With NASA grounded until 1988, space science is 'on hold'

It is sadly ironic that the latest triumph of Voyager 2, in its historic close encounter with the little-known and less-understood planet Uranus, took place the weekend before the Challenger space shuttle exploded with the loss of seven lives on 28 January. Voyager 2 symbolizes what NASA can do to advance space science with unmanned spacecraft launched with expendable rockets. The robust robot has journeyed more than 2 billion miles without a glitch since it left Earth in September 1977, proving without question that humans can explore the solar system at no risk to themselves. Having already sent back data and images of Jupiter, Saturn and now Uranus, with its dark rings and five moons (PHYSICS TODAY, August, page 17), the aptly named Voyager is careering on toward its flyby of Neptune in 1989.

It is also ironic that the National Commission on Space issued a grandiose cost-is-no-object vision of NASA's interplanetary adventures for the next 50 years only a few days before the Presidential Commission on the Space Shuttle Challenger Accident submitted its searing report (PHYSICS TODAY, August, page 41). Created by Congress and appointed by President Reagan, the space commission, headed by Thomas O. Paine, a former NASA administrator, endorses the development of a new generation of spacecraft to replace the shuttles and, in proposing this, conjectures that voyages to the moon and Mars can be done much more cheaply, safely and reliably. The Paine commission's bold agenda for space exploration is intended to help scientists know whether the solar system is unique in the universe. It also is likely to have a great deal to do with determining what the world will be like in the 21st century.

New world missions. "We're not predicting it," says Paine. "We are simply trying to say what we can make happen." Even so, says the Paine report, "we are confident that the next century will see pioneering men and women from many nations working and living throughout the inner solar system. Space travel will be as safe and inexpensive for our grandchildren as jet travel is for us."

In the predicament NASA now finds itself the commission's agenda appears far off. After an incredible string of launch failures so far this year, US space capabilities are nil. The loss of Challenger has left the three surviving shuttles grounded, awaiting the redesign of the solid-fuel rocket boosters, which provide most of the thrust during launch, and other components that are deemed unsafe or unreliable, including the nose-wheel steering and braking systems that the accident commission found wanting. The commission, commonly known by the name of its chairman, William P. Rogers, a former Attorney General in the Eisenhower administration and Secretary of State in the Nixon period, pointed out that total reliance on shuttles for launchings had put heavy pressure on NASA to increase its launch rate. This was an undeniable factor in the decision to ignore the warnings of engineers against launching Challenger in freezing temperatures at Cape Canaveral, the Rogers commission decided.

Off-course rockets. All other launch vehicles are also grounded. In April an Air Force Titan 34D booster, with a KH-11 Defense Department reconnaissance satellite, exploded seconds after liftoff, badly damaging the launch pad. This was the second Titan to blow up in the past year. In early May a Delta rocket, carrying a weather satellite, shut down during launch and had to be blown up by NASA ground controllers. NASA's internal inquiry into the mishap revealed the cause as an electrical short in the main engine control circuits. To make matters worse, just as NASA began exploring the idea of using the European Space Agency's Ariane 2 to fly some commercial and scientific cargoes, two of the rockets had to be destroyed because of third-stage ignition failures during liftoff from French Guiana in May.

These debacles have curtailed the western world's ability to reach into the heavens, at least temporarily. The immediate effect is to delay all launches until at least the end of the year in the case of Ariane 2 and perhaps as long as mid-1987 for Titan and early in 1988 for the shuttle. The US space effort looks so bedraggled right now that Donald E. Fink, editor of *Aviation Week & Space Technology*, recently complained in a "Who's in charge?" editorial that it was time to stand up and holler: "Saying that the US space program is in a shambles overstates the case, but not by much."

For the next few years, says Laurel L. Wilkening, vice-president for research at the University of Arizona and vice-chairman of the Paine commission, planetary scientists, astronomers and geophysicists must endure "a devastating delay." Albert Wheelon, executive vice-president of Hughes Aircraft Co and a member of the Rogers commission and of the President's Foreign Intelligence Advisory Board, puts it more bluntly: "We have here an unqualified disaster. For all purposes in space, we are out of business."

'Marking time.' As NASA's chief scientist, Frank McDonald, sees it, "We're marking time when we should be up and away. If that's not bad enough, we're losing momentum for starting new missions and we're possibly losing some young talent who fear that space is not where the action is."

