U.S. Space Scientists Look to Europe

The European Space Agency's Horizon 2000 program is attracting a growing number of proposals from U.S. researchers, who are lured by its coherent structure and stable funding

At the beginning of June, the European Space Agency (ESA) announced its latest space science project, a gamma-ray observatory called Integral to be launched in 2001. That may not seem like big news, but Integral represents a remarkable breakthrough: It is the first space mission to involve all three of the top space powers. The European-built satellite will have one American instrument among its four sensors and will be carried into orbit by a Russian launcher, for which the Russians will gain a share of observing time.

In a world of shrinking budgets, international collaboration is becoming the norm, and such a joint project was bound to happen sooner or later. But it is perhaps no accident that the first tripartite mission was initiated by Europe. Over the past few years, ESA has assumed an increasingly prominent place in the world of space science. The agency's long-term science program, Horizon 2000, is now approaching the halfway point of its 20-year lifespan, and it has invigorated the space science community in Europe. "There's a confidence in European space science like in the United States in the '60s," says physicist Tony Dean of Southampton University, who led the team that proposed Integral to ESA.

And it is not just Europeans who are impressed. Roger Bonnet, director of ESA's science program, says there has been a definite increase in the number of U.S. researchers proposing projects to the agency in recent years. Of the 53 proposals so far submitted for the next "medium-sized mission" in the Horizon series, six have come from collaborations led by groups from the United States; in the previous round, there were just two led by U.S. researchers. Many European-led proposals also include American partners. According to ESA figures, of the 941 researchers who are participating in the 53 proposals, 181 are from the United States and 41 are from other countries outside ESA's 13 member states. "There were nowhere near so many U.S. applicants" for previous ESA missions, says astrophysicist Mike Cruise of Britain's Rutherford Appleton Laboratory, who sits on an ESA advisory committee.

It is not that ESA has a particularly generous budget for space science. Horizon 2000's $382 million annual expenditure, after all, is only about one-fourth the amount the National Aeronautics and Space Administration (NASA) spends on comparable activities. Instead, foreign scientists are lured by Horizon's clearly defined structure, open proposal procedure, and—especially—the fact that once a project is approved, funding is virtually guaranteed. "Horizon 2000 puts across an overall plan; it gets at the big picture. NASA doesn't do this as well," says astrophysicist Neil Gehrels, project scientist for NASA's Compton Gamma Ray Observatory (GRO), who is involved in the Integral project. James Matteson, another member of the Integral team based at the University of California, San Diego, agrees: "Horizon 2000 seems to be a regularized process. There's a certain coherence to the whole thing."

That coherence is all the more attractive to U.S. researchers in the light of their frustrations with NASA. These include a complex, multi-tiered long-term planning process, an arcane proposal procedure that is often bewildering to outsiders, and a budget that must be approved by Congress every year, leaving projects prone to delays—or even cancellation—caused by unanticipated budget squeezes. Researchers also complain that NASA has been obsessed with large projects with a 15- to 20-year lifespan that squeeze out opportunities for smaller, faster projects. As a result, "the opportunities for scientific research in space are becoming extremely limited," says Matteson. "The demand for access to space is much larger than NASA's ability to provide it."

A public process

The clearly defined structure of Horizon 2000 comes largely from the work of Bonnet in the 10 years since his appointment as science director (see box). The backbone of the 20-year program, begun in 1985, is four large "cornerstone" projects that were chosen at the outset from proposals submitted by space scientists. Two of these—a clutch of solar and plasma probes and an x-ray satellite—are scheduled for launch in 1995 and 1999, respectively. And schedules for the other two—a telescope operating at far infrared and submillimeter wavelengths, and a mission to retrieve a sample of material from a comet—will be determined this November.

In addition to these fixed, long-term projects, every few years ESA seeks suggestions from space scientists for a new medium-sized project—in the $400 million range—

HORIZON 2000

Cornerstone Projects

1. SOHO/Cluster — Launch: 1995 for both

SOHO will look at the sun's internal structure and corona, and the solar wind.

Cluster is a group of four identical satellites that will look at the 3-D structure of the Earth's plasma environment.

2. XMM — Launch: 1999
   A high-throughput x-ray spectroscopy satellite.

3. and 4. (order to be decided later this year): Launch: 2002 and 2006
   FIRST: far infrared and sub-millimetric space telescope.
   Rosetta: a mission to land on a comet nucleus and return samples to Earth.

