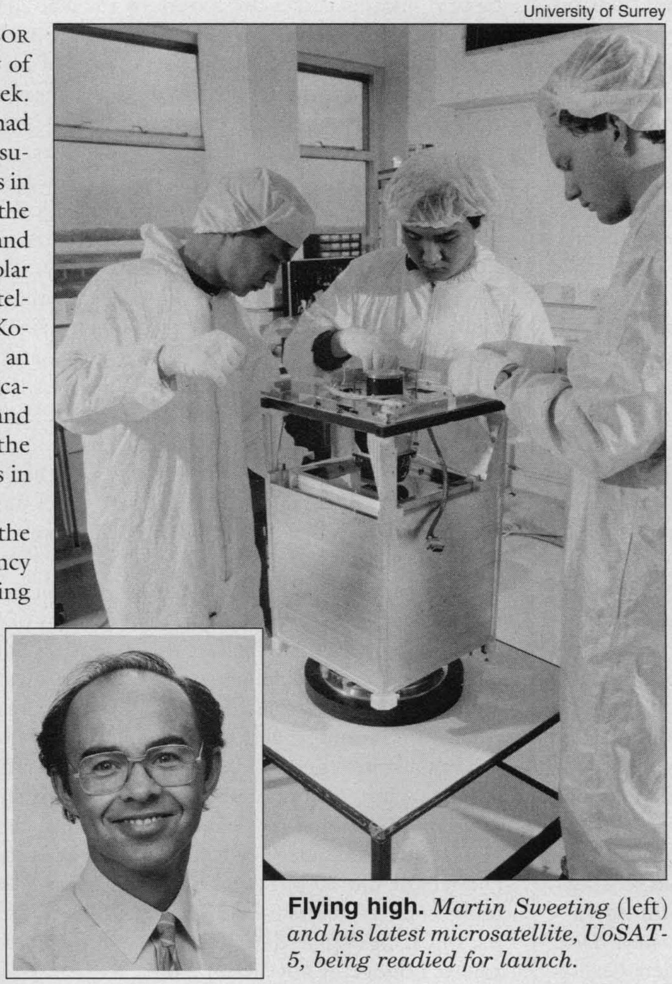
Small Is Beautiful for University Space Outfit

With a lot of imagination, a million dollars is all you need to run your own space agency

London—MARTIN SWEETING, PROFESSOR of satellite engineering at the University of Surrey, was in an ebullient mood last week. His fifth satellite was safely in orbit and had just begun transmitting back to Earth superb photographs of the burning oil wells in Kuwait. On-board experiments to detect the effects of radiation on semiconductors and the performance of gallium arsenide solar cells were running flawlessly. And the satellite had successfully linked up to South Korea in a test of its chief function as an orbiting relay for HealthNet, a communications system for Third World hospitals and disaster relief teams. "Better than the phone," was the verdict from researchers in South Korea.

All this would be enough to make the head of any multibillion-dollar space agency break out the champagne. But Sweeting was having a more modest celebration—one more in keeping with the scale of his space agency, a tiny British organization called Surrey Satellite Technology (SST) partly owned by the University of Surrey. SST has an annual budget of just £2 million ($3.5 million) and its latest satellite, called UoSat-5, is the size and weight of a backpack. Sweeting is the pioneer of the "microsatellite."

University of Surrey



Flying high. *Martin Sweeting* (left) *and his latest microsatellite, UoSAT-5, being readied for launch.*

If you are a space scientist who cannot bear the agonizing delays and huge costs that go along with a conventional satellite launch, then Sweeting is the man to talk to. And if you are a university teacher whose students are turned off to space research because they think it means years slaving in a huge design team, then you might care to learn from the University of Surrey. Since founding SST in 1985, Sweeting has shown that $2 million and 2 years is all that is needed to take a satellite from design to orbit. And at the University of Surrey they find students rush to the laboratory when they know they can leave with both a master's degree and a microsatellite in space.

Sweeting, now just 40 years old, says he hit on the idea of microsatellites in the 1970s when he was a junior researcher at the University of Surrey. The sophisticated miniaturization techniques then being developed for microcomputers would, he realized, mean that a lot of technology could be packed into a tiny satellite—in fact, diminutive size would be a big advantage because a small satellite could be launched more quickly, which would mean it could incorporate the very latest technology.

