# YES, IT IS ROCKET

BY SUSAN MCDONALD

## CAL POLY STUDENT-DESIGNED SATELLITE DEPLOYER TO LAUNCH FROM KAZAKHSTAN

It sounds like science fiction: former Soviet Cold War-era rocket blasts into outer space with fleet of tiny American satellites on board.

Fact is, students from Cal Poly and other universities have actually designed and built the satellites – called CubeSats because they're small cubes – and some of the students will travel this fall to the former Soviet republic of Kazakhstan in Central Asia to launch the CubeSats.

Helping to coordinate the launch is Armen Toorian, a fifth-year Cal Poly mechanical engineering major. Earlier this year he went with Cal Poly graduate student Simon Lee to the Ukraine to make sure their equipment would be compatible with the rocket that will travel 400 miles into space. They plan to attend the actual launch with their faculty advisor, Jordi Puig-Suari, in Kazakhstan in October.

The launch will take place outside the United States, Toorian explained, because launch opportunities here are not only expensive but hard to find. A Russian company, Kosmotras, has contractual agreements to launch the rocket – one of many Cold War missiles Russia decommissioned as part of a disarmament treaty with the United States.

Dealing with a foreign company, sometimes through interpreters, has given him a global perspective, Toorian said. "The

# SCIENCE

whole communication aspect is interesting."

He recalled one teleconference with the Russians when the conversation was really dragging. The translation was difficult and very slow over the phone, he said, and they were laboring over the agenda, point-by-point. "All of a sudden, the Russians got very serious. 'Okay, for the next point, we must discuss the designation of the P-PODs,'" the translator said, referring to the small device that deploys the CubeSats from the rocket. "'Will you use dash or slash?'"

The Cal Poly contingent was totally confused at first, Toorian said, but then realized the P-PODs are labeled A through E, and the Russians wanted to know if they were spelled "P-POD-A" or "P-POD/A," and so on.

"I remember looking up at everyone sitting around the table. The seriousness of the Russians' tone had everyone about ready to burst into laughter. I took a deep breath and said, 'I think we will use the dash.' After they talked it over for a few minutes in Russian, and after a delayed silence, the translator came back with, 'Okay, let it be dash. Now for next topic.'

"To this day, we're not sure if they were serious, or if they were just messing with us," Toorian said.

Cal Poly and Stanford University teamed up in 1999 to pioneer the CubeSat program. At that time, Bob Twiggs, director of Stanford's Space Systems Development Lab, and aerospace engineering Professor Puig-Suari were looking to come up with a satellite project that students could complete during their college careers.

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Previous student projects focused on much larger satellites, which are extremely expensive and take more than five years to build, Puig-Suari said. "Because they take so long to develop, and then more time to launch, our students didn't get to work on them start-to-finish and see them fly. We found a way to make them simpler, smaller and lighter."

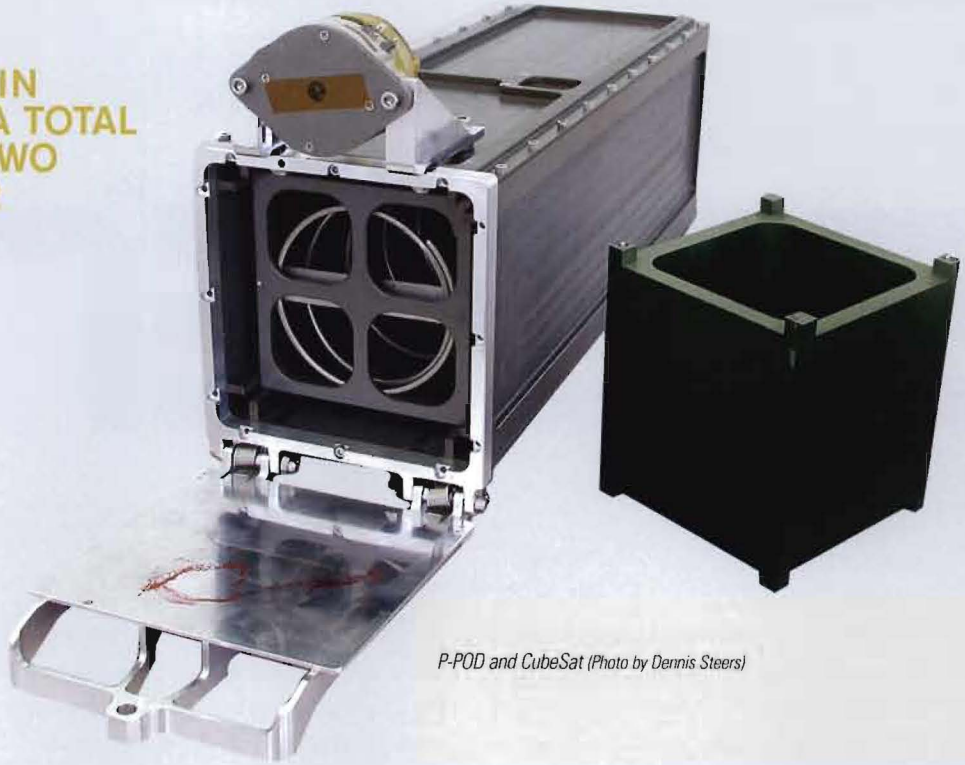
CubeSats measure just 10 centimeters – about four inches – in size and weigh one kilogram, or 2.2 pounds. Their standardized shape makes them cheaper to produce in a much shorter period of time. While the students are still in school, they can design, build, test, launch and operate the satellites. "That's important," said Puig-Suari, "because it allows them to learn about systems integration. And it's just a great experience for them."