Medium-sized missions:

M1. Cassini/Huygens — Launch: 1997
NASA's Cassini probe to Saturn will carry with it ESA's Huygens probe, which will land on the moon Titan to study its atmosphere and surface.

M2. Integral — Launch: 2001
A gamma-ray imaging and spectroscopy satellite.

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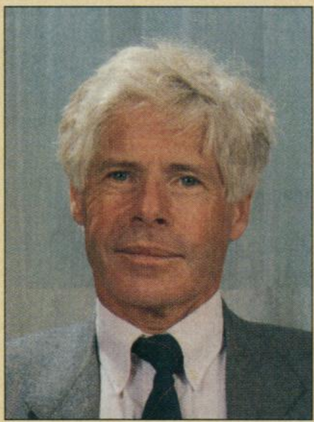
M3. 53 proposals received. Selection will be made in mid-1996 and launch is tentatively set for 2003.

The Making of a Space Program

Roger Bonnet is disarmingly modest about his achievements as director of the science program of the European Space Agency. But insiders say that the stature of Europe's space science program, known as Horizon 2000 (see main text), owes much to his stewardship. Says physicist Tony Dean of the University of Southampton, Bonnet has "fought hard, and knows exactly where he wants to go."


ESA

Horizon's architect. ESA chief scientist Roger Bonnet.

Bonnet came up from the ranks of space scientists, starting out as a graduate student launching rockets in the Sahara carrying instruments of his own design to look at the ultraviolet spectrum and disc of the sun. Back at the University of Paris he was writing his thesis during the 1968 student riots; to submit it, Bonnet had to hand it over a barricade to a policeman, who passed it on to his professors holed up inside.

His career then took off like one of his rockets: In little more than 6 months after gaining his Ph.D. he was appointed director of the Laboratoire de Physique Stellaire et Planétaire at Verrières-le-Buisson and rapidly built up a reputation as an expert on space instrumentation, acting as an adviser to the European Space Research Organisation, one of the forerunners of ESA. He says he liked the international approach of such organizations and became more and more involved in ESA, joining its Science Advisory Committee in 1976 and chairing it in 1977. Six years later, he became ESA's top scientist. "The job excited me, things needed to be done. I would be dealing with 2000 rather than 22 scientists," Bonnet says.

Things certainly did need to be done. ESA had no long-term plan at that time. Projects were considered when they turned up and were often rejected because the technology was not fully developed—which was not surprising because there was no advanced planning structure to develop the technology. Projects were also getting bigger and bigger while the science budget remained static. Fewer and fewer missions were being approved and the scientific community was starting to complain.

Together with a few supporters, such as Vittorio Manno of ESA and Johan Bleeker of the Laboratorium voor Ruimteonderzoek in the Netherlands, who chaired what had then become the Space Science Advisory Committee, Bonnet set about drawing up a long-term plan for Europe's space science. In October 1983 the trio sent letters to 2000 scientists across Europe requesting ideas for mission concepts, large, medium, or small. Over the next 6 months, a committee and several specialist subcommittees under Bleeker analyzed the more than 70 proposals that came in. Outsiders were brought in from bodies such as the European Science Foundation, CERN, the European Southern Observatory, and the International Astronomical Union. At the end of May 1984, the 50 committee and subcommittee members gathered for a 3-day brainstorming session in Venice. The structure of Horizon 2000—four big cornerstone projects, with flexibility provided by medium-sized projects to be approved at regular intervals—grew out of that meeting, Bonnet says.

With his new plan in hand, Bonnet set out to secure the necessary funding: A science budget that would grow by 7% per year up until 1991 and then level off. His networking paid off as the community registered its support, and a meeting of government ministers of the ESA member states gave Horizon 2000 the green light in January 1985. Bonnet did not quite get everything he wanted—the budget increase was held to 5% per year—but even when the economic boom years of the mid-1980s slid into recession, the program was kept on track. "Scientists behaved wonderfully and mobilized to defend Horizon 2000," Bonnet says.

