

built, lacks an adequate existing scientific infrastructure to support it. They claim that some of the criteria used to judge the sites, such as international communications, had been applied to the disadvantage of developing country locations, and have accused the committee of placing more weight on social factors sought by highly-paid scientists, such as climate and recreational opportunities, than on the social and economic needs of the host country.

Soon after the opening of the Madrid meeting, it became clear that the Indian delegation intended to fight tenaciously for the center. Anticipating a tough battle, several of the other candidates announced substantial increases in their offers of financial aid. Italy, for example, which had a 19-member delegation in Madrid, headed by the Minister of Science and Technology, Luigi Granelli, announced that its initial \$19.5 million offer (previously matched by an almost equal offer from Belgium) had been increased by a further \$28.5 million from its foreign aid budget, half of which was to support the activities of affiliated cen-

ters in both developed and Third World nations. And Spain, which was hosting the meeting, offered a \$15 million interest-free loan in addition to the money it had already proposed to cover initial costs.

It soon became clear however, that the final selection of the site was not going to be made on scientific, technical, or financial grounds alone. It was rapidly becoming a test of political muscle—particularly between Thailand, which the site visit committee had previously identified as the only developing country candidate offering a sufficient scientific infrastructure and India who, with the support of several other developing nations present, continued to argue that the committee's conclusions were wrong and that the decision should be made on broader grounds.

A special negotiating group was set up to identify one location which it felt was "feasible and acceptable" but announced after 3 days of discussion that it had been unable to reach a conclusion.

It was agreed that the siting decision would be postponed yet again and that

another committee would meet at the UNIDO headquarters in Vienna to try to come up with a solution over the next 4 months.

UNIDO officials are putting a brave face on the meeting's failure to reach an agreement on the site. "We are victims of executive enthusiasm," says executive director Khane, pointing out that, if nothing else, discussions about the proposed center have helped draw the attention of Third World nations to "the importance of this emerging field of science and technology."

Plans for the center are far from dead, even though the longer it takes to reach consensus, the more difficult it could prove to raise adequate financial support, particularly because funding is currently planned to be based on voluntary, rather than assessed, contributions from member states. But some inspired act of diplomacy could still break the deadlock and produce a rabbit out of the hat, even if its final shape is considerably different from that envisaged by the scientists who first met in Vienna two and a half years ago.—**DAVID DICKSON**

The Commercialization of Space

Suddenly there is a lot of interest in high-tech development in orbit; NASA and the White House are working hard to encourage it

Nearly two decades after the launch of the first communications satellite, the business and financial communities seem poised for a new wave of commercial expansion into space. Mindful of the recent booms in computers and biotechnology, investors are paying close attention to endeavors such as remote sensing, private launch services, and zero-gravity materials processing. In some cases people have begun to risk serious money—McDonnell Douglas and Johnson & Johnson have already put several tens of millions of dollars into experiments on purifying pharmaceuticals in the zero-gravity environment of the space shuttle—and high-level policymakers in Washington, eager to promote high technology in any form, are working hard to find ways to encourage them.

Several trends have been converging in recent months:

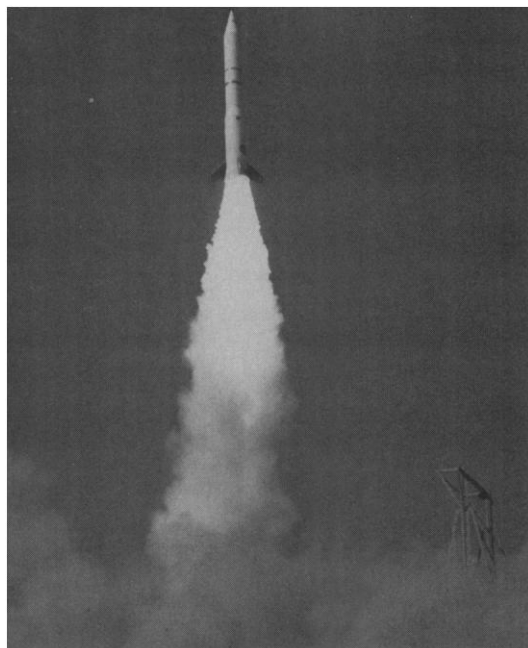
- In keeping with his Administration's sympathy for private enterprise, Ronald Reagan promised in his space policy message of 4 July 1982 to "provide a climate conducive to expanded private

sector investment . . . in civil space activities." He underscored that commitment on 16 May of this year by directing NASA to transfer its expendable launch vehicles, the Delta and Atlas-Centaur rockets, to operators in the private sector. (NASA had planned to phase them out anyway in favor of the shuttle.)

The Reagan Administration is also continuing its efforts to transfer the weather satellites and landsats to the private sector (*Science*, 12 August, p. 632). Meanwhile, the White House's top-level Senior Interagency Group on Space is drawing up a "National Space Agenda" for release some time this fall. The section on commercialization is being written by Craig L. Fuller, assistant to the President for Cabinet Affairs. On 3 August Fuller brought in 12 corporate managers to discuss space commercialization with the President. Among other things the businessmen stressed the desirability of some kind of national space station, both as a research center and as a potential factory site for space-based materials-processing industries. Reagan

promised nothing, of course, but by all reports he was fascinated and enthusiastic.

