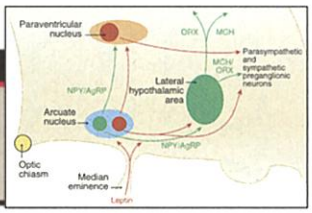


some researchers expressed concern about the pace and complexity of the missions, others were delighted with the program's newfound popularity.

But orbiting Mars is tricky; numerous Russian spacecraft have missed their target, and NASA's massive Mars Observer apparently exploded in 1993 as it reached its destination. Landing is even tougher, given the distance from Earth and the uncertainties about the martian terrain. And collecting samples, ferrying them to orbit, and rocketing them to Earth, as proposed in the sample return, has never been done.

Despite the odds, the 1997 success of Mars Pathfinder, with its innovative balloon landing and its tiny but indefatigable rover, raised hopes that NASA was up to the technical challenge. And the overall success of Mars Global Surveyor, despite some notable glitches, raised expectations that the 1999 missions would succeed. The subsequent losses of the lander and the climate orbiter stunned NASA managers and alarmed the scientific community.

The climate orbiter's demise was quickly pegged to a miscalculation in units made by contractor Lockheed Martin. The lander's fate, however, remains a mystery. "We still don't have a 100% smoking gun," says Weiler. A panel led by retired JPL manager John Casani came up with several theories, including the premature shutdown of the descent rocket, but none is certain.

In the aftermath, the finger-pointing has begun in earnest. Some scientists blame Goldin and the White House for pushing the program too hard and too fast with too little money. Others cite JPL's poor management of the projects and Lockheed Martin's underbidding of the Mars contract and problems on the factory floor. Weiler, however, says "everyone is to blame"—including the scientific community—for overconfidence.

A JPL-led panel chaired by Charles Elachi last week briefed NASA officials and the Young panel on their proposed new exploration blueprint. The most pressing issue is whether to launch the 2001 lander, which is roughly identical to the one that failed, or to scrap the launch and use the hardware for a later mission. Weiler said after the briefing that JPL suggests the latter and strongly hinted that he sees no other option. Flying the mission next year, he added, would require adding a hefty package of communications hardware to avoid the unknown fate that befell the December landing; this modification would reduce by half the amount of science the lander could perform and boost costs by another $30 million to $40 million. On the other hand, the 2001 orbiter will likely get a green light, because the failure last year of a similar spacecraft was easily explained and easily corrected.

The Elachi plan includes launch of a communications system and navigational beacons in the next few years to aid later orbiters and landers, while a series of "micro" missions would complement the larger landers by examining the planet more broadly, according to sources familiar with the details. A sample would likely not be returned to Earth before 2010. So far, however, Weiler is not satisfied with what he's seen of the Elachi plan, although he declines to be specific. "It's not even close," he grumbles, adding quickly that "it's a work in progress" and that "the people at JPL have made a good start." Weiler says that whatever the details, he will insist that the new plan include a contingency fund of at least 25%—far more than the current 10%—as well as funding for handling and studying the Mars samples. And he says that although "the sample return will be a major part of the new architecture, it will not drive it like the old one did." Hashing out the details may take until summer, he says. "Let's slow down and do this right. Taking it slow sometimes is better than speeding up—and screwing up."

Going slow is fine with many scientists who say they were nervous about the earlier plan. "If you delay a cycle or so, it's not a disaster," says David Black, an astrophysicist at Houston's Lunar and Planetary Institute. Michael Malin, a geologist who heads San Diego's Malin Space Science Systems, agrees. "Mars just isn't the place we thought it was," he says. "A slower, more deliberate and diversified scientific investigation program would be a better long-term investment than an Apollo-like race to return samples." So unlike the Hollywood version, NASA's Mars rescue mission likely will include more patience than daring.