Bonnet is now in his tenth year in the job, and history is repeating itself. ESA's council has asked him to start planning for the follow-on to Horizon 2000, due to run its course by 2005. The structure, he was told, should stay the same, and he was given free rein to be more imaginative in the choice of projects but encouraged to keep within a realistic budget. At the end of last month, almost 10 years after his first appeal to the space science community, a new letter was sent out asking for more ideas.

–D.C.

to take advantage of progress in technology and emerging fields of research. The first of these projects, a probe that will land on the surface of Saturn's moon Titan, will hitch a ride with a NASA spacecraft in 1997, and it will be followed by the Integral project in 2001. In the main, small projects are left to ESA's member states to organize on their own or in smaller collaborations: The agency's mission is to undertake projects too large for any one European state.

The procedure for choosing the medium-sized projects is somewhat unusual, however. It involves open competition coupled with a very public peer review. "It's an open process. Everyone knows the rules and the timetable," says Cruise. Take ESA's selection of the Integral project. The American instrument on Integral began life in the mid-1980s as a NASA project called the Nuclear Astrophysics Explorer (NAE), which was intended to be a follow-up to GRO. GRO opened up the field of gamma-ray astronomy, and it continues to raise many tantalizing questions that NAE's much more sensitive spectrometer was expected to answer. It was highly rated by NASA's peer-review boards, but NAE never got the green light. "NASA didn't have the money to do it," says Gehrels.

Meanwhile, a European team led by researchers at Southampton University had proposed a gamma-ray imager for consideration as the first medium-sized mission (M1) under Horizon 2000, but it lost out to the Titan proposal. The Europeans saw an opening for a transatlantic alliance in the competition for ESA's second medium-sized mission (M2). "It was a wonderful opportunity," says Matteson. "Two teams from two studies all ready to move into M2 with a mature concept." In February 1990, after vetting by ESA's three specialist working groups, a short list of six proposals was selected for further study from the 22 proposals for M2. Then, in April 1991, four of the six were awarded up to $1.3 million each for a full feasibility study.

But then came the hard part. Representatives from each of the short-listed projects gathered in Paris in April this year. At an open meeting, each team gave a presentation and then fielded questions from members of the space science community and from their rival teams. Although Integral had been the favorite all along, it had to overcome a strong challenge from an unusual proposal called STEP, which was designed to test the principle, central to general relativity theory, that an object's gravitational mass and its inertial mass are identical. "It very nearly knocked Integral off its perch," says Cruise. An advisory panel of scientists made the final recommendation, and ESA's Science Program Committee, made up of representatives of the member governments, gave final approval.

Although selecting missions by open competition may, to the outsider, seem like reducing science to the level of a game show, the scientists seem to like it. The pressure of the impending tournament means that proposals are honed that much closer to perfection, while having your work judged openly by your peers can be less dispiriting than rejection by a faceless committee. "The space science community is much more involved than in the United States," says Gehrels.

In search of greener pastures

For U.S. researchers, perhaps the biggest attraction of winning an ESA project is the stability: Once accepted, a project has a guaranteed budget to completion and a fairly strict timetable. ESA can do this because its science budget is agreed upon by the member states in 5-year chunks. "ESA is the only space agency with this advantage," says Bonnet. "It's an ideal situation for space scientists," because it reduces the lead time of projects, says physicist Peter Bender of the University of Colorado at Boulder. Bender is hoping for some of that stability himself: He is part of a consortium proposing a gravity-wave detector for M3.

In contrast, "There is no guaranteed funding [from NASA]; everything is done annually," says Massachusetts Institute of Technology physicist Claude Canizares, who chairs NASA's space science and applications advisory committee. Although space scientists recommend priorities every 10 years through a committee sponsored by the National Academy of Sciences, and they meet at 3-year intervals at Woods Hole to go over the list, there is no guarantee that even highly rated projects will fly. The reason? Congress and the White House chew over NASA's budget every year and in years when the belt is tightened, projects can be cut back, frozen, or canceled. Scientists then have to spend large amounts of their time in Washington lobbying to get their projects reinstated. "Every year you stick your neck out and hope it isn't cut off," says physicist Ho Jung Paik of the University of Maryland.

Paik should know. He has been working for the last 15 years on a superconducting gravity gradiometer for a NASA mission that has now been postponed indefinitely. Like many of his colleagues, Paik has now turned to Europe: He was involved in the STEP proposal for M2, is participating in several proposals for M3, and is collaborating with European researchers on an ESA-funded technology project to develop a superconducting gravity gradiometer. "Europe could well take the lead in geodesy," he says.

