

Ingenuity - Mars Helicopter



Ingenuity first flight Apr 19, 2021

NASA and JPL officials described the first Ingenuity flight as their "Wright Brothers moment", by analogy to the first successful airplane flight on Earth. A small piece of the wing cloth from the Wright brothers' 1903 Wright Flyer is attached to a cable underneath Ingenuity's solar panel. In 1969 Apollo 11's Neil Armstrong carried a similar Wright Flyer artifact to the Moon in the Lunar Module Eagle.

Ingenuity is a small robotic solar helicopter operating on Mars as part of NASA's Mars 2020 mission. On 19 April 2021, it successfully completed the first powered controlled flight by an aircraft on a planet besides Earth, taking off vertically, hovering and landing. The battery-powered coaxial drone rotorcraft is serving as a technology demonstrator for the potential use of flying probes on future missions to Mars and other worlds, and will have the potential to scout locations of interest and support the future planning of driving routes for Mars rovers.

Ingenuity travelled to Mars attached to the underside of the Perseverance rover, arriving at the Octavia E. Butler Landing site in Jezero crater on 18 February 2021. It deployed on 3 April 2021, and after unloading the drone Perseverance drove approximately 100 m (330 ft) away to allow it a safe "buffer zone" in which it made its first flight. First takeoff was on 19 April 2021 at 07:15 UTC, with livestreaming 3 hours later at 10:15 UTC confirming the flight. Ingenuity rose 3 m (9.8 ft), hovered there for about 30 seconds, before returning to the surface of Mars with a total flight time of 39.1 seconds.

Because the atmosphere of Mars is only about $1/100$ as dense as that of Earth at surface level, it is much harder for an aircraft to generate lift, a difficulty only partially offset by Mars' lower gravity (about a third of Earth's). Flying close to Mars' surface has been described as equivalent to flying at more than 87,000 ft (27,000 m) above Earth, an altitude that has never been reached by existing helicopters. Made mostly of carbon dioxide, Mars' atmosphere requires blade rotation speeds of 2,400 rpm for Ingenuity to stay aloft, about five times what's needed on Earth.

The helicopter uses contra-rotating coaxial rotors about 1.2 m (4 ft) in diameter. Its payload is a high resolution downward-looking camera for navigation, landing, and science surveying of the terrain, and a communication system to relay data to the Perseverance rover. Although it is an aircraft, it was constructed to spacecraft specifications in order to endure the g-force and vibration during launch.

