the manned spacecraft system promoted China's space activities into a new stage.

**The launch vehicle:** The safety indicator and the reliability indicator for the Long March 2 F Launch Vehicle have reached 0.997 and 0.97 respectively, up to the advanced level of launch vehicle for manned spaceship in the international community.

**The manned spaceship:** The manned spaceship for China's Manned Space Flight Project is the Shenzhou Manned Spaceship, which is composed of three cabins, namely the Orbit Cabin, the Reentry Capsule and the Propelling Module, as well as one segment, namely the Affixed Segment. There are several unique features for the Shenzhou Manned Spaceship:

- in design, the development directly adopts the tri-cabin structure capable of carrying three astronauts; and
- when the spaceship returns, the Reentry Capsule returns to ground while the Orbit Cabin remains in orbit to continue its work for half a year more.

On 29 September 2011, China successfully launched the Tiangong 1 Target Spacecraft, and will launch the Shenzhou 8 Spaceship for a space rendezvous and docking test. By 2015, China will also launch a space lab and work out a solution to space applications with human care in the short term. It is predicted that, around 2020, the manned space station will be built in orbit, in order to carry out space application missions up to a certain scale with human care in the long term. Thus, the manned space activities will play an active role in peaceful development and utilization of space resources while protecting Earth's environment.

*Manned Space Flight, the "Three-Step" Strategy:*

- **Step 1:** in 2003, being symbolized by the launch of the first manned spacecraft to realize the initial manned spaceflight, which was already successfully accomplished.

- **Step 2:** around 2010, achieving the breakthrough of key technologies for astronaut's fulfillment of EVA missions and spacecraft's rendezvous and docking in space. This step is in progress now.
- **Step 3:** around 2015, constructing the 20-ton-class space station, so as to work out a solution for carrying out space application missions up to a certain scale with human care in the long term.

## **Lunar Probing**

In January 2004, China officially initialized its Lunar Orbiter Project, named Chang'E-1 Project. China's space activities entered its third milestone. For China's lunar probing activities, the three-step targets have been set up, namely orbiting, landing and returning.

- **Phase I: Orbiting**—launching the lunar probing satellite to realize circumlunar probing for lunar surface and space environment.
- **Phase II: Landing**—realizing the soft landing and cruise probing on the lunar surface
- **Phase III: Returning**—realizing the return of the lunar probe with lunar samples.

On 24 October 2007, the Chang'E-1 Lunar Probing Satellite was launched, and completed the four-phase flight of entering the initial orbit, the phasing orbit, the Earth-Moon transfer trajectory, and the circumlunar orbit, and successfully entered the circumlunar working orbit on 7 November. And on 20 November, the Chang'E-1 Lunar Probing Satellite transmitted back the lunar probing data, and the first lunar surface image was completed, symbolizing the first total success for China's Lunar Orbiter Project.

On 1 October 2010, the Chang'E-2 Lunar Probing Satellite was launched. After seven days of flight and the performance of three near-lunar brakes, the Chang'E-2 Lunar Probing Satellite smoothly entered the circular circumlunar working orbit at an orbital altitude of 100 km. On 8 November, the partial image for the area of Rainbow Bay on the Moon, an area preselected for the landing of the Chang'E-3 Lunar Probing Satellite, was transmitted and released to the public for the first time, symbolizing a complete success for the preset missions to be fulfilled by the Chang'E-2 Lunar Probing Satellite.

China's lunar probing activities will enter a new phase of development. Around 2013, the missions of soft landing on the lunar surface and cruise probing by the lunar probe will be realized; and around 2017, the reentry lunar probe will be launched to fulfill the mission of lunar sampling and bringing back the lunar samples. The manned lunar landing project can only be carried out until after 2020.

## Approach

Reviewing the development process of China's space industry in the past half century, the most important experience is that, with full consideration on the national demands and conditions, we have all along adhered to the path of development through independent innovation and self-reliance with Chinese characteristics. Such independent innovation and self-reliance are not meant to be achieved by closing the door to the outside world, but to learn the advanced experience and absorb the latest achievements of science and technology in the space industries of the developed countries. Thanks to such efforts, China has been able to score glorious achievements with moderate investment within a shorter period time, of which the Chinese people have felt proud, and to which the international community has paid attention.