Part of NASA's problem, say researchers like Paik and Bender, is that the big three U.S. science projects—the x-ray observatory AXAF, the Cassini probe to Saturn, and the Mission to Planet Earth—are dominating the science budget. "There is less flexibility for other missions," says Bender. Canizares agrees that this was certainly true in the 1980s when the shuttle's ability to heft large payloads into orbit with ease led to a philosophy of big is best. The resulting monster projects —such as Hubble and GRO—turned out to be more difficult than expected and ate up the NASA budget. "Once you've invited an elephant into your house, it's very difficult to learn to accommodate it," he says. NASA, however, is now trying to make some difficult adjustments: All of the three current big projects have been cut back drastically and more emphasis is being put on small missions. "We're not quite in balance yet but we're getting there," Canizares says.

While NASA tries to transform itself, however, scientists are voting with their feet. "European space science is really making progress," says Paik. The Integral team is particularly looking forward to the beginning of the next century when, in addition to their own satellite, ESA's x-ray observatory XMM, one of Horizon 2000's cornerstone projects, will be in place. According to Dean: "The sky will be ours in the high-frequency range, and the Americans feel that."

–Daniel Clery

MARINE BIOTECHNOLOGY

Regulations Go Swimmingly

Here's a science policy puzzler: How does a proposal to give an extra $20 million a year to marine biotechnology researchers become a vehicle to regulate experiments involving the intentional release of transgenic fish? Such a transformation is no problem for the U.S. Congress, where every political action generates a reaction and compromise is the coin of the realm. But this case does have one rare feature: scientists and environmentalists joining hands to resolve a small part of a very contentious issue—the safety of genetically modified organisms.

Marine ecologist Chris D'Elia, director of the Maryland Sea Grant program, started the ball rolling in an attempt to rejuvenate the National Sea Grant College Program, a 27-year-old effort to foster ties between academic researchers and the marine industry. The project's budget has stagnated at $40 million for more than a decade, and to move it ahead D'Elia and his colleagues around the country put together a proposal for a new marine biotechnology research program. They sold the idea to Representative Gerry Studds (D–MA), chairman of the House Merchant Marine and Fisheries Committee, who in April introduced a bill (H.R. 1916) creating such a program, along with a national advisory board of experts to make sure the money would be spent on the best science. It authorizes $20 million in each of the next 2 years and $25 million in 1996 and 1997.

The bill caught the eye of Margaret Mellon, director of the national biotechnology center at the National Wildlife Federation, an environmental group that believes scientists don't always think enough about the environmental consequences of their work. The legislation, she realized, might be a way to plug a gap in existing federal regulations involving the intentional release of transgenic fish. That was a gap many marine researchers were already painfully aware of. Because there are no formal rules in this area, and because biotechnology regulation was a political football during the Reagan and Bush presidencies, it took 5 years for Rex Dunham of Auburn University to obtain permission to conduct experiments with transgenic carp and catfish kept in an outdoor, manmade holding pond.

Mellon took her concerns to a Studds aide, who began dealing, congressional style. The result, a bill both sides say they can live with, was passed on 13 July by the House of Representatives on a voice vote. The bill would create a mechanism for dealing with genetically modified organisms developed by researchers funded under the new program. It would require the Commerce Department, which runs the Sea Grant program, to make sure the work complies with safety standards being developed by the Agricultural Biotechnology Research Advisory Committee (ABRAC) for scientists funded by the U.S. Department of Agriculture.

On 18-20 August an ABRAC working group will meet in Minneapolis to hammer out what those standards should be. The group, chaired by fish geneticist Anne Kapuscinski of the University of Minnesota, would like to help all institutions and companies assess the risks posed by work being done in their laboratories and offer guidance on how to manage them to protect the ecosystem.

Similar legislation is expected to be introduced shortly in the Senate, although the chief sponsor, Senator Ernest Hollings (D–SC), would prefer to see an interagency biotechnology panel, coordinated by the president's science adviser, play the role now assigned to the Commerce Department. Hollings is also chairman of the relevant appropriations committee, which improves the chances, otherwise slim, that the research program can be funded for the 1994 fiscal year, which begins on 1 October.

–Jeffrey Mervis