BURNS McDONNELL

CASE STUDY

A Propulsion Test Facility for a Company Known for Blasting Through Precedents

When your business is lean and your goal is to be the first private company in history to land on the moon, your only choice is to pioneer something new. That philosophy drove the success of Intuitive Machines, a space technology company, as it developed a new propulsion testing facility for its lunar lander engine.

Challenge

A space mission's success depends in no small part on its propulsion system — the propellants, injectors and other engine components that create the thrust needed to launch into outer space, navigate through the cosmos and land on celestial bodies. This design has little margin for error. To be considered safe and ready for use, propulsion systems must meet stringent performance requirements, verified by a multitude of testing protocols.

Propulsion testing facilities perform this important work at a high cost. Few such facilities could accommodate the tight budgets, aggressive scheduling demands and next-generation manufacturing methods of Intuitive Machines, a private space exploration company with a reputation for creating reliable, economical and innovative space products and technologies.

Project Stats

Client
Intuitive Machines

Location
Houston, Texas

Project Cost
$3.5 million

3.8K
SQUARE FEET IN TESTING FACILITY

16
THICKNESS, IN INCHES, OF CONCRETE FACILITY WALLS

10
MONTHS FROM START TO FINISH

Intuitive Machines is under contract with the National Aeronautics and Space Administration (NASA) to deliver a lunar program focused on building, commanding and communicating with lunar vehicles and other sophisticated technology in cislunar space. The company's three planned unmanned missions — the first of which was successfully achieved with launch on Feb. 15, 2024, and landing on Feb. 22 — are part of NASA's Commercial Lunar Payload Services program, which is designed to demonstrate critical technologies, perform lunar experiments and establish a lunar communications network.

Meeting the program's ambitious budget and schedule would require propulsion testing innovations. Leaders at Intuitive Machines knew there had to be a better, faster and cheaper way to test these systems. In 2021, they started down a path that soon led them to a solution.

That was the year when planning began for the company's new 12.5-acre headquarters at Houston's Spaceport, where Intuitive Machines is one of three anchor tenants. Using a qualifications-based interview and selection process, Intuitive Machines selected Burns & McDonnell in April 2021 as its design and construction partner for the company's headquarters and manufacturing complex.

At the project's kickoff meeting, Intuitive Machines representatives mentioned the idea of a propulsion test facility to drive efficiencies within the testing and verification of the company's new propulsion engine. Intuitive Machines leadership shared an aggressive price point and completion window for the propulsion test facility and empowered the team to question and challenge anything that would interfere with the project's overarching goals. That would include adjusting operational protocols, if necessary, to fit the facility's capabilities. A collaborative spirit among team members helped reduce red tape and churn from the process, allowing the team to focus on solving the problems at hand.

Solution

The Intuitive Machines propulsion test facility would be a unique structure in Houston, and the team understood that the permitting process could pose special challenges. Due to its location at the Houston Spaceport, the project would require the approval of the Houston Airport System, the local jurisdictional authority. Existing permitting standards were designed for airport facilities and did not apply to a propulsion test facility.

Working in collaboration with the Houston Airport System and Intuitive Machines, the team was able to satisfy stakeholder curiosity regarding the propulsion test facility's design and identify operational adjustments to comply with building codes. All this was accomplished in a two-month permitting approval process.

The design for the propulsion testing facility itself continued to evolve in other ways, growing leaner with each iteration. In its final form, the facility consists of a 3,800-square-foot reinforced concrete chamber surrounded by a 25-foot-high perimeter wall that encloses an additional 6,500-square-foot yard and delivers multiple advantages for testing protocols.

The orientation of the building, the layout of the yard wall, and a section of sloping yard wall were all specifically coordinated to direct the acoustics from testing rocket engines away from neighboring residential areas.

With 16-inch-thick reinforced concrete walls on three sides, a reinforced concrete roof deck, and a sacrificial metal wall on

the fourth side, the testing facility was designed to protect adjacent facilities from any potential accidental fuel explosion by directing the blast through the metal wall and into the protected yard.

Propulsion testing typically is performed in remote locations where a large setback is required for any testing operation. Intuitive Machines' testing is completed instead within the small footprint of the building and yard. This confined environment is 200 yards from its manufacturing center at the Houston Spaceport.

The proximity of the testing facility to manufacturing operations offers multiple benefits, beginning with significant savings in testing setup costs and streamlined logistics. Locating the testing facility next to the headquarters also allows Intuitive Machines to adjust quickly, utilizing all its manufacturing capabilities. Given the ability to produce on-demand engine prototypes and parts, engineers can now conduct tests on even small, incremental changes in engine design.
Unlike other propulsion testing facilities, Intuitive Machines' contains no permanent, built-in test stands. Instead, the reinforced-concrete chamber's wide-open space houses two mobile testing units that are connected to an integrated command center within the larger headquarters facility. Storage space for a lunar lander and space flight hardware is also included. This spartan approach minimized cost and enhanced the building's long-term flexibility.

Before a propulsion test is conducted, the engine is mounted onto a mobile unit, which is maneuvered into the appropriate position for that test. The chamber's overhead doors are opened so the test rocket blast can be safely projected into the surrounding enclosed yard.

The mobile units provide the flexibility needed to conduct a wide range of tests on propulsion engines with a thrust range of 9,000 to 50,000 pounds, as well as tests involving high-altitude scenarios and fuel source alternatives.

Results

Ten months after the project kickoff, the engine verification test facility was completed at a final cost of $3.5 million, hitting both Intuitive Machines' price point and schedule.

In its inaugural lunar mission 18 months later, Intuitive Machines became the first private U.S. company to land on the moon. The successful soft landing of the company's unmanned Nova-C class lunar lander, Odysseus, also marked the U.S.'s first lunar landing since NASA's Apollo 17 mission in 1972.

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