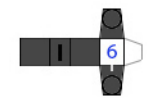
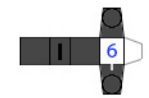
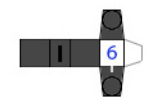
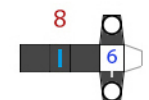
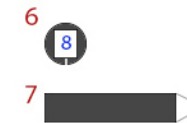
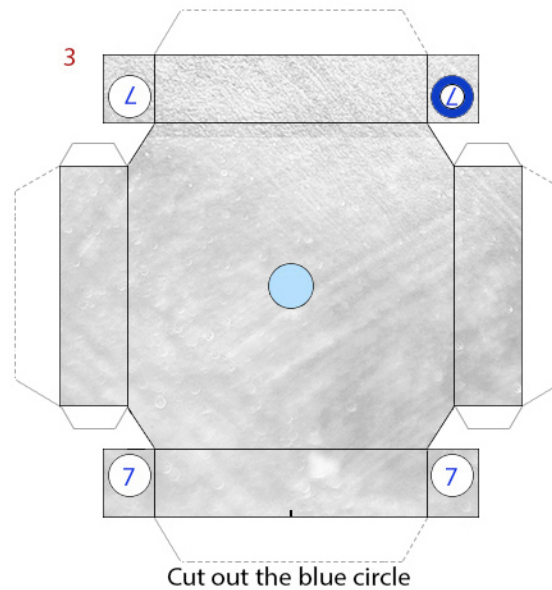
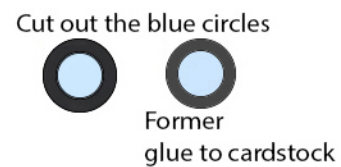
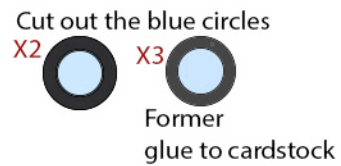
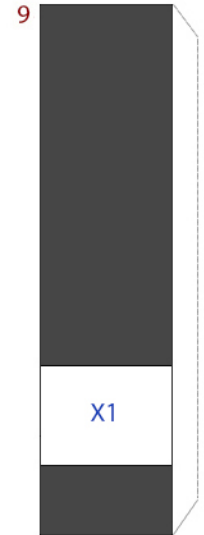
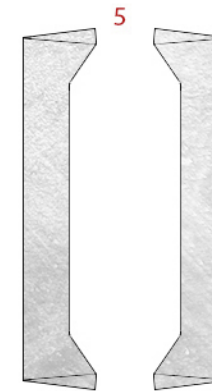
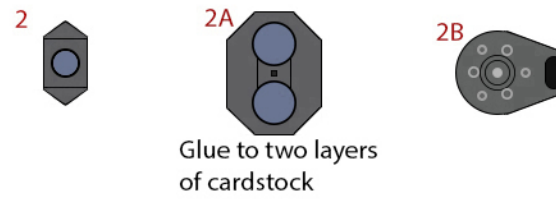
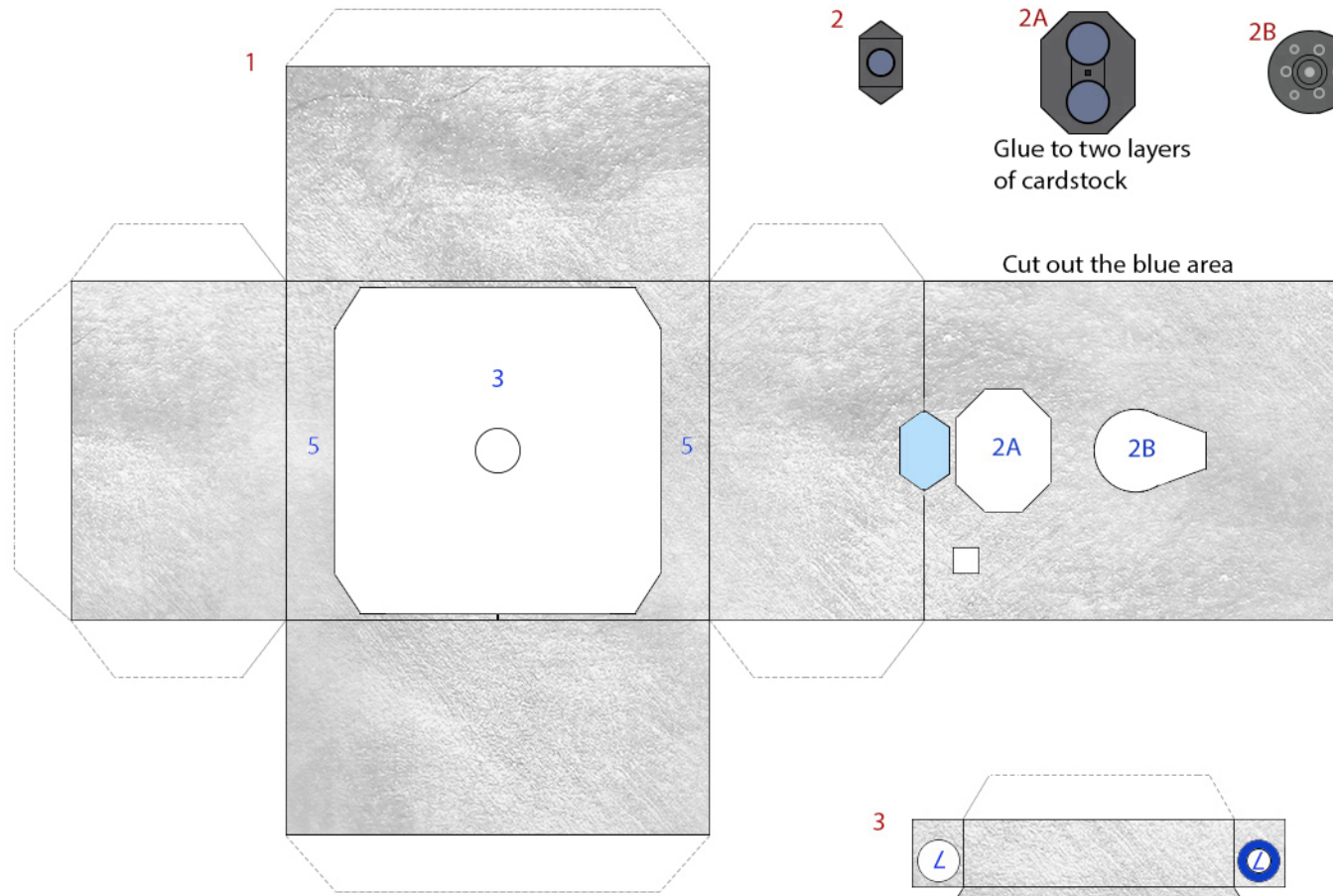
The Ingenuity technology demonstrator could form the foundation on which more capable aircraft might be developed for aerial exploration of Mars and other planetary targets with an atmosphere. The next generation of rotorcraft could be in the range between 5 and 15 kg (11 and 33 lb) with science payloads between 0.5 and 1.5 kg (1.1 and 3.3 lb). These potential aircraft could have direct communication to an orbiter and may or may not continue to work with a landed asset. Future helicopters could be used to explore special regions with exposed water ice or brines, where Earth microbial life could potentially survive. Mars helicopters may also be considered for fast retrieval of small sample caches back to a Mars ascent vehicle for return to Earth such as the one to be launched in 2026.

