Student-built rocket with experimental motor blasts to 1st-place finish

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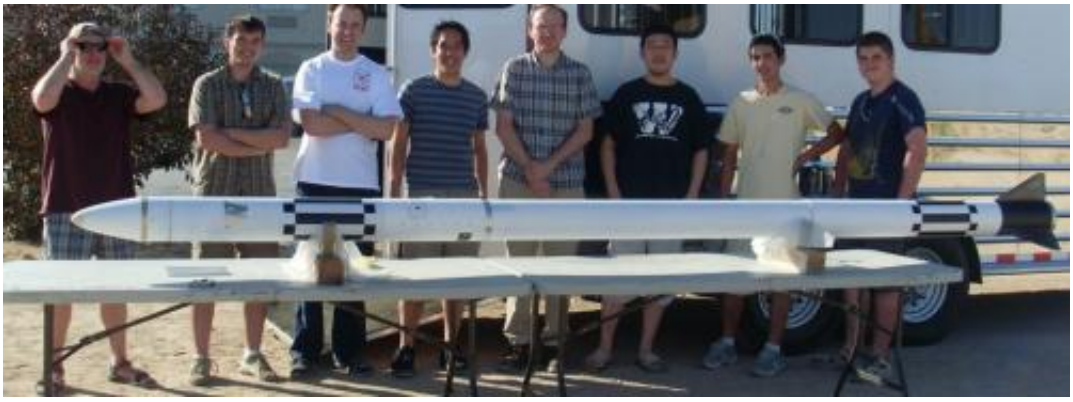

Members of the winning team. Faculty adviser Carl Knowlen is on the left, team lead Viggo Hansen is third from left, and propulsion lead Travis Edwards is fifth from left.

(Phys.org) -- A team of University of Washington students designed a unique rocket motor and launched it 5 miles up to claim first prize this summer in the Intercollegiate Rocket Engineering Competition.

The UW students built a new type of motor powered by a combination of solid paraffin and liquid nitrous oxide. So-called hybrid propulsion systems are a nontoxic, safer alternative to space agency rockets that use hazardous liquid propellants such as hydrazine, nitrogen tetroxide and fuming nitric acid.

Safe but powerful hybrid rocket motors are not yet commercially available. Professional aerospace engineers are working on the technology, but as far as the UW students know this is the biggest launch of a paraffin hybrid rocket to date.

“Developing a motor is very ambitious,” said faculty adviser Carl Knowlen, a research scientist and lecturer in aeronautics and astronautics. Other attempts to design a motor for this competition “failed spectacularly,” he said, with midair explosions and erratic flights.

The UW rocket, by contrast, flew straight and true to an altitude of more than 26,000 feet.

“We spent about 90 percent of our time on the propulsion system,” said team lead Viggo Hansen, who graduated in the spring with a bachelor’s degree in applied computational and mathematical sciences.

The UW rocket project began in 2011 as part of a six-month graduate-level course to design and build a sounding rocket, a research rocket designed to carry instruments or record data. But it was not yet ready for takeoff by last summer’s competition.

Four students continued the project as a UW student club, the Society for Advanced Rocket Propulsion, and recruited more members. The rocket’s development ended up taking 18 months, and many long hours in the lab using a variety of equipment.

The students conducted seven static tests in which they fired the motor without launching the rocket. To fine-tune the motor’s performance, students used a flash X-ray to analyze the structure of the paraffin in the combustion chamber, and a gas chromatograph to analyze the composition of gases in the exhaust.

In the end, the rocket's motor achieved 93 percent of theoretical combustion efficiency, compared to about 95 percent efficiency that Knowlen said is typical for commercial motors.

"The performance they got out of that motor, to do that out of a student-based project with limited resources, is remarkable," Knowlen said.

In addition to winning the advanced class of the competition, the UW group won the contest's Furfaro Award for Technical Excellence, as did the previous UW entry in 2009.

In the final push, the students worked around the clock for three weeks to prepare for the June competition in Green River, Utah.

The contest draws a small but distinguished group of entrants. Other schools competing in the advanced category this year include Embry-Riddle Aeronautical University, which placed second, Canada's University of Waterloo and California Polytechnic State University, San Luis Obispo.

The UW rocket was built from aluminum and composite materials. All parts, including the combustion chamber, were manufactured on campus. The completed rocket measured 12 feet long and weighed 130 pounds. It was named the DAQ (for data acquisition) Destroyer.

A custom electronics system recorded information during the flight. The students used an open-source Arduino platform to transmit live data from the onboard sensors, which included a GPS chip, barometric pressure sensor, a magnetometer to measure the Earth's magnetic field and sensors to track the rocket's orientation and speed. Students also tried using a cellphone card to send text messages during the flight, but the rocket was not able to get a signal during its voyage.

The group plans to apply for funding from NASA or other agencies to further develop its propulsion technology.

Liquid-fuel rockets operated by space agencies are more powerful, but the UW's hybrid-fuel rocket gives more bang per unit fuel than the solid-fuel rockets now being sold for widespread use.

"There's a real development path toward this technology being used in the next 10 or 20 years," Hansen said.

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