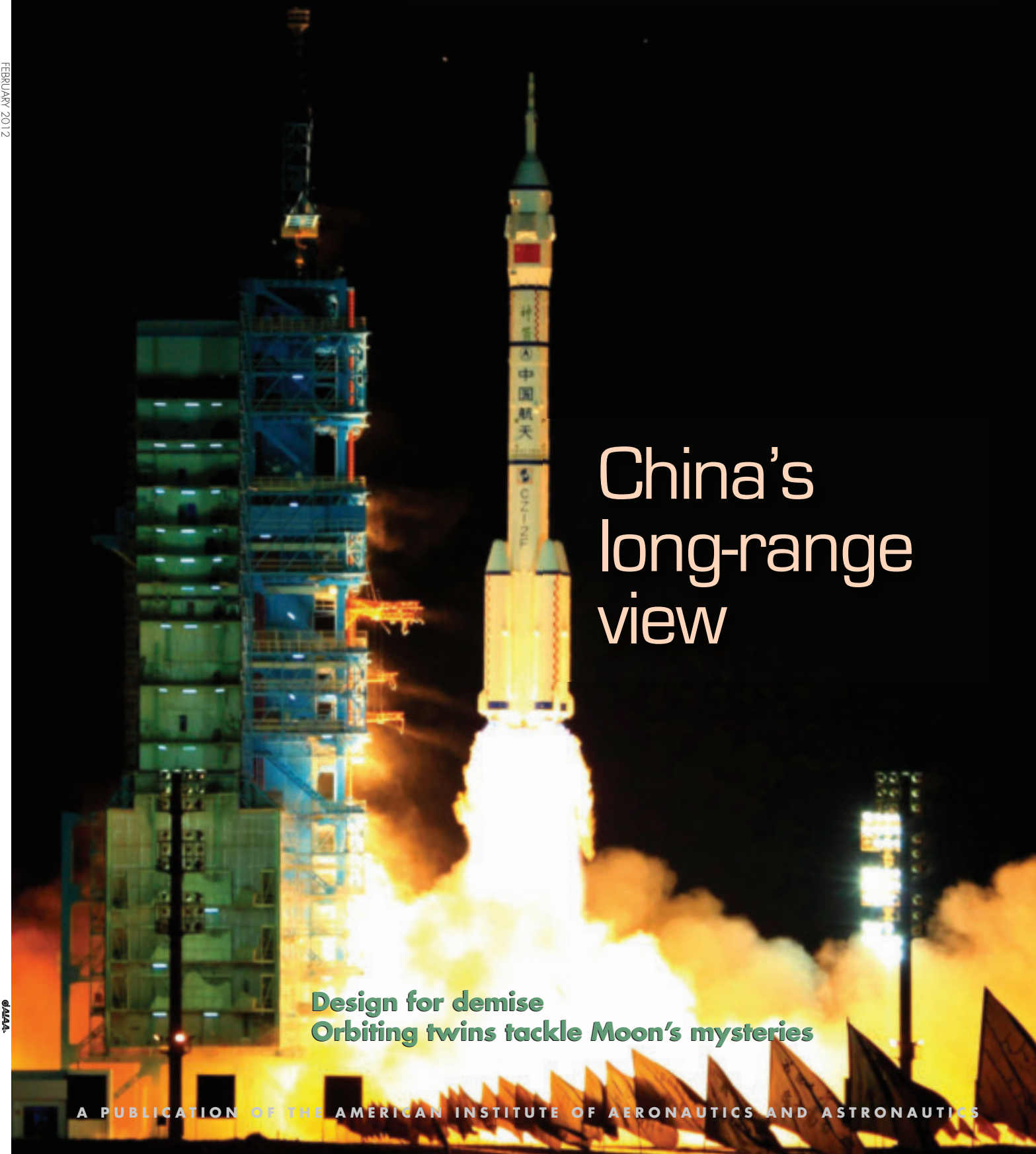
February 2012

AEROSPACE AMERICA

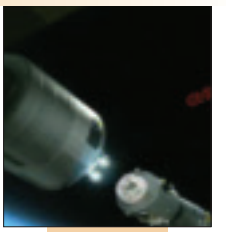


China's long-range view

Design for demise

Orbiting twins tackle Moon's mysteries

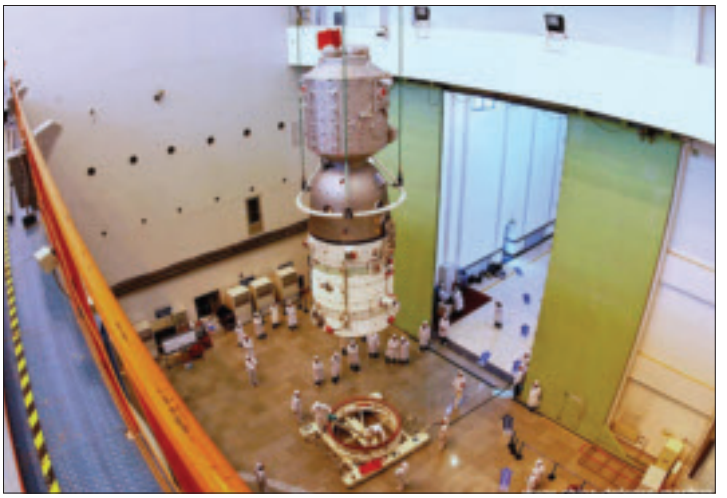
A PUBLICATION OF THE AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS



China's long-range view

THE NOISE SURROUNDING China's use of an Australian space tracking station in November threatened to overshadow what the country achieved when it managed to run two unmanned spacecraft through two dockings in quick succession. What was really achieved was China hauling itself up to the level of space transport roughly equivalent to where the U.S. was during the Gemini program in 1966.

That's not to say it was not a real achievement. The U.S. had been galvanized by competition from the then-Soviet Union with the 'Sputnik moment' (the first satellite, in 1957) and the first manned spaceflight, in 1961. It has taken China a little longer, but from a far lower technical baseline—it has jumped from its first manned, orbital spaceflight with a crew of one in 2003 to three-crew vehicles, space walks, and now a docking system in just eight years.



A Shenzhou successfully docked twice with the Tiangong 1.

Setting, and meeting, goals

In 2003 the China National Space Administration issued a white paper stating its intentions. For the short term, these were:

- Developing an Earth observation system.
- Building an independent satellite telecommunications network.
- Setting up an independent satellite navigation and positioning system.
- Offering commercial satellite launch services.
- Building a remote sensing system.
- Studying space science topics such as microgravity, space materials, life sciences, and astronomy.
- Planning for exploration of the Moon.

Scientists and engineers have managed various levels of success in most of these areas, some of which in any case are obviously continuing fields of endeavor.

For the longer term, the nation's targets are:

- Improving its standing in the world of space science.
- Building a manned space station.
- Sending manned missions to the Moon.
- Establishing a manned lunar base.

Progress in these goals is proceeding, with the first certainly achieved and the second now firmly in sight, though of course nothing is certain in high-tech projects except that there will be surprises and, very possibly, tragedies. In the history of manned spaceflight so far, and making a possibly large assumption about negative information being widely available, the *Encyclopaedia Astronautica* says there have been five crews lost, involving about 2% of manned missions.