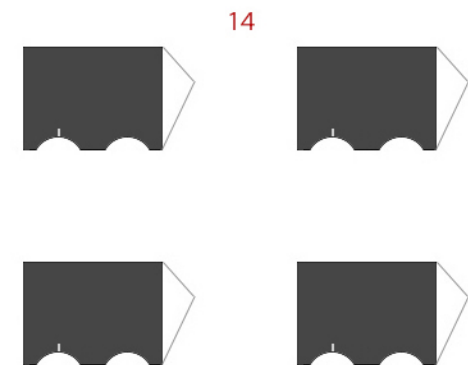
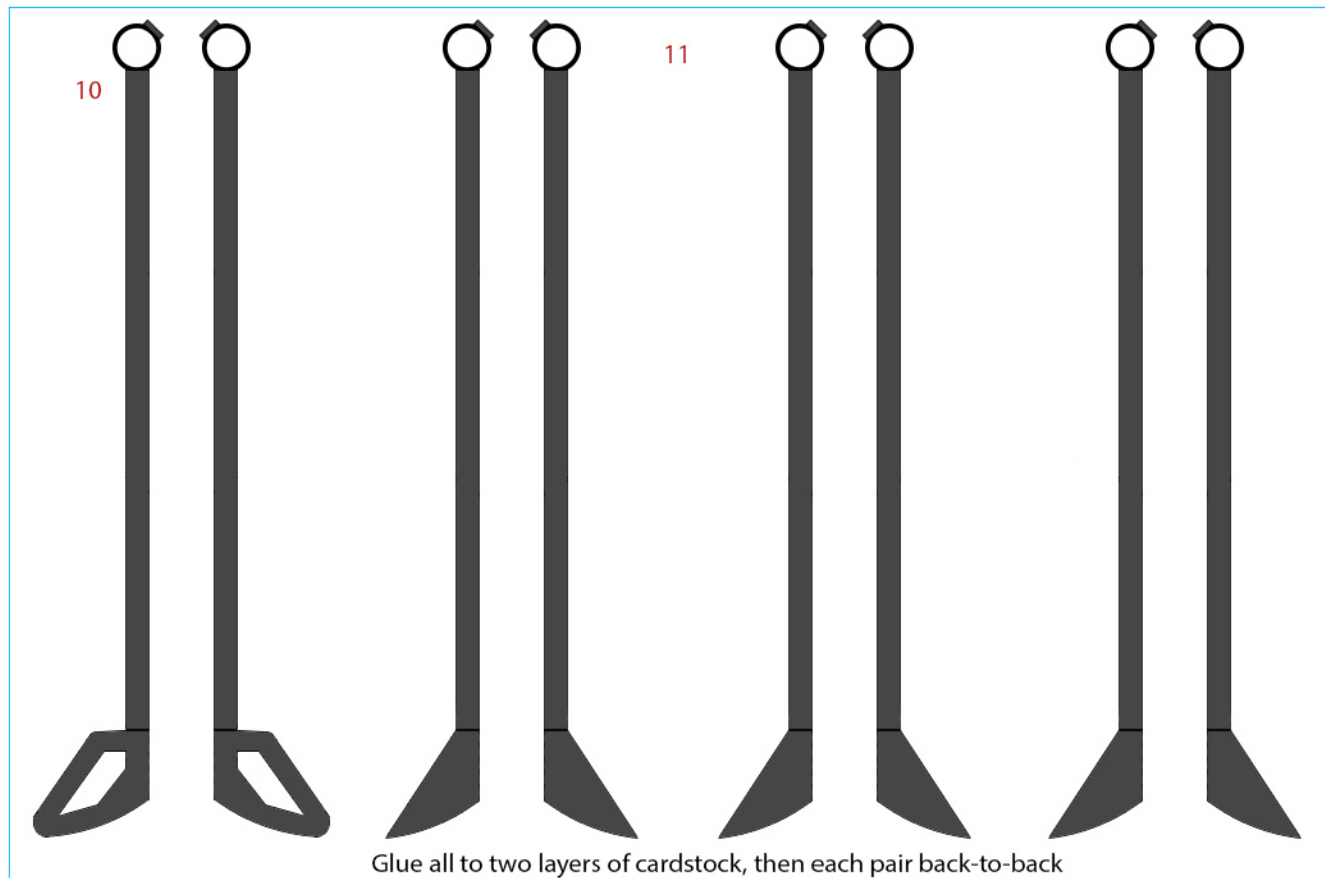
Ingenuity made five successful flights between April 19 through May 7, 2021.

