"Shenzhou - China's First Piloted Spacecraft"

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For the past 40 years, manned spaceflight has been dominated by the United States, the Soviet Union and its succesor, Russia. This changed at 22:30 UT on November 19, 1999 when China launched "Shenzhou" (or "Divine Craft" in English) - the long awaited automated test flight of the first Chinese manned spacecraft. While a a heated debate has started about the implications of this launch and the actual utility of the craft, the launch does make China the third nation capable of launching humans into space.

Chinese intentions to send people into space were made public for the first time back in February of 1978. Over the coming years Chinese authorities confirmed that manned space capsules, a space station, and even a spaceplane were being developed and that people were being trained to fly them. But the infant program came to an abrupt halt in December 1980 because of its cost. Aspirations for a manned space program languished until April of 1992 when the Chinese leadership decided that the country could finally afford the effort. The Chinese National Manned Space Program, also known as Project 921, was officially started with the goal of launching a manned spacecraft before the end of the millennium. The Shanghai Astronautics Bureau got responsiblity for Project 921 with Qi Faren assigned as its Chief Designer.

Early proposals called for the development of a new series of launch vehicles that used kerosene and LOX as propellants instead of the highly toxic nitrogen tetraoxide and UDMH used in the CZ-2 ("Chang Zhen-2" or "Long March-2") family of commercial launchers. Eight different spacecraft were also proposed including a three-module design similar to the Russian Soyuz and some early American Apollo design proposals. While some might conclude that Chinese engineers simply copied these earlier designs, it is more of a case of independently adopting the same engineering solution to the same problem. A three-module design (with a small recoverable capsule and expendable service and laboratory modules) maximizes the pressurized work volume for a given orbital mass. Capable of carrying four passengers, the original Project 921-1 design called for a large return capsule shaped like a truncated cone and having a greater base diameter than its service module.

In October of 1993 these proposals were presented for inclusion in the Chinese Eighth and Ninth Five Year Economic Plans but they proved to be far too ambitous. The three-module Project 921-1 spacecraft was approved but the development of the new family of launch vehicles was deferred. Instead, a man-rated CZ-2E designated the CZ-2F would be used to orbit the new spacecraft. The 921-1 spacecraft would allow China to get badly needed spaceflight experience and could eventually be used to ferry crews to the new 921-2 space station.

The CZ-2E is the largest in a series of launch vehicles the Chinese have developed for domestic and international commercial use. First launched in 1990, the CZ-2E consists of a two-stage CZ-2 core with four liquid fueled strap-on boosters with a total liftoff thrust of 6,526 kilonewtons. The modifications made to the CZ-2E to produce the CZ-2F have not been revealed but likely include measures to increase hardware reliability and changes to the upper

stage to handle the large 921-1 spacecraft and its fairing. At launch the CZ-2F with the faring and the launch escape system stands about 51.2 meters tall and has a liftoff mass of about 464,000 kilograms. It is estimated payload is over 8,000 kilograms into low Earth orbit. A dedicated launch facility for the manned program was built at China's rocket range at Jiuquan in the Gobi Desert. Included was a large assembly building similar to the American VAB and apparently capable of handling two rockets at a time, movable launch platforms, and a single launch pad.

By 1994 Chinese officials approached Russia and its cash-strapped aerospace companies for assistance. In 1995 they were able to purchase in a private deal with RKK Energia (Russia's lead manned spacecraft manufacturer) outdated rendezvous and docking hardware as well as a Soyuz descent module stripped of all its avionics and most essential systems. While the fragments of Russian technology were useful, Chinese engineers still had to design and build most of the important systems for themselves contrary to popular opinion. In order to save development time, however, they did adopt a modified Soyuz descent module configuration for use in a two-man version of the 921-1 spacecraft. The Russian government also provided astronaut training starting in late 1996 for a pair of Chinese pilots and over a dozen doctors and engineers

The final 921-1 design seen in Shenzhou had a length of 8.8 meters, a diameter of 2.8 meters and a mass of about 7,600 kilograms - all larger than Soyuz. Despite its superficial resemblance to the Russian Soyuz, Shenzhou has a number of design improvements over its Russian equivalent. The service module carries solar panels that can gimbal to face the Sun. The Shenzhou orbital module is more cylindrical in shape and likely offers substantially more internal volume than its Soyuz equivalent. In addition, the Shenzhou orbital module carries its own pair of solar panels to provide subtantially more power for operations in orbit. The front of the orbital module can carry either a docking system or, as in this first flight, a small experiment module.

While Chinese officials wanted a manned flight in time for the 50th anniversary of the Revolution on October 1, 1999, schedule slips pushed this back but an unmanned test flight remianed a possibility. But even this date came and went without a launch. While the propaganda value of an October 1 flight was lost, launch preparations continued and Shenzhou finally lifted off on November 19 (UT). On board for the flight was a dummy "taikonaut" (the Chinese equivalent for "astronaut"), scientific equipment, various seeds, the flags of China and Macau, and postage stamps. After CZ-2F successfully finished its job, Shenzhou had been placed into a 196.3 by 324.4 kilometer orbit inclined 42.6 degrees to the equator. It has been speculated that this unique orbital inclination was chosen to avoid flying over Japan during ascent.

Once in orbit, the solar panels on the service module were deployed but but the same was not apprently planned for the set on the orbital module. While Shenzhou was capable of maneuvering in orbit, Chinese engineers adopted a simple flight plan for this first flight and no major orbit changes were attempted save for the retrograde burn at the end of the mission. Towards the end of its 14th orbit as Shenzhou was passing over the South Atlantic, it received the descent command from the Chinese tracking ship Yuan Wang 3 (one of four ships deployed around the globe) stationed off the coast of Namibia at 18:49 UT on November 20. Unlike modern variants of the Soyuz, Shenzhou jettisoned its orbital module before initiating descent. After the service module completed its job, it too was cast off.

When the worse of reentry was done, a drogue chute deployed at 30 kilometers altitude followed later by a single main parachute. Just 1.5 meters above the ground, the heat shield was dropped and braking rockets fired to soften

the impact. Shenzhou came to rest in Inner Mongolia 415 kilometers east of its launch site. Only 10 kilometers from its intended landing point, Shenzhou successfully completed its 14-orbit mission in 21 hours and 11 minutes. China was justifiably proud of its accomplishment.

Future plans for the Chinese manned space program are still subject to speculation. Undoubtedly one or two more unmanned test flights of the 921-1 design will take place before the first flight with a crew. While a manned flight is still possible before the end of the millineium (i.e. its actual end on December 31, 2000), it could be 2001 before it actually occurs. Still in development is a Project 921-2 space station which could fly by 2015. In the interim, missions with two 921-1 spacecraft which could dock in orbit are likely in order to build experience. The Chinese are also working on a 921-3 spaceplane similar to the USAF X-20 Dyna Soar but capable of carrying two passengers. With any major Chinese participation in the ISS program is likely to be years away, they will still be laying the groundwork for a vigorous, independent program which may one day compete with the other space powers.

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