# Long March Launch Takes China's Aerospace Technology to a New Platform

by Marsha Freeman

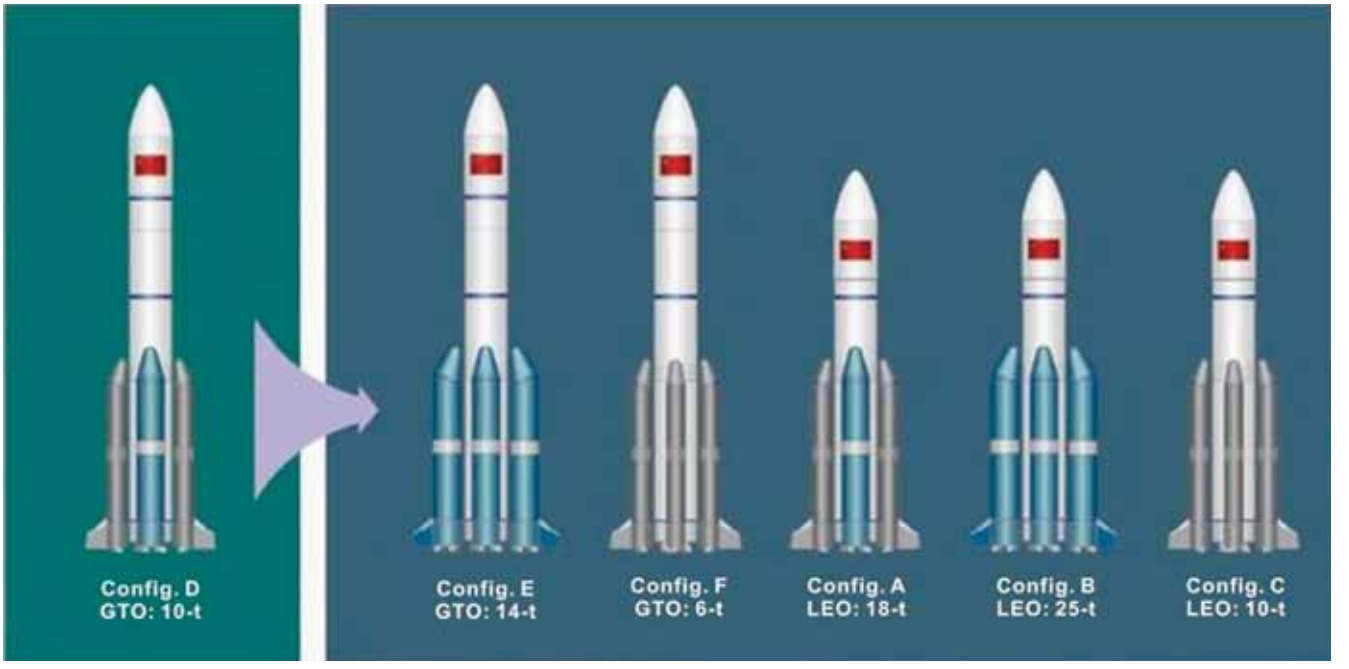
Nov. 6—On November 3, China conducted the test launch of its new Long March 5 rocket. It was a complete success. Liftoff took place at 8:43 PM local time (8:43 AM EDT), and the payload was successfully placed in a predetermined orbit. But the importance of this launch was not to deliver a payload, but to test the results of more than a decade of research and development of a new family of technologies which, in addition to enabling the next-generation lunar and manned missions, and China's first foray into interplanetary space, will increase productivity throughout the economy. Meng Fanxin, a manager in the Tianjin branch of China Aerospace Science and Technology Corp., which built the Long March 5, pointed to this on the day of the launch: "The rocket is a big step forward, not only for China's aerospace industry, but [it] will also boost the development of the country's whole industrial system."

Chinese economists, scientists and engineers, and scholars have studied the historical precedent—the impact of the Apollo program on the U.S. economy. The economic benefit of the Apollo program is most often measured in dollar terms, on the order of a 10:1 return on investment. But what the investment in the American lunar program created, was entirely new technologies in order to meet the challenge of putting men into space. Applied later in manufacturing, agriculture, medicine, transportation, communications, and almost every field of human endeavor, the technological transformation of the U.S. economy through the applications of space technologies was the driver of economic growth for more than a decade after the lunar landings were accomplished. The longest-lasting contribution of the Apollo program was the generations of young people who became scientists and engineers, inspired by space exploration, and the optimism that they could contribute to creating the future.

Since the 1970s, China has used a family of Long March rockets that has seen incremental improvements in payload capacity and other factors over the


China National Space Administration

*The Long March 5 rocket at the launch pad.*




China Aerospace Science & Technology Corp.