Zach's



Ingenuity - Mars Helicopter





Cut out the
blue circle



19 Former-glue to
cardstock, cut out
the blue circle



15 Former-glue to
cardstock, cut out
the blue circle



Cut out the
blue circle



Former-glue to
cardstock, cut out
the blue circle



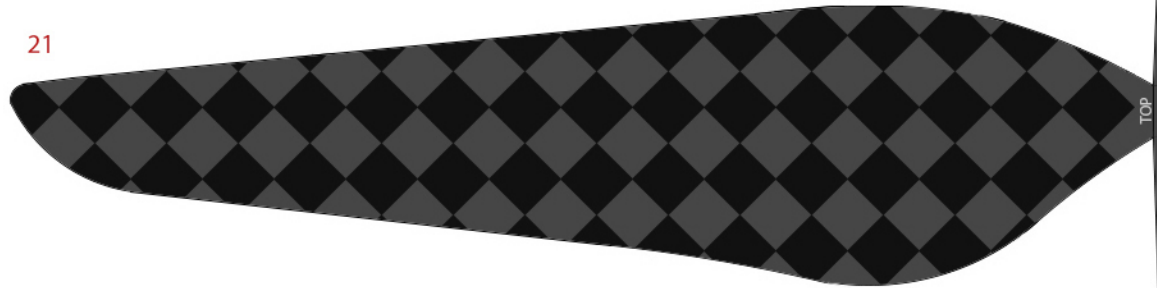
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the blue circle



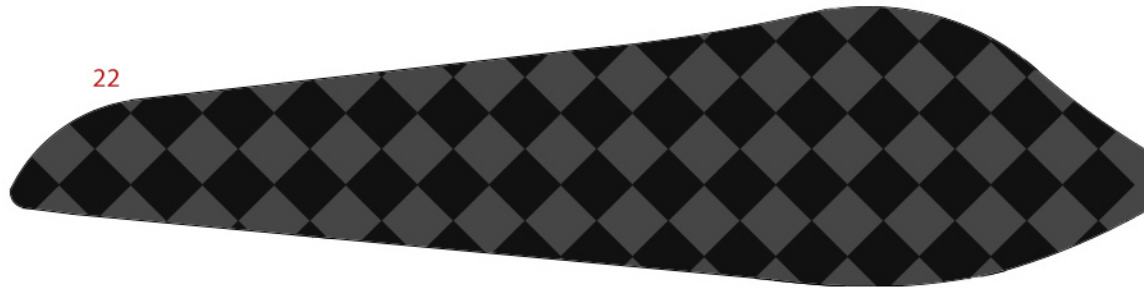
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21



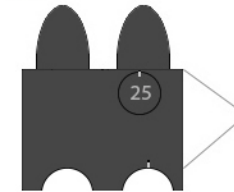
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24 Former, glue to cardstock