- NASA wants very much to build that space station and is actively courting the business community's support. In addition, some of the other things the agency would like to do seem ripe for joint ventures with private industry—for example, a reusable Orbital Transfer Vehicle that would ferry communications satellites from the space shuttle's 1100 kilometer maximum orbit to the 35,900 kilometer geosynchronous orbit. Thus, on 6 June NASA administrator James M. Beggs organized a Commercialization Task Force at agency headquarters. "There's been a big change in attitude on the part of industry," says task force head L. J. Evans. "In the past two months I've had about 200 people walk through my door asking what they can do in space—and the gratifying thing is, they're from all over, not just aerospace firms." By December his task force will report back on what kind of incentives and joint endeavor arrangements will



Paul Maley/Space Shots International

The Conestoga I

Space Services, Inc. launched the first private rocket from Matagorda Island, Texas, on 9 September 1982.

best encourage this sort of thing. Meanwhile, requests for proposals on commercializing the Delta and Atlas-Centaur should be going out in September. And NASA has taken the first step toward eventual commercialization of the space shuttle itself by awarding a \$400-million-per-year contract to Lockheed to manage all the shuttle servicing and launch preparations on the ground.

- With NASA committed to the space shuttle as its sole launch vehicle, and with only four orbiters in the currently planned fleet (*Science*, 18 March, p. 1299), a potential niche has opened up for private launch services at the "low" end of the market—those smaller satellites that do not really need an astronaut's supervision. NASA's offer of its expendables thus finds many potential takers. Included are such giants as Federal Express, RCA, General Dynamics, and United Technologies, as well as such start-up firms as Transpace Carriers, headed by David Grimes, the former manager of NASA's Delta launch operations. In a similar vein, Martin Marietta has hopes of taking some of the new Intelsat VI communications satellites away from the space shuttle and/or Europe's Ariane with a private version of its massive and venerable Titan.

Meanwhile, the backers of Space Services, Inc. of Houston have already put more than \$10 million into the company's effort to develop its own private fleet of launchers. Following up on the successful suborbital test of its Conestoga rocket last year, Space Services recently signed contracts for a full-scale Conestoga II with Morton Thiokol, the

firm that builds the space shuttle's boosters. It is also negotiating for a permanent launch site on Cat Island, Mississippi. On 7 September, Space Services announced a joint venture with two small Bethesda, Maryland, firms—American Science and Technology Corporation and AEROS Data Corporation—to develop three private, land remote sensing satellites. The first launch is scheduled for 1986.

- Finally, the first dollar of profit from a new space industry may already be in sight. The McDonnell Douglas/Johnson & Johnson electrophoresis module has now been flown on the space shuttle four times, and has demonstrated the ability to purify materials in zero gravity some 700 times more efficiently than on the ground (*Science*, 10 September 1982, p. 1018). The partners have begun to talk about flying a prototype production module by the mid 1980's. Possible early products include interferon, and insulin-secreting beta cells extracted from the pancreas. Meanwhile, the European Space Agency's Spacelab is scheduled for its first shuttle flight in late October, during which the crew will perform more than 30 hands-on experiments in zero-gravity crystallization, solidification, and alloy formation. After years of speculation, materials researchers can finally begin to sort out what really works in space from what does not.

Now, there is widespread agreement that commercial activity in space is a good thing and should be encouraged. But as usual, there is considerably less agreement on how to do so.

For example, the launch service companies complain about having to compete with a highly subsidized space shuttle (*Science*, 2 July 1982, p. 35). Space Services vice president Charles M. Chafer points out that the Conestoga II will be able to launch a satellite of up to 430 kilograms into an 800-kilometer polar orbit; the charge to the customer will be about \$10 million. For a shuttle launch under current NASA pricing policy, however, that same customer will have to pay only \$6 million to \$8 million. "Actually our costs are much lower than the shuttle's," says Chafer, "but we have to make a fair return on investment."

NASA says that the shuttle price will reflect the true cost—eventually—but that the horrendous costs of getting the shuttle system set up means that some subsidy is necessary in the early years or no one at all could afford to fly. However, it is also true that the agency's instinct is to keep its launch price down to help out the high technology people, the ones who actually want to produce

things like semiconductors and pharmaceuticals in space. "We have to make space look close," says Evans. "We have to get the risk/return ratio down somewhere near what it is in a new venture here on Earth."

Evans' task force report will thus stress financial incentives, joint ventures, and easy access to space. A prototypical example is the agency's arrangement with McDonnell Douglas and Johnson & Johnson: the electrophoresis module gets a series of free rides during its experimental phase because the shuttle is flying anyway for other reasons. The agency has agreed to similar joint ventures with two other companies. A broader goal is to set up a NASA-wide framework for commercial initiatives, so that the agency will no longer have to respond to proposals ad hoc.

Meanwhile, the business community itself has pointed to a number of ways that the Administration could foster space commercialization without spending a lot of money. One set of recommendations was presented to NASA last spring by the National Academy of Public Administration;* another is being prepared by the Space Enterprise Project of the National Chamber Foundation, the research affiliate of the Chamber of Commerce of the United States. "So much can be done just by clarifying the environment," says economist Gregg Fawkes, who is managing the Chamber Foundation project. For example:

- How will private activity in space be constrained by international treaty obligations and our own national security considerations?

- When will the government modify the antitrust laws so that firms can pool their resources for large-scale research ventures, as President Reagan (and many others) have asked?

- Where will the government draw the line between federal and private launch services? Between federal and private research and development? "It has to be a *clear* line," says Fawkes, "because nobody is going to get into this if there's a chance they'll end up competing with Uncle Sam."

"I don't think that the government or anyone else should try to pick the winners in space," says Fawkes, "because I'm convinced that the biggest economic winners in the year 2000 will be products that nobody has thought of yet. What we do need to do is break down the barriers and get a lot of people out there trying things."—**M. MITCHELL WALDROP**

*Encouraging Ventures in Space Technologies (National Academy of Public Administration, Washington, D.C. May 1983).