The saving grace for China is that its scientists have not been sprinting ahead at breakneck speed to push people into space. The plan for the space station, for instance, envisages manned docking tests starting in 2012 and completion of a relatively small 60-ton station by 2020.

The pace of the November docking experiments makes the point. The docking target was a sample module of the future station, called Tiangong 1 (Heavenly Palace 1), in this case intended to survive in space for only two years while testing continues. An unmanned spacecraft called Shenzhou 8 (Divine Craft 8) was launched on September 29 and rendezvoused with Tiangong 1 on October 31.

After various checks were carried out, the vehicles docked for the first time on November 2, then orbited together until separation and a second docking on November 14. Shenzhou 8 contained two mannequins in spacesuits, but at least one of the two future docking trials this year is expected to have human crew aboard.

The capsule returned home as planned, on November 17. Having proved that the Shenzhou capsule can rendezvous and dock automatically with the target craft, the docking ring and associated technology have been shown to work properly. This is both a step ahead of U.S. equipment (which has not done this automatically) and a step behind, because it has yet to be done by humans.

Next is to prove that cargo-carrying rockets can also dock autonomously, as the means of resupplying a space station. Whether this will happen before Shenzhou 9 and 10 are launched to do a manned docking and enter the Tiangong 1 module has not been announced, but it would seem logical. Nor has it been said whether Shenzhou 9 will have a crew of two or three—some suspect the cautious approach

will be used for the first manned docking in case of problems, as two people need less oxygen and supplies than three. The Tiangong 1 module is fairly small, so logistics matter.

Space station and lunar base

When the space station is eventually set up, it is to comprise three modules grouped around a 'docking center,' with at least four docking ports at right angles to each other. First is the core module, about 18 m long—the 'house' of the station containing living space and controls for power supplies and communications. On each side and connecting to the docking center is an experiment module 14.4 m in length and, like the core module, having a maximum width of 4.2 m. Each module weighs 20-22 tons, for a total station weight of about 60 tons, compared with the international space station at 419 tons.

Opposite the core module will be a supply rocket that will dock automatically, while behind the core module a Shenzhou spacecraft will be docked to transport crew to and from the Earth.