–ANDREW LAWLER

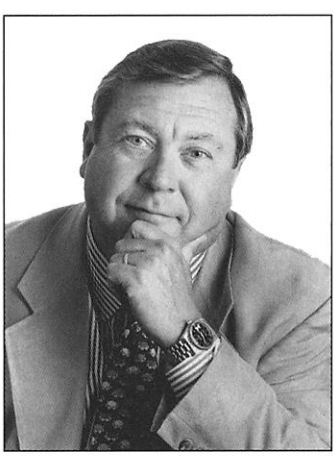
CREDITS: (RIGHT TO LEFT) PE CORP.; SAM KITTNER

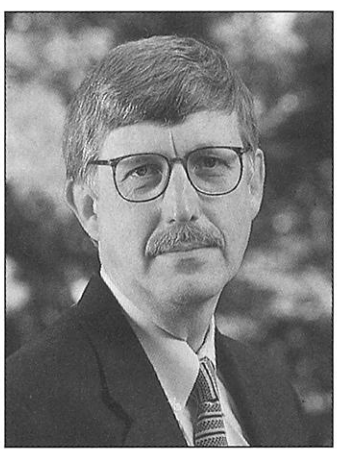
GENOME SEQUENCING

Talks of Public-Private Deal End in Acrimony

Any hope of getting publicly and privately funded scientists to work together on the human genome dissolved this week in a bitter dispute over who would control the raw data. The dispute went public on 5 March, when the Wellcome Trust, a British charity that funds genome research, released a letter spelling out the details of a controversy that has been simmering for months. As word spread that the trust had released the letter, tempers flared, triggering a flurry of finger-pointing as each side accused the other of sabotaging a potential collaboration.

The principals in the dispute seem to think the chances of mending the break are slim. "I'm pretty angry," says Tony White, CEO of PE Corp., chief backer of the private effort to sequence the genome. White even goes so far as to call the attitude of Francis Collins, director of the U.S. National Human Genome Research Institute (NHGRI), the chief U.S. funder of the public venture, "hypocritical." Collins was more restrained, calling the experience "disheartening." In retrospect, neither side was very eager to have the negotiations succeed.





Sparring partners. PE head Tony White *(left)* and NHGRI chief Francis Collins.

This is the latest and sharpest upset in a long-running dispute between scientists involved in determining the precise sequence of the 3 billion units of DNA in the human genome. PE Corp. of Norwalk, Connecticut, and its subsidiary, Celera Genomics of

Rockville, Maryland, galvanized the field when Celera's president, Craig Venter, announced in 1998 that he was planning to sequence the entire human genome by 2001. Venter said he would patent "several hundred" genes and offer conditional viewing rights to everything in his database. Nonprofit centers, led by NHGRI and the Wellcome Trust, responded by stepping up their own efforts. They rushed ahead with plans to generate a "draft" version of the human genome early in 2000, pumping results into public databases, which could undercut Celera's claims of exclusivity.

Some observers saw this as wasteful and urged the academics to collaborate with Celera. Celera did forge a successful partnership with one group of publicly funded researchers—those working on the genetics of the fruit fly (*Drosophila melanogaster*). Together, Celera and these university-based scientists cranked out the fly's genome with stunning speed (*Science*, 25 February, p. 1374). But attempts to collaborate on human DNA haven't gone smoothly.

After unproductive discussions on sharing data in early 1999, Celera and NHGRI let the subject drop. Then last autumn, a newcomer began mediating between the public and private labs: Eric Lander, director of one of the best funded academic sequencing centers, the Whitehead Institute/MIT Center for Genome Research in Cambridge, Massachusetts. As the talks grew more formal, Collins says, the public centers elected four colleagues to represent them. In White's recollection, Lander was "kicked off the team" and replaced by Collins; National Institutes of Health (NIH) director Harold Varmus (now president of the Memorial Sloan-Kettering Cancer Center in New York City); Robert Waterston, director of the genome center at Washington University in St. Louis; and Martin Bobrow, a medical geneticist at Cambridge University in the U.K. and a governor of the Wellcome Trust.

These four met with a Celera team on 29 December. Then, claiming to have received no serious response from Celera after that session, they sketched out their unhappiness with Celera's bargaining position in a letter to Celera dated 28 February. In a telephone interview with *Science*, Bobrow confirmed that the trust gave this letter to the press on 5 March but said, "I don't know" exactly how this decision was reached. Bobrow says that the talks "are at an end," in his view, because Celera "basically turned [its] back on the discussion."