1. The authorities at the national level have attached great importance to the development of space industry in China, so that relevant domestic resources can be allocated as a whole to key projects. The specific measures include, first, to identify such key projects, for example, the manned spaceflight project, as special projects with property of national interests, so that the authorities at the national level attach priority attention to them; second, specialized institutions are set up to take the full responsibilities for working coordination from the top level and guaranteeing the full supply of necessary human, financial, and material resources; and third, the development and achievements in those key projects with property of national interests in other industries help to motivate the development of the entire space industry, as well as the growth of national economy.

2. A great importance has been attached to the development strategy and the technology planning. In every five years, the technology development plans and the long-term development strategy for the space industries are set up. Out of tens of thousands of technologies for space projects, four major fields are determined: the core technology, the specialized technology, the forefront technology, and the essential technology, plus almost 200 key technologies, which are taken as the top priority to work on.

3. A practical organization structure for technology innovation has been established to meet the needs of technology innovation. From the initial structure of research academy—research team, to the later structure of research academy—research institute, and to the present structure of R&D centers and research institutes as the main body, an opening and collaborative platform for technology innovation at different stages has provided the organizational guarantee for the momentum of independent technology innovation.

4. The management for space endeavors, in addition to technology innovation, is under constant improvement through practice. Facts have shown that a sustainable enhancement to the capability of technological innovation must be guaranteed by the corresponding management system. Only through the integration of management innovation with technology innovation, and through the promotion to technology innovation by management innovation, can the fundamental issue that constrains the technology innovation be settled. Through 50 years of exploration, an organization structure has been gradually consolidated in China, which is favorable to the development of technology innovation for the space industry. Also taken into shape are the philosophy and methodology in systems engineering, resource optimization, and smooth flow of working procedures, providing substantial support for the implementation of the development strategy for space project management with Chinese characteristics. In a word, it is summed up as one department for overall design, flanked by two commanding lines of the commander in chief and the chief designer.

5. The pursuit of success—the Chinese Aerospace Culture:  
Though unaware of how much the cost would be,  
Though unaware of how much the time would be,  
Yet well aware of what the target to strive for will be.

## **Future**

Subsequent development of China's space activities will be implemented in the following key directions:

- To speed up the R&D of the new-generation launch vehicle with low cost, high reliability, high thrust, non-toxic and non-polluting, the heavy launch vehicle, and the renewable technology for launch vehicles, as well as to establish a space transportation system that meets the national demands;
- To gradually establish China's independent space information and application system;
- To implement the follow-up manned space project;
- To carry out deep space probing activities, represented by the lunar probing; and
- To carry out selected and key scientific experiments in space.

The following is a brief presentation of the new-generation launch vehicle with low cost, high reliability, high thrust, non-toxic and non-polluting:

## **Development of Two Engines**

The hydrogen and oxygen engine with 50-ton class thrust and the liquid oxygen kerosene engine with 120-ton class thrust.

## **Three Modules**

The 5-m diameter module, using two hydrogen and oxygen engines with 50-ton class thrust.

The 3.35-m diameter module, using two liquid oxygen kerosene engines with 120-ton class thrust.

The 2.25-m diameter module, using one liquid oxygen kerosene engine with 120-ton class thrust,

## **Establishment of Three Platforms for Launch Vehicle Series**

The launch vehicle with a 5-m diameter module will be the basic model, from which six configurations for such launch vehicle with 5-m diameter module will be derived, and which will lay a foundation for generating mid-sized and small-sized launch vehicles.

The 3.35-m diameter module will be used as the basis for the 3.5-stage mid-sized launch vehicle, which can be upgraded to the 2.5-stage and 2-stage mid-sized launch vehicles.

The 2.25-m diameter and 3.35-m diameter modules will be used as the basis for small-sized launch vehicles.

## **Conclusion**

The space endeavors are filled with not only hardships but also brilliant prospects. The development and exploration of space is the common cause of mankind, and science and technology is the common wealth of mankind. In review of the development course of China's space endeavors, China has scored enormous achievements by carrying out space activities on independence and self-reliance. Facing the future, China will continue to take the path of independent innovation, and will strengthen its exchange and cooperation with other countries in the international space field to promote the progress of space technologies in the world, and make new contributions to the development of human space endeavors.