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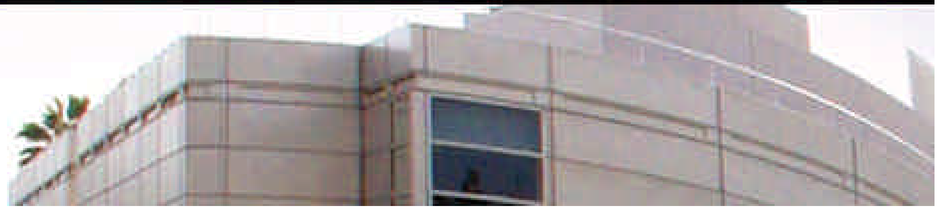

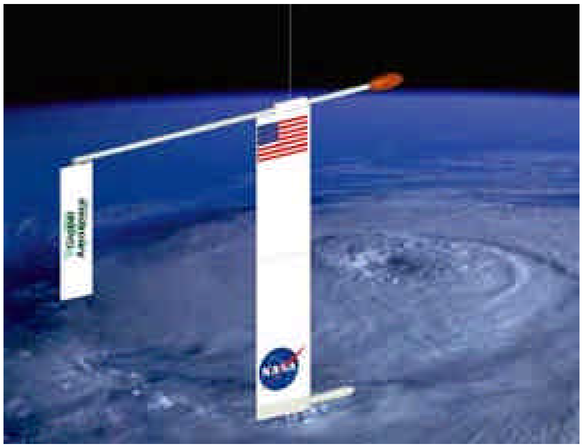

Global Aerospace’s StratoSail flies over the earth in an artist's rendering.

Up, Up, and Away

On a wing and a NASA grant, Alexey Pankine hopes to send balloons into space.

By Michael Rogers

Ballooning forays by the likes of the Wizard of Oz and thrill-seeking moguls like Steve Fossett and Richard Branson notwithstanding, balloon flight has never exactly set the world on fire. But that’s not stopping Alexey Pankine, PhD ’01, from trying to set balloons on a course for outer space.

Pankine is project scientist for Global Aerospace Corporation, a start-up company with a name that’s far more impressive than its headquarters: a handful of offices located on the dusty fringes of Altadena, just down the road from the Jet Propulsion Laboratory. With backing from NASA’s Small Business Innovation Research program and NASA’s Institute for Advanced Concepts—which provides funding for some of the most imaginative and innovative space projects—Global Aerospace has designed a system that can steer balloons, potentially overcoming the age-old problem that wind poses for balloon transportation.

Pankine’s job is to develop computer models to aid in steering the balloons around the earth. He’s also developing models of the atmospheres of different planets so that Global Aerospace can figure out how best to maneuver its balloons in wildly dissimilar planetary conditions. Pankine is also coming up with a list of things for the balloons to do if they ever get to another planet.

Pankine himself wouldn’t have gotten to Global Aerospace if it hadn’t been for Caltech. In fact, if not for the Institute, he says that he’d probably now be working somewhere in the struggling Russian space industry.

Growing up in Moscow, Pankine had the same interests as many American kids. He loved reading science fiction, dreamed of space exploration, and built his own telescopes to look into the heavens. Unlike many American kids, he didn’t have a backyard, so he did his observing from the window of his family’s flat on the sixth floor of a nine-story apartment building. Says

Pankine, “My parents often complained because I was letting the cold air in during autumn and winter.”

But they couldn’t complain about his facility with numbers. By sixth grade, he was attending a special school for mathematics and physics. From there, he went to Moscow State University. In late 1993, he was at Russia’s Institute for Space Research, putting the final touches on his undergraduate thesis on remote-sensing computer models, when Caltech’s Arden Albee came through for a visit. Pankine’s adviser introduced his student to the Caltech professor of geology and planetary science (and then dean of graduate studies), and Albee, who shared an interest in remote sensing, encouraged Pankine to apply to Caltech for graduate studies. The deadline was only a few weeks away, but Pankine took his advice.

“It seemed so difficult to go to a foreign country,” recalls Pankine, 32. “But he said I should try to do this.” His application got in under the wire, and by summer he was in Pasadena, ensconced in the Division of Geological and Planetary Sciences.

At Caltech, Pankine found a new mentor in Professor of Planetary Science Andrew Ingersoll, and worked with him studying atmospheric conditions around Jupiter, in preparation for the arrival of the Galileo spacecraft, which reached the giant planet in December 1995. Pankine also investigated the unpredictable, two-month-long dust storms that occur on an irregular basis on Mars. For his thesis, he developed a computer model that tracks how changes in Mars’s surface and atmospheric conditions are linked to the onset of dust storms.

“We developed a model that can simulate changes in the Martian atmosphere over 100 years,” he says. “We were able to test different scenarios” showing how the dust storms develop, which may someday help researchers predict why the storms occur.

“I was very happy at Caltech,” he says. “It’s an awesome place. You meet very interesting people, get a first-class education, and I was able to work with experts in the field.”

After Pankine graduated, Dmitri Kossakovski, PhD ’00, a friend from Russia who had gone from Caltech to JPL, told him about Global Aerospace. Pankine already had a job offer in hand from an energy trading company, and was also slogging through the paperwork required for foreign nationals to apply for jobs at JPL. But Kossakovski’s description of the research under way at Global Aerospace caught his attention.

