Equipped with new sensors, Morpheus preps to tackle landing on its own

April 25 2014, by Steven Siceloff

Jon Olansen, Morpheus project manager at Johnson Space Center in Houston, and Greg Gaddis, the Kennedy Morpheus and ALHAT site manager, discuss the lander and its unique systems. Credit: NASA/Kim Shiflett

(Phys.org) —A test flight later this week will challenge a set of sensors to map out a 65-yard square of boulder-sized hazards and pick out a safe place to land.

Mounted to an uncrewed prototype lander called Morpheus that flies

autonomously several hundred feet above the ground, the sensor system will have 10 seconds to do its work: six seconds really, as it will take four seconds to map the area before choosing a landing site.

The sensor system is a 400-pound set of computers and three instruments called ALHAT, short for Autonomous Landing and Hazard Avoidance Technology.

If it works Thursday and in a pair of later flights, the sensor package and a host of technologies introduced by the lander may find themselves instrumental in the success of future missions to other worlds – perhaps propelling a descent stage on a spacecraft landing people on Mars.

That's a big dream for the two small projects called Morpheus and ALHAT. Morpheus is the lander - a 10-foot-diameter, 2,400-pound four-legged metal frame holding four spheres of propellant that feed into a single, 5,300-pound-thrust engine. They were developed in the Advanced Exploration Systems Division of the agency's Human Exploration and Operations Mission Directorate. The branch pioneers new approaches for rapidly developing prototype systems, demonstrating key capabilities and validating operational concepts for future human missions beyond Earth's orbit.

The good news for the team of about 45 engineers who have been working on the combined projects for years is that the sensor set did just what it was supposed to during an earlier free flight, so it should do just as well during Thursday's flight over a landing field at the Shuttle Landing Facility at NASA's Kennedy Space Center in Florida.

"I generally don't sleep much the night before a flight," said Jon Olansen, project manager for Morpheus, which is based at NASA's Johnson Space Center in Houston. "But the team has really done a fantastic job of trying to tease out potential issues and mitigate them. I have

tremendous faith in the team."

Just as during a spaceflight, the lander controls itself once it's launched.

Engineers and technicians prep the Morpheus lander and its ALHAT guidance and navigation system before a free-flight test. The white box is one of the sensors used by the ALHAT system to determine where the spacecraft needs to go to land safely. Credit: NASA/Kim Shiflett

"The only thing we do in the control center is push the go button and watch the data," Olansen said.

Morpheus is filled with innovations, including an engine that burns methane mixed with oxygen, which has also, for the first time, been coupled with smaller roll control jets using the same propellants. Methane is considered an earth-friendly fuel and its importance in spaceflight is that it can be stored in space without boiling off like hydrogen. It's also a chemical that has been seen by robot scouts surveying the moon and Mars.

"We know these technologies have a place in the future of spaceflight," Olansen said.

Bolted to different parts of the lander, the suite of sensors surveys the target landing area, identifies safe landing sites, and then uses three methods to tell the lander where it needs to go to avoid rocks or slopes or other hazards.

"We've been working a long time, eight years, to prove we can do autonomous, precision landing and hazard avoidance and guidance," said Chirold Epp, project manager for ALHAT. "We really need to show the world that everything we've been advertising for eight years works."

The technological advancements have come with the work of a team that comprises people from seven NASA field centers.

"The opportunity to take people from seven different centers and get them to work together on what is a relatively small project really is phenomenal," Olansen said.

Thursday's free flight is an open-loop test, which means Morpheus' own flight computer will fly the lander above 800 feet before heading several hundred feet away to the landing field and landing softly on a predetermined pad. While this is happening, the ALHAT system will employ its flash Lidar system, a laser altimeter and a Doppler

velocimeter – think of it as a super-accurate speedometer for spacecraft – to scan the field and pick out the best place to land.

The benefit of the hazard avoidance system is that it gives spacecraft far more flexibility to land accurately and to land on worlds that are not as well-studied as Mars and the moon. The ALHAT team is shooting for a system that can land within 10 feet of a given spot, a big improvement on the current best of about 270 feet.

The precision isn't academic – it could be the difference between setting down on a stable plateau or tipping over into a ravine.

A successful flight Thursday will clear the way for the next important step in this development: closed-loop flights that turn over control of the lander to the ALHAT system, letting it tell the lander where it needs to park.

"We've done airplane tests, helicopter tests, but this is the first time we've been in this environment," Epp said. "Free flight 10 gave us tremendous information. Some things didn't work quite right and other things worked quite well. Everything worked to some degree. So we go back and we fix it and we test it again."

"We've already achieved an awful lot with this project," Olansen said. "We just need to wrap up well and get the closed-loop flights accomplished."

Provided by NASA