CHINA'S HYBRID SPACEPLANE COULD RESET THE 21ST CENTURY SPACE RACE

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This screenshot from state television broadcast on the hypersonic spaceplane shows an aerodynamically optimized aircraft beginning to accelerate to hypersonic speeds. Operating such a spaceplane by 2030 would place China ahead of the space race, and other races.

While SpaceX is making news with its recoverable rockets, China announced that it is working on the next big thing in spaceflight: a hypersonic spaceplane.

The China Aerospace Science and Technology Corporation is beginning advanced research on a high tech, more efficient successor to the retired Space Shuttle, with hybrid combined cycle engines that can takeoff from an airport's landing strip and fly straight into orbit. The hybrid space plane's combined cycle engines would use turbofan or turbojet engines to takeoff horizontally from a landing strip. Once airborne, the engine then shifts to ramjet propulsion and, as speed increases, adjusts into a scramjet engine with supersonic airflow. At the scramjet stage, the hybrid

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spaceplane would enter hypersonic flight in 'near space', the part of the atmosphere between 20km to 100km above sea level. Finally, the hybrid spaceplane would use its rocket motors to push out of near space and into orbit.

Broadcasts by both state television broadcaster CCTV, and its English service, note that the CASTC spaceplane's easy reusability would exponentially bring down space launch costs.

China Combined Cycle Turbo-ramjet engine Variable Cycle

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The combined cycle engine shares the same inlet and exhaust nozzle for both the turbojet/turbofan and ramjet. In the upper diagram, the air intake ramps behind the ramjet spike direct airflow into the turbo core. In the bottom diagram, the air intake ramps gradually block off air flow to the turbo core, redirecting air into the ramjet combustion engine for high supersonic (Mach 3.0-Mach 4.0). Chinese combined cycle engines like this blueprint would be paired with a scramjet (presumably via changing the ramjet) and a separate rocket motor to create a hypersonic space plane.

Skylon

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Skylong Space Plane Reaction Engines

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While the Skylon and the Chinese hypersonic space plane are both powered by combined cycle air breathing engines and rocket motors, the British Skylon uses pre-cooled jet engines built by Reaction Engines Limited to achieve hypersonic atmospheric flight, as opposed to scramjets. Both spacecraft will probably first fly around the mid 2020s.

China Hybrid Spacecraft

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Hybrid Propulsion

While this CCTV-13 clip of the hybrid spacecraft appears instead to show a conventional space rocket, China plans to have a combined cycle engine and rocket motor prototype ready for testing by 2021.

Zhang Yong, a CASTC engineer, claimed that China will master the spaceplane's technologies in the next three to five years, and a full-scale spaceplane would then enter service by 2030.

Interestingly, another CASTC engineer, Yang Yang, mentioned that the spaceplane would improve "ease of access to space for untrained persons," as the space plane would have more gradual

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acceleration than a space launch rocket (reducing the physical strain on astronauts during takeoff), suggesting a version of the spaceplane which could be used for space tourism.

CSAA Feng Ru Award 2015

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Feng Ru

Professor Wang Zhenguo was one of the nine recipients of the 2nd Feng Ru awards at CSAA's biennial conference in September 2015. His successful scramjet engine may be the core of the combined cycle engine for the planned hypersonic space plane.

China UAV Mach 4 Supersonic Hypersonic

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The Missing Drone

China was rumored to make the first flight of a Mach 4+ test drone in September 2015. Launched from an H-6 carrier aircraft, the drone fired up its combined cycle turbo-ramjet engine to accelerate from subsonic to high supersonic speeds. Given CASTC confidence in applying preexisting aeronautical experiments to build a working prototype by 2021, it seems that the September 2015 flight was for real.

Getting the complex technologies, like the combined cycle ramjet/turbo engine, in the reported timeline is an extremely ambitious target. Yet China is actually a world leader in a number of the key technologies for the project. In 2015, Professor Wang Zhengou was awarded the Feng Ru prize (China's top aeronautical medal) for his work in successfully developing and flying a scramjet engine, making China the second nation in the world after the United States to master scramjet technology. CASTC's rapid research timeline also suggests that the reports in 2015 of a Mach 4 test flight for a recoverable drone testbed for a combined cycle ramjet/turbofan engine were accurate. And China also has the world's largest hypersonic wind tunnel, the Mach 9 JF-12, which could be used to easily test hypersonic scramjets without costly and potentially dangerous flight testing at altitude.

China already has a variety of advanced solid-and liquid-fuelled space rockets and even China's historical weakness in turbine engines may not be a problem (the proven WS-10 turbofan is likely to provide enough thrust for the combined cycle engine's ramjet to take over). For CASTC, the biggest challenge may be in integrating all these components into a single propulsion package, as well as building an airframe light and strong enough to resist the rigors of hypersonic flight and atmospheric reentry

China hypersonic aircraft

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The Future of the PLAAF, 2030?

This "what if" piece of CGI fan art from the Chinese Internet shows what a hypersonic military aircraft could look like; with a streamlined fuselage, a large ventral air intake and relatively small wings. (The artist imagines that this hypersonic bomber could carry a payload of eight tons.) Flying in near space (20km to 100km altitude), hypersonic aircraft can easily dodge existing air defenses (and they are generally too maneuverable for anti-satellite and missile defense systems to work

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well against them).

Whether the project meets with success within the targeted timeframe or it slips by several years, the results would be significant, and not just on the civilian side of any space race. In addition to increasing the rate of access and lowered costs for space launches, the Chinese military could draw direct military benefits from the combined cycle engine technology. Without the rocket motor component, the combined cycle engine would be a good fit to power hypersonic UAVs and manned aircraft. Flying in near space at speeds above Mach 5, such aircraft could have global reach, while their speed and high altitude would make them effectively immune to all existing air defense systems (though the turbine part of the engine would need to emphasis fuel efficiency and high thrust to weight).

China Hypersonic Plane Bomber Shadow Dragon

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Shadow Dragon Hypersonic Bomber

The Shadow Dragon hypersonic bomber concept, from the PLAAF's Engineering College, won a second prize in the 4th National Future Aircraft Design Competition at the 2010 Zhuhai Airshow. That the PLAAF has long been making such high profile public efforts to promote hypersonic and near space aircraft suggests that such systems are envisioned to be a key part of China's future arsenal.

Coming on the heels of other Chinese space advances, including the successful tests of a 3 meter diameter solid rocket booster, and the fuel turbopump for the LM-9 superheavy rocket, the present attention given to such a longterm project is notable. The high profile broadcast of Chinese breakthroughs in space technologies suggests that, in addition to boosting Chinese prestige, the Chinese leadership is looking to raise public awareness and support to justify costly investments in next generation space technology like hybrid spaceplanes and super heavy "Moon" rockets. Getting the first mover advantage in these aerospace milestones would definitely give China

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superpower status in both Earth and space.

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