At first few people were willing to listen. "The idea was considered heretical," says Sweeting, "because all the work since Sputnik had been aimed to make spacecraft larger and more powerful. People had become railroaded into thinking that big is beautiful in space and underestimated the impact of sophisticated electronics."

Sweeting was eventually able to persuade a few people in industry to help him defy the "prophets of doom" and build a demonstration satellite. Then he struck it lucky: NASA offered a free ride on board a Delta rocket in 1981, using space that was not being occupied by the main payload.

The launch was a success and NASA came forward with a second offer. Sweeting began to feel confident. "We then realized that the microsatellites had a real future, not as competitors to big satellites, but with a complementary role to work with small, well-focused missions," he says.

Sweeting wanted to push on and develop microsatellites for basic research, but he knew that the squeeze on university funding in Britain meant that even the modest £1 million a year he needed would never be granted. So in 1985, he formed SST as a technology transfer company owned mainly by the university with some venture funding. Profits from the company go into research and education at the university.

Six years on, SST has gone from strength to strength. It has developed, built, and launched five microsatellites to carry store-and-forward communications systems, radiation experiments, solar cells, and cameras. Around 85% of the on-board experiments are funded by commercial customers including NASA, the European Space Agency (ESA), the UK's Defense Research Agency, and the French aerospace and telecommunications companies Matra and Alcatel. The rest are paid for by Britain's Science and Engineering Research Council.

Each satellite is built on the university campus by the company's 30-odd staff, working alongside about two dozen undergraduate and post-graduate students. On the order book are three more satellites to be designed and built by SST and launched over the next 2 years by ESA.

The latest satellite shows that innovative technology can pack a sizable punch into a 110-lb load. Besides the semiconductor and solar cell test systems, there is a two-way store-and-forward communications system and a camera that can download as the satellite passes over Surrey twice a day.

The communications system provides health information for developing countries and communications to disaster relief teams. SST is operating the service—at a low but still commercial price—for Satelife and Vita, two U.S. relief organizations. Medical schools in developing countries and relief workers in the field can upload their messages from a low-cost mobile ground station for transmission back to any location on the earth within 12 hours.

"It's rather like overnight electronic mail and is ideal for communications into earthquake or flood disaster zones, " says Jacky Radbone, SST's general manager.

The camera is designed to take snapshots and get them down to Earth quickly and cheaply. "Already the results look extremely good; we can see swamplands, erosion areas, and the effects on Kuwait of the burning oil," says Radbone. In the future, microsatellite-borne cameras could provide for paying customers who do not want to wait for the high-cost, high-resolution images from large earth-observation satellites.

The growing commercial potential of microsatellites is gratifying for the University of Surrey, but it's only part of the story. They see the main value of SST in its link to graduate education—students and staff can work together to design and build a satellite for a commercial customer and add on research projects of their own.

As Mike Cruise, head of the astrophysics division at the Rutherford Appleton Laboratory near Oxford, puts it, "Sweeting's students can see a project through from first design to launch and operation within a 2-year M.Sc. course." And that, says Cruise, "generates a huge amount of enthusiasm among students."

Ask Marc Fouquet, a 26-year-old research student on the M.Sc. course who designed the camera that is flying on board UoSat-5. "At SST I've had lots of responsibility," he says. "I've been able to define experiments, choose components, and get involved in the whole satellite design. And we can find out whether our ideas are any good within 2 years."

Sweeting believes that the SST success story will continue with its unique combination of its high-quality graduate education supported by a low-cost commercial satellite service. He even has plans to go up-market and begin designing and building "mini-satellites" some two to five times as big as his microsatellites. But there is a cloud on the horizon—microsatellites may become a bit too successful, and commercial companies with big budgets may move in on the field.

There are already signs of that happening. In the past 2 years, interest in microsatellites has exploded, partly as news of Sweeting's successes got around and partly because others learned the same lesson—small satellites are the only way to get the very latest technology into space very quickly.