CubeSat electronics include a computer, a battery and/or solar power system to generate energy, and a radio and antenna for sending and receiving data to and from the ground.

The students who put it all together represent a diverse group of majors, including computer science and electrical engineering among others, along with the aerospace students. "They all come in with completely different perspectives, and they learn early on that they have to work together to get the job done," the professor said. "That just multiplies the learning."

*Russian launch providers, Cal Poly students, and others involved in the CubeSat program pose with a mock-up of the SS-18 Satan rocket in the Ukraine.*

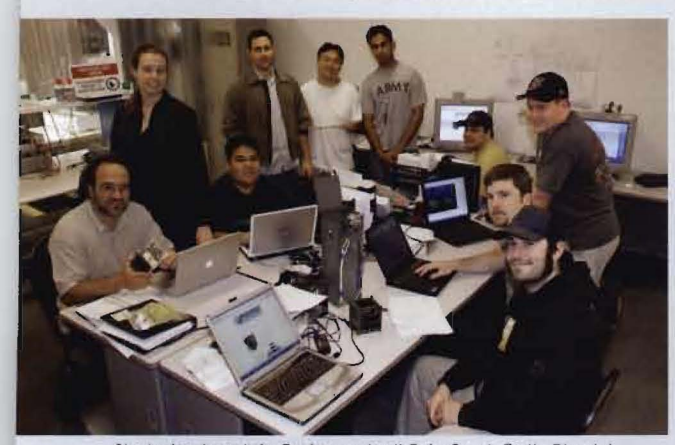
## THE OCTOBER LAUNCH IN KAZAKHSTAN WILL CARRY A TOTAL OF 14 SATELLITES – TWO FROM CAL POLY AND 12 FROM OTHER SCHOOLS.



*P-POD and CubeSat (Photo by Dennis Steers)*

Cal Poly developed the P-POD deployer that releases the small satellites from the rocket. Like the CubeSat, P-PODs are "very simple by design," said Toorian, the student in charge of deployment. He described them as metal boxes with spring-loaded doors that open like a jack-in-the-box. Each box gets bolted inside the rocket and holds three CubeSats snug "like peas in a pod" until a signal is given to release them.

When the boxes open, switches release the satellites, and the satellites "power up" once they are deployed into space. They are programmed to delay opening their antennae until they have separated a significant distance. Once they are released, the satellites go into "beacon mode," Puig-Suari said, beeping every few minutes "so we know they are working. Then they switch to whatever operational mode we choose."



*Clockwise from left: Professor Jordi Puig-Suari, Emily Blundel, Roland Coelho, Armen Toorian, Simon Lee, Parin Patel, Derek Huerta, Carl Clausson, Spencer Studley and Chris Noe*

Each satellite's mission is often accomplished in just a few weeks, but they can continue to function hundreds of miles from Earth for six months to a year.

Since the birth of the CubeSat program six years ago, more than 40 universities and high schools from around the globe have developed their own small satellites. The October launch in Kazakhstan will carry a total of 14 satellites – two from Cal Poly and 12 from other schools. Cal Poly provides all the P-PODs for the program.

Participating institutions often look for funding from sponsors before choosing an experiment, including corporate sponsorships for items such as flying cameras and communications equipment.

A satellite in a previous launch tested equipment for predicting earthquakes. For the October launch, one of the Cal Poly satellites will contain an experimental sensor that will take readings from the sun to report the direction the satellite is heading. The other will test an energy-storage device.

The total budget for the launch is $500,000. The Russian company, Kosmotras, charges $10,000 per kilogram for the rocket launch, and Cal Poly will charge the schools $40,000 for each CubeSat the P-PODs send into space.

Sponsors include the California Space Authority and the Department of Defense, as well as aerospace firms like Boeing, Lockheed, Raytheon and Northrop Grumman, which provide much more than funding. They also provide technical assistance and hands-on opportunities for students hoping to enter the aerospace field after they graduate.

"Cal Poly is a natural choice for this program," said Ray Haynes, a former Cal Poly professor who now works as director for university technical alliances at Northrop Grumman. "With its learn-by-doing philosophy, Cal Poly combines well with Stanford and other top research universities. Theory and practicality – it's a nice mix."

The benefit for companies is twofold, he added. "When graduates show up for a job, they have hands-on experience. They've been trained in building, launching and tracking satellites, and that's a big deal."

The students also have innovative ideas that they share with industry, he said. "Our engineers get involved in campus activities. They spend time with the students and gain fresh perspectives. Sometimes the students have ideas that we'd never imagined. Besides it's just great fun."

Professor Puig-Suari gets his satisfaction from watching his students develop as professionals. "The learning experience is so amazing. They are getting so much more than we could ever teach them in the classroom."

Not the least of which is traveling to Central Asia and watching their CubeSats blast into space. With that, Puig-Suari pointed out one final benefit: "Those Soviet rockets. They used to be pointed at us." ■