Work is proceeding in parallel on lunar missions—an unmanned lunar mission may be launched this year as a follow-on to two lunar probes launched in 2007 and 2010.

Not that China sticks so rigidly to the plan—first announced in 1992—that it is incapable of changing according to circumstances. Problems developing a rocket with enough thrust to cater to the lunar missions have brought about a delay and a readjustment of intended payloads. It is now intended that an automated lunar rover vehicle be sent in 2013, to be followed in 2017 by an automated landing and a return with surface samples. A manned landing followed by the setting up of a lunar base are intended for 2025-2030.

Keeping track

That China tends to stick to what it says it will do, and that much of this information has been in the public domain for a long time, made it all the more surprising that media leapt on the fact of China using an Australian tracking station during the Tiangong 1 docking experiments as if it were indicating some nefarious guile.

The station at Dongara, about 200 miles north of Perth in western Australia, is owned by the Swedish Space Corporation (SSC), which in turn is owned by the Swedish government. SSC has worked with China's space scientists and engineers openly in relation to agreeing to help set up a meteorological satellite ground station at Esrange in northern Sweden in 2011 and a project to build an antenna system near Santiago, Chile, in 2010.

The docking target for the November effort was a sample module of the future Chinese space station, called Tiangong 1.

SSC also established an extension of one of its Dongara sections for China as 'ITAR-free' (clear of restrictions under the International Traffic in Arms Regulations, the U.S. rules that govern exports and imports of defense-related items). None of this was secret—all three of these items were announced in an SSC newsletter in June last year.

Through separate subsidiaries, SSC operates two distinct Dongara ground stations—Dongara West and Dongara East. Dongara West is owned, operated, and maintained by SSC's U.S.-based subsidiary, Universal Space Network (USN). It has been in operation since 2001, eight years before USN's purchase by SSC. USN operates under U.S. government approval and oversight and mainly serves U.S.-government and commercial customers.

Dongara East is a new facility that is owned and operated by SSC. It provides spacecraft-related services to European, Asian, and other civil space agencies and commercial space companies. It was used by SSC to support the docking between Shenzhou 8 and Tiangong 1.

Each of the facilities has its own control center and separate antennas and ground equipment, and SSC and USN maintain what SSC describes as "separate and distinct capabilities between its Dongara West and Dongara East ground stations."

The fact that Australia is a strong U.S. ally had nothing to do with China's need for another ground station (or as many as it can get), which is a product of simple physics. The Tiangong 1 target was in a low Earth orbit, limiting the 'visibility' of any single point on the ground to its sensors to about 15-20 min. Its time for each orbit was about 90 min, so each time it came around to the same latitude the Earth had moved eastward by about 1,350 nautical miles. Communications between the satellite and the ground are therefore limited to places covered by a circle below the satellite of 4,800-3,600 nautical miles in diameter, a circle that is apparently moving southward at more than 14,000 mph. A spread of ground stations is therefore needed to maintain contact with the spacecraft; but even then, coverage is incomplete.

China has in the past used four ground stations, in Pakistan, Namibia, Kenya, and Chile, as well as its domestic tracking stations and a fleet of ships equipped with large dish antennas. For Shenzhou missions, the three Yuanwang (Long View) ships have previously been deployed to the Yellow Sea in the western Pacific, the South Atlantic, and the Indian Ocean off the coast of western Australia. The use of Dongara near Perth thus frees one ship to be deployed elsewhere,

The first Tianlian data relay and tracking satellite was launched on Long March 3C in April 2008.

extending coverage of communications with the spacecraft.

In addition, although it may have been necessary for political reasons to use the ships, they are necessarily moving points of reference and so inherently less accurate in orbital measurements than ground stations or other satellites referenced to ground stations.

There are also two Tianlian (Heavenly Link) tracking and data relay satellites, the second of which was launched in July, before Shenzhou 8's docking mission. According to the Internet magazine *Spaceflight Now*, the ground stations provided only about 12% coverage of each orbit; the Tianlian satellites in geostationary orbits have increased this to more than half of each orbit.

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The simple fact is that China is proceeding with its space projects and is gaining ground in its quest for knowledge and ability at its own pace. It is not in a race with the U.S., unless the race is a marathon. Nor is it in any hurry to cooperate with U.S. space efforts. Why would it, when U.S.-inspired export controls are aimed at it?

Having been kept out of U.S. space activities for some years, China has had to develop at its own rate and find its own solutions—whether or not these are 'borrowed' from other countries' technologies is another story.

This has led to a situation whereby now, if a Chinese spacecraft were—in theory—asked to rescue people from the international space station, it would be unable to help because its docking equipment does not match that of the ISS or the Russian spacecraft that now resupply it.

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