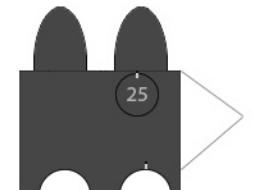
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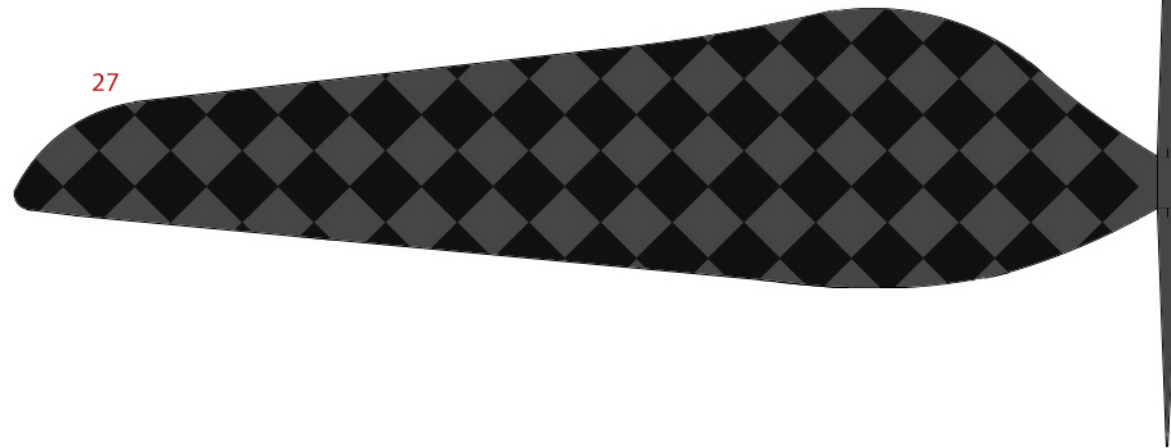
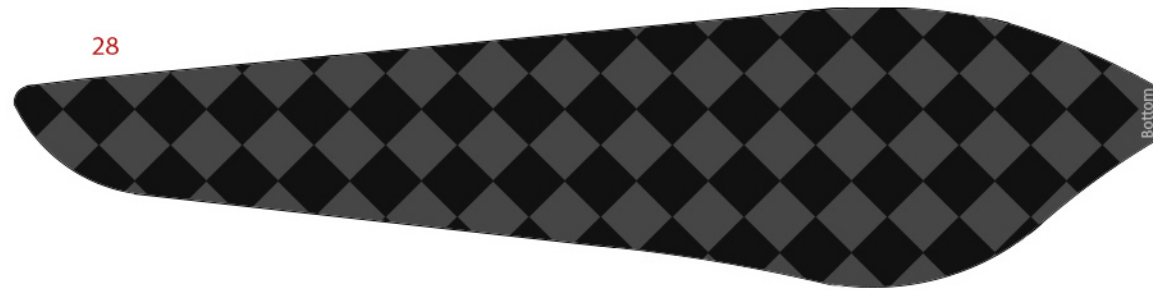


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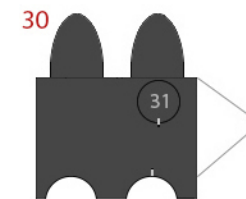


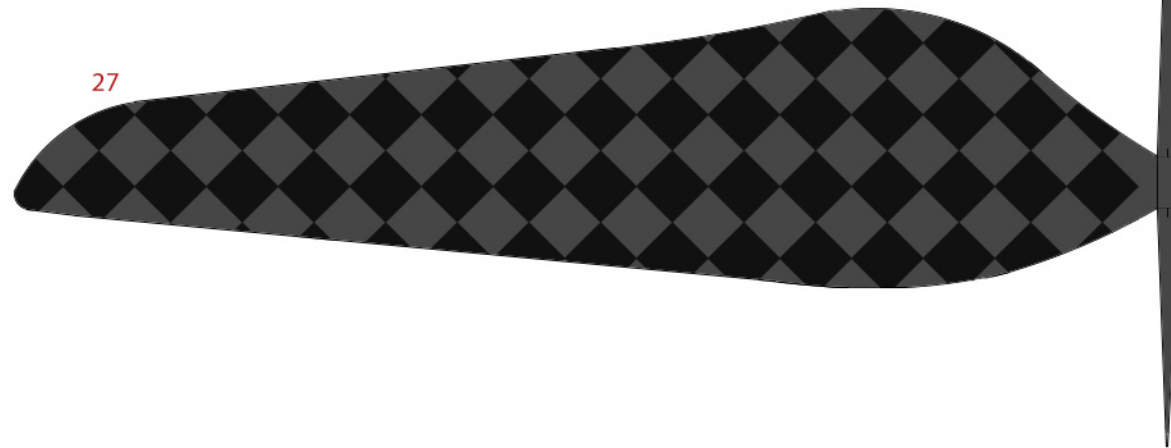
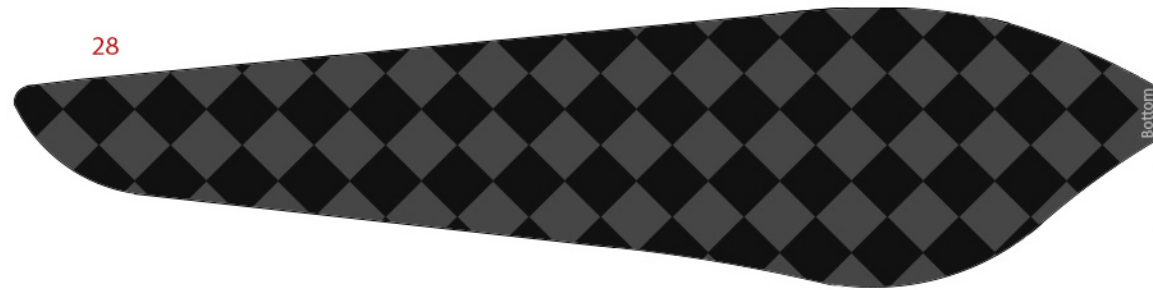
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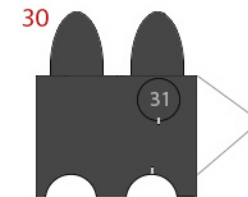