*Configurations of the Long March 5 rocket, showing payload tonnages and destinations (geostationary transfer orbit and low Earth orbit).*

decades. But to take the next steps in its manned exploration, with a space station, the challenging lunar sample return and far-side missions, and its first planetary exploration mission to Mars, an entirely new class of launch vehicles is required. The Long March 5, with its ability to deliver a 25-ton payload into low Earth orbit, and place about 14 tons of payload in a transfer orbit to the Moon, now places China in a league comparable to that of the U.S., Russia, and Europe.

The Long March 5 is not an incremental improvement over earlier versions, but a leap in technology, with a payload capacity two-and-half times that of China's existing fleet. This dramatic increase required a complete redesign of the rocket, the development of new materials, the creation of a new launch center and of the processes for carrying out much more complex missions. The new rocket, "is not just a simple enlargement of the diameter [of the rocket]," explained Lou Luliang, a designer from China's State Administration of Science, Technology and Industry for National Defense after the launch. "It raised new requirements of materials, manufacturing, and equipment." He added that components from the new rocket would be retrofitted to older Long March vehicles.

Professor Yang Yuguang, from the Beijing Institute of Electronic Systems Engineering of the China Aerospace Science and Industry Corp., explains that the Long March 5 adopted a larger, 5 meter diameter for its core stage, as compared to the 3.35 meter diameter Long March 2 series, which just weeks earlier had taken a two-man Shenzhou-11 crew into orbit. The larger rocket raised the requirement for the rigidity of the core, because of the increased stress of aerodynamic forces. In order to manufacture the new core stage, Dr. Yang explains, new welding technology was adopted. "Generally speaking," he reports, "spacecraft manufacturing always has higher requirements for welding procedures than other industry."

The new welding technique, he says, can be transferred to other industrial fields, and "benefit daily life." An interesting application that Dr. Yang mentions, is the adoption of these welding techniques from the spacecraft manufacturing factory, for new statues that are being built in China. Many industries require very large welded components, such as pressure vessels for fossil fuel and nuclear plants, so there will be many potential applications.

Another example Dr. Yang cites is the fact that the Long March 5 "needs tens of thousands of connecters, fasteners, and other small parts with very special performance requirements. Most of these parts are made of

titanium alloy. The processing and manufacture of these titanium alloy parts [required] some special technologies. Similar material-making technologies adopted in the Long March 5 are also widely used in industry," he reports.

When a component produced in a factory is flawed, it is generally discarded and replaced. If a component, or even the smallest part of a rocket malfunctions, it could mean the life of the crew. The Long March 5 "is a completely new rocket," Dr. Yang says. "Almost 100 percent of the technologies it used are being applied for the first time. To ensure the success of its launch, the testing procedure is very critical." The new procedures that were developed for "testing facilities in the ground-support system, both the hardware and software, can be transferred automatically to manufacturing industry," greatly increasing productivity. "Failure-detection and testing for malfunctions can ensure the safety of automated manufacturing processes, and efficiently reduce the cost," says Dr. Yang.

## New Space Infrastructure

In order to launch the Long March 5 and the follow-on larger versions, an entirely new launch complex was needed. The larger-diameter core stage could not be transported by rail, as had been the mode until now. The Wenchang launch site, situated on southern Hainan Island, was the ideal location, where rockets of any size could be delivered by ship. Two new specially designed ships, designated Yuanwang 21 and 22, deliver components to the launch center from the factory in the port city of Tianjin. The new factory incorporates the tooling and manufacturing capacity needed for this new family of larger rockets, which will be assembled from modular components. Another advantage of the island launch site, is that falling rocket stages would land in the ocean, and not in villages, as the path of the rocket takes it over water. The more favorable southern latitude also increases the efficiency of each rocket launch. All of these same characteristics account for the Florida location at Cape Canaveral, of the Kennedy Space Center.

The new Hainan Island facility will be for civilian space launches, as distinct from its other launch sites which are used for military payloads. So China has opened up the site to visitors, tourists, and families. Foreign guests were invited to the Nov. 3 Long March 5 launch, which was shown live on television. Educational facilities, a space theme park, and accommodations for both astronauts and visitors are planned for the site. The development of the Long March 5 was approved by the government in 2007, and construction of the new launch site began then.

To increase payload capacity, a safer and more energetic petroleum-based rocket fuel is used in the Long March 5. The new vehicle also includes high-energy liquid hydrogen engines, the largest ever used by China. Using liquid hydrogen for propulsion, which was originally pioneered by the great space scientist Krafft Ehricke, opens up the possibility of more advanced deep-space and planetary missions. The cryogenic liquid hydrogen must be kept at near-zero-degree temperature, requiring handling technologies which can also be used in industry.

As the new materials, technologies, and processes developed for the Long March rocket are "spun off" into industry as well as people's daily lives, Dr. Yang says that "most of the benefits from making the Long March 5 are indirect technological transfers, which we can not see or describe directly. But the whole national economy indeed gets a remarkable return from this project."

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