Printed on NHGRI stationery, the six-page letter itemizes "fundamental differences" that emerged between the academics and the Celera group. The letter describes the talks as "discouraging" and suggests that the idea of combining data from the public and private efforts "is no longer workable."

The letter says that Celera sought to retain control over the human genome for as long as 5 years by requiring that everyone seeking access to data produced by the collaboration agree to Celera's licensing terms. According to White and Venter, these terms are simple: Shared company data may not be redistributed to others or used in a commercial product without Celera's permission. This would be enforced through a license that data users would agree to with a mouse click as they either start up software on a DVD-ROM or log on to Celera's Web site. According to the letter, however, Celera also wanted to control future uses of the data, including publication of a finished version of the genome produced by the publicly funded labs. And the letter mentions that Celera wanted to reach "beyond databases," controlling technical applications such as DNA chips.

The representatives of the nonprofit institutions who signed the letter claim that they offered Celera 6 to 12 months of unilateral control over merged human genome data on Celera's Web site. But Celera wanted more time, they wrote—and this, combined with other demands, was "not in the best interests of science or the general public."

But White insists that he only suggested that Celera be given 5 years' control over the DNA sequence if Celera went along with a request to share its raw data (such as "tracings" from DNA sequencing machines) with co-authors. Otherwise, he said, exclusive control might end in 2003, when the public effort to finish the genome is due to be completed. Similarly, White said, the discussion of long-term claims on DNA chips and other applications arose only in the context of sharing confidential trace data.

The authors of the NHGRI letter were especially concerned that Celera might use data from the publicly funded labs in its own sequencing efforts, and, if no agreement were reached, might publish a scientific paper on the final sequence without consulting the academics who generated the data and deposited it in public data banks. "Publication of other groups' primary data without consent is considered to be a breach of scientific ethics," the NHGRI letter scolds. Venter shoots back that NIH officials have talked about publishing data derived with Celera's help, but without seeking Celera's consent.

This part of the dispute particularly annoys White. He fumes that the whole argument seems to boil down to who will get credit for completing the human genome. No, says Collins, the real issue is whether the human genome will be locked up in a "monopoly" for the next 3 to 5 years.

–ELIOT MARSHALL

With reporting by Leslie Roberts and Elizabeth Pennisi.

ScienceScope

William Hamilton Dies Evolutionary biologist William Hamilton, 63, died 7 March from complications of malaria that he acquired in Africa while on an ambitious expedition to acquire new data about the origin of AIDS. "The most important thing is that he was out there doing something new in research, which is what he loved best," says Paul Harvey, head of the department of zoology at Oxford University, where Hamilton worked.

A bad malaria bout in late January forced Hamilton to rush home from the Democratic Republic of Congo, where he and co-workers had collected chimpanzee feces and urine samples. Hamilton, who is renowned for his studies of the evolution of social behavior and of sex, hoped to find HIV in the chimp samples. If some do test positive, analyzing those viruses could help clarify whether an oral polio vaccine tested there in the 1950s sparked the AIDS epidemic. The thesis, explored at length in a recent book, *The River*, hinges on the fact that the vaccine's developers had a large research chimp colony in Congo.

"Some of his ideas you thought were lunatic and some great, and it sometimes turned out that the lunatic ideas were the great ones," Harvey says. "He was the most loved and respected person we had in the department."

Make a Wish Representative Curt Weldon (R–PA, right), chair of the House Armed Services subcommittee that oversees defense research, wants more money for military R&D. At a hearing last week, Weldon told Pentagon science czars Jacques Gansler, Frank Fernandez, and Dolores Etter that although a proposed 4%, $50 million increase for basic research in 2001 is "good news," the $38.6 billion military science budget remains "overly squeezed." He is particularly concerned that the Pentagon is shortchanging studies that may not pay off for years in favor of applied projects that promise near-term results. "There needs to be a better balance," he said.

In response to questions, Fernandez and Etter admitted that they could easily spend a few hundred million dollars more on wish-list projects, from computer security to advanced robotics. And Weldon promised to do what he could in coming months to "plus up" Pentagon science spending, which is the major source of cash for university math and engineering departments.