Significantly, the Ariane rocket that put Sweeting's fifth microsatellite into orbit also carried the United States' first microsatellite—ORBCOMM-X—from a commercial company. Its builders, Orbital Science Corporation (OSC) of Fairfax, Virginia, did not get off to a good start, loosing contact with their satellite 6 hours after launch. But they still say they expect a boom in the microsatellite business "late next year."

OSC already has plans to put a 24-satellite constellation into orbit for low-cost data communication. And Motorola is planning an even more ambitious 77-strong satellite network for mobile phones. In addition, Globesat of Logan, Utah, and two more small Virginia-based companies—Defense Systems Inc. of McClean and AeroAstro of Herndon—are planning microsatellite ventures.

Sweeting says he is not worried by the arrival of U.S. companies. SST will fight to keep its leading position, he says. "We've had 15 years experience and most of our rivals have yet to launch a satellite....Our experience gives us an advantage. We will stay ahead." The University of Surrey and a generation of Sweeting's students are banking on it. ■ **JANE BIRD**

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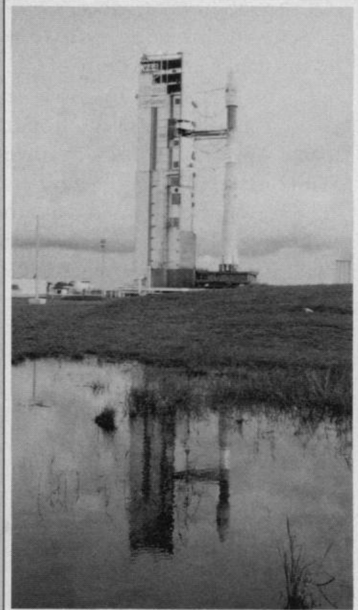
In Search of a Free Launch



ESA

Ariane with piggyback payload.

NASA played fairy godmother when microsatellites first appeared on the scene in the 1980s, granting Martin Sweeting's first two wishes of a free ride into space for his experimental microsatellites, designed and built at the University of Surrey. But as U.S. space flights switched to the troubled Space Shuttle, NASA could no longer guarantee a free "piggyback" launch for even a tiny load. Instead, the magic wand passed to the European Space Agency (ESA) and its conventional Ariane rocket.

Last month, ESA allowed four microsatellites—each weighing less than 110 lbs—to ride along with the massive 5200 lb European Remote Sensing Satellite (ERS-1) on an Ariane 40 rocket. The biggest (at 110 lb) was from Sweeting's own University of Surrey; the others (each from 50-85 lb) came from the Technical University of Berlin (TUBSAT), the aerospace club of the Ecole Superieure d'Ingenieurs en Electronique (SARA), and Orbital Science Corporation of Fairfax, Virginia (ORBCOMM-X).

In function, the satellites are as varied as their country of origin. While the Surrey satellite carried commercial communications equipment, electronic test equipment, and a camera (see main story), SARA is intended for basic research in radioastronomy. It will monitor radioemissions from Jupiter to complement information gathered on the Ulysses and Galileo missions. TUBSAT is a student-led project to test communication systems that might be used on expeditions to remote regions. ORBCOMM-X has a strictly commercial focus—it's a test vehicle for a project intended to link 20 small satellites into a low-cost data transmission net.

ESA has plans for many more low-cost ($250,000 a time) microsatellite launches. Thanks to the special Ariane auxiliary payload (ASAP) system, up to six microsatellites can be packed out of the way and released just a couple of minutes after the main payload has separated. With luck, two to three flights will be available each year.

Whatever their numbers, the microsatellite launches will never be profitable according to Jacques Chapelle, Arianespace's marketing service manager. The gain for Arianespace is in public relations, says Chapelle. With the bill for the development of the Ariane V rocket standing at $5 billion, ESA needs to show its 13 member nations that it is not just a vast bureaucracy.

So far, ESA has not had to turn away any microsatellite. But demand is now starting to boom, and in the future, Chapelle says, Arianespace will "select groups that have the most developed program and the least problems with funding." No preference will be given to university groups over commercial organizations, although the latter will be allowed only one launch each. And will there be preference for European over U.S. groups? That question, says Chapelle, has not yet been faced. ■ **J.B.**