“It seemed like a good place to work,” he says. “They were working on the problem of chaos in the atmosphere and that was relevant to what I did at Caltech.” He joined the company in April 2001.

Global Aerospace was founded in 1997 by two former JPL employees. Its president and chairman of the board is Kerry Nock, who worked at JPL on the design of several planetary missions, including Mariner 9 to Mars, Mariner 10 to Venus and Mercury, and the Voyager and Galileo missions. He and his colleagues figured that balloons had enormous promise to replace satellites, since instruments aboard balloons could also gather information on the weather, relay communications signals, conduct surveillance, and provide other functions. They also thought that they could be used in planetary exploration.

The company maintains that balloons would not only be 10 to 100 times cheaper than satellites, but could also fly much closer to the earth and other planets, providing up to 20 times higher resolution of surface images and 160,000 times higher signal-radar.

Despite their advantages, balloons are not without problems. The biggest roadblock is that no one has been able to build one strong enough to last more than a couple of weeks in flight. NASA is planning to launch an ultralong-duration balloon next year as part of a cosmic-ray experiment, but that is expected to fly for 100 days, still far below the amount of time aloft that balloons would need to compete with satellites.

Balloons, not to mention their proponents, also suffer from the Rodney Dangerfield syndrome—they don't get no respect. Global Aerospace would like to change that, but Nock recognizes the obstacles. "Balloons have always fought an uphill battle in that they're 'simple,'" he says. More to the point, they fly at the mercy of the wind, which can blow them far off course. So government agencies would rather spend money on the expensive hardware that goes into sturdy, dependable satellites than on something as elastic and unpredictable as balloons.

Global Aerospace figured that if it could tackle the wind problem, it might be able to convince the space industry to give balloons a chance. The company's main achievement so far has been to design and build a device called a StratoSail Trajectory Control System. Basically, it's an 18-foot-long wing with an eight-foot-long rudder controlled by radio telemetry. It hangs vertically by a tether below the balloon and is meant to keep it on course under most wind conditions. Global Aerospace successfully tested a scale model in the Mojave Desert in April 2001, and it is now seeking additional funding for testing the full-scale prototype.

The company is also developing a concept for a constellation of dozens of balloons that could stay up in the stratosphere for hundreds of days. Because the winds would vary greatly over the hundreds of miles covered by the constellation, Pankine is working on a system that would keep the network formation in place. He is looking at the dynamics of atmospheric changes and even at biological systems to develop a computer model to keep the balloons in formation.

Alexey Pankine, PhD '01 stands in front of the Altadena headquarters of Global Aerospace, where he is project scientist.

Biological systems? Pankine explains that in recent years, scientists working in control theory have developed mathematical models to mimic the behavior of biological systems that feature coordinated movements, such as flocks of birds. Global Aerospace worked with a group of scientists from Princeton University to adapt these models to distributed systems. After all, given the reputation of the average bird's intelligence, if pigeons can fly in formation, why can't balloons? "We're using a simple formula that calculates the force between objects and applies to every element of the constellation" or group, Pankine says. "It works like a spring. If two neighbors get too close, the spring pushes them apart, and when they're too far apart, it pulls them together."

Pankine's role is to figure out what to do with the formula when you throw wind or weather vortices into the equation. "It's hard enough to keep one balloon flying over a general area," he says. "But it becomes enormously complex with hundreds of them." Having dozens of air-traffic controllers on the ground, each keeping several balloons on course, might be a great training ground for the FAA, but it wouldn't be very practical in a scientific investigation. So Pankine has to come up with a system in which the balloons with steering mechanisms act somewhat like a flock of geese being buffeted by wind.

Choreographing the movements of balloons is challenging, but Pankine seems most excited about the interplanetary uses for them. "Planetary science is my interest," he says. "By understanding other planets better, we can gain more knowledge about the earth." He looks forward to the day when scientists could gain a wealth of information about planets by sending up spaceships that would release into planetary atmospheres balloons equipped with small or inflatable versions of the StratoSail device. He envisions them dropping probes with instruments that could profile the atmosphere and gather information from a wide swath of a planet's surface. Compare that, he says, to the Mars Pathfinder, which explored a small area of terrain and could see no farther than the hills about a kilometer from where it landed.

It could be a long wait, however, before balloons start sailing over Mars. Nock of Global Aerospace estimates that it will take approximately five years before the technology is ready for balloons to go to Mars or for a balloon constellation to soar into the earth's atmosphere. "Scientific and programmatic issues may delay that schedule," he says. Whatever the time frame, he hopes that any such effort would by then be part of a larger NASA project for a comprehensive sensor web to gather data from the earth. But in the meantime, the StratoSail system could steer and guide balloons that are currently used for scientific experiments.

In any case, none of this deters Pankine. Ambitious goals and investigations, he says, are worth the investment in time and energy.

"We are developing radically new approaches to observe the earth and the planets that can potentially revolutionize the way we do solar system exploration," he says. "We are working in a field that is just starting to develop, and the problems we are solving were never addressed before. This is like discovering a 'terra incognita.' Discoveries await around every corner. What could be more exciting?