29 Former, glue to cardstock





29 Former, glue to cardstock

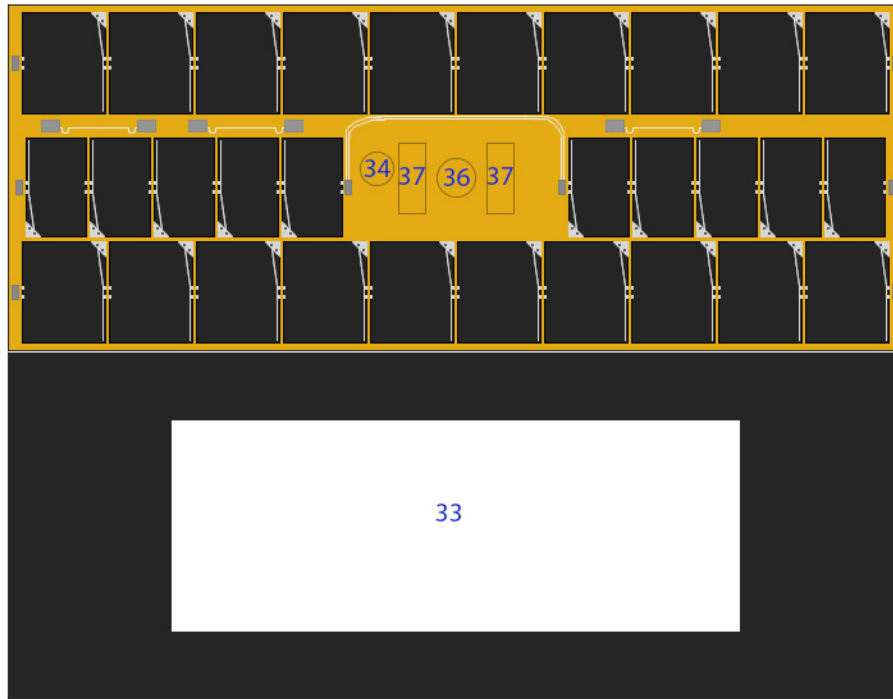


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[Print on 110lb cardstock](#)

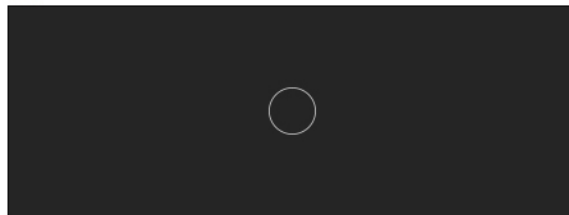


32



Fold-glue back-to-back

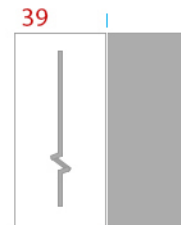
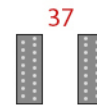
33



Poke pin hole on
the black dot



Glue to two layers
of cardstock



Fold-glue back-to-back

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Photo taken during Ingenuity's first historic flight

