Rocket test will carry Purdue experiment

November 30 2009, by Emil Venere

(PhysOrg.com) -- Purdue University researchers are designing and building an experiment that will operate during a test flight of a new type of reusable rocket to be launched by aerospace company Blue Origin LLC.

The experiment will be used to study how fluids behave in low gravity, providing information that could help engineers design better components for a variety of technologies used both on the Earth and in space, said Steven Collicott, a professor in Purdue's School of Aeronautics and Astronautics.

It is one of three scientific research payloads recently selected by Blue Origin to be carried to suborbital altitudes during a flight test of the company's New Shepard rocket. The rocket enables researchers to study phenomena that cannot be effectively observed on Earth or during the relatively brief low-gravity periods that can be created in aircraft flights, Collicott said.

Such experiments provide critical data for creating better mathematical models used to design technologies that rely on the precise control of fluids, said Collicott, who leads work to build the university's experiment.

Purdue's experiment, funded by the National Science Foundation, involves studying conditions in which liquid wicks or remains stationary when influenced by a specially designed structure inside a spherical vessel.

"There has not been a good mathematical foundation for making predictions about the performance of systems that have practical three-dimensional shapes," Collicott said.

The transparent spherical vessel will contain vanes, or thin metal plates, that will be moved progressively closer to the vessel's inner walls during the three-minute, low-gravity portion of the flight. The researchers will use a camera to record and study how fluid wicks within this shrinking gap between the vanes and vessel walls.

Various types of devices rely on wicking fluid, or capillary fluid physics, including spaceflight life-support and fuel systems, and, for applications operated in ordinary Earth gravity, small fuel cells and miniature sensors and instrumentation for health sciences.

Because of the weightlessness of a spacecraft in orbit, liquid propellants float freely inside fuel tanks and water drops bounce around inside recycling systems. This complicates efforts to design fluid management systems for spacecraft, Collicott said.

To compensate, engineers have developed devices called vanes and screens. Vanes are grooves designed to guide fluid through a tank, and screens filter out bubbles. Both devices use capillary forces to position the fluid, or create "capillary flow."

However, complex three-dimensional capillary action is difficult to study in Earth laboratories, and mathematical models of the "critical wetting" that takes place in these devices are based largely on two-dimensional analyses, which restricts application of these models to cylindrical vessels, Collicott said.

"Yet most practical systems are not cylinders," Collicott said. "So we need data about what happens in practical three-dimensional geometries

such as spheres. We predict beforehand with computer models what will happen and then compare those predictions with data from the experiment. If the predictions of the computational model are confirmed, then the model is shown to be useful for practical design work. If not, we will know where additional model development is required."

The sphere is about 5 inches in diameter, and the entire experiment, including the camera and lighting system, will fit in a container about 18 inches square and 9 inches high.

The rocket will reach an altitude of about 100 kilometers, or 60 miles. The New Shepard rockets are reusable, reducing the cost of flights.

"That's one of the great things about the emerging commercial rocket industry," Collicott said. "The private sector is finding ways to dramatically reduce the cost of suborbital spaceflight for research and for tourism through innovation."

The Purdue team is scheduled to deliver the experiment by next November to Blue Origin, based in Kent, Wash. The company will launch the rocket from its West Texas launch site. A launch date has not been announced.

Provided by Purdue University (news : web)