The last major US scientific space probe was Pioneer to Venus in 1978. It seems certain the next one will be at least a decade later now that NASA has decided not to resume shuttle flights until early 1988. NASA has given up hopes of fixing the defective booster seals and joints that caused the Challenger catastrophe and is opting instead for a complete redesign and possibly a different manufacturer. Until the timetable for the next shuttle launch was announced on 14 July by James C. Fletcher, back for a second stint as NASA's administrator, the space agency had insisted the shuttle would be in flight by July 1987, although outside experts and some inside NASA had said that was overly optimistic.

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Lost on Challenger were several experiments (including studies of chicken embryo development, crystal growth and low gravity effects on a titanium alloy, all devised by young students) and two satellites—Spartan–Halley, a $25 million spacecraft that would have been deployed to photograph Halley's comet and measure its ultraviolet spectrum, and Tracking and Data Relay Satellite System-B, a $100 million relay station that was expected to join TDRS-1 to provide communications between Earth and shuttles and such other orbiting operations as the Hubble Space Telescope. Postponed in the aftermath of Challenger were two scientific missions named Ulysses and Galileo, as well as the Hubble Space Telescope.

'Windows' to Jupiter. Ulysses, a cooperative venture with West Germany, is intended to whip around Jupiter, where it will be kicked by the planet's gravity into a polar orbit of the sun, which has never been seen from the angle that the spacecraft will view. Once scheduled for launch in May 1986, Galileo, is to orbit Jupiter and study its atmosphere. Both spacecraft need to be launched in specific "windows" of time by using the Earth's position relative to Jupiter.

Because of their size and weight, each was designed to be launched from the shuttle, needing an extra boost into interplanetary space by a powerful Centaur Upper Stage rocket. NASA decided in June to abandon any plan to use the Centaur because its liquid hydrogen and liquid oxygen would constitute an unacceptable risk to astronauts aboard the shuttle. Another source of worry about the Centaur is that Ulysses and Galileo carry radioisotope thermal generators that work on plutonium to provide electricity, because the spacecraft will be too far from the sun to use solar cells. Studies by the Department of Energy caution that an explosion of a shuttle might release radiation that could contaminate hundreds of square miles of southern Florida. NASA engineers claim the pressures involved in a shuttle explosion are unlikely to rupture the radioisotope generators, but, taking no chances, they proposed that the spacecraft carry special protective shrouds.

Even before Challenger's accident, the Pentagon's version of Centaur, which is not yet ready to fly, was undergoing modification for safety. But, said the Rogers commission in its report, "because of the rush to get the 1986 [Ulysses and Galileo] missions launched, these improvements were not approved" for the spacecraft. After Challenger, NASA allotted $75 million to modify the Centaur to enhance its safety. Even so, it seemed clear to agency officials that much more money would be needed to eliminate the possibility in the post-Challenger era that radiation could leak.

'Veritable bomb.' The shuttle–Centaur combination was a subject of scrutiny in Congress at the time of the Challenger episode. After the accident, Representatives Bill Green, a New York Republican, and Edward Boland, a Massachusetts Democrat, both members of the House Appropriations subcommittee that deals with NASA, asked Fletcher to review Centaur's place on the shuttle. In a letter to Fletcher, the Congressmen observed that "since the accident the yardstick against which . . . risks will be measured has forever changed." Representative Edward J. Markey, another Massachusetts Democrat, who had alerted Congress to Centaur's safety problem, noted that NASA's own internal documents had referred to the rocket as a "veritable bomb."

Fletcher's decision to forbid the use of Centaur rockets also affects the Pentagon's plans for launching advanced versions of communications and early-warning satellites from shuttles. According to the Federation of American Scientists, several DOD missions, including the Milstar communications satellite, were to be deployed by Centaurs from shuttles. The newly appointed head of NASA's shuttle program, Rear Admiral Richard H. Truly, is conducting a study of alternative ways of launching important scientific and military missions.

At NASA's Jet Propulsion Lab, a few miles from the Caltech campus, there was no surprise over leaving Centaurs off the shuttle. In fact JPL staff has been examining alternative launch possibilities for Ulysses and Galileo as well as for the Magellan spacecraft that is being built to orbit and map Venus. With more than 20 spacecraft sent to Venus by the US and USSR since the early 1960s, it is by far the most visited world in the solar system. The launch options:

- A larger version of the Inertial Upper Stage, a solid-fuel rocket used for launching some large communications satellites from a shuttle. This had once been considered the most promising way of launching from shuttles, but its development was so costly it was abandoned in favor of the Centaur.
- A Titan 34D-7 rocket, now under development by the Air Force, with either a Centaur upper stage or the larger version of the Inertial Upper Stage, could launch from the ground.
- A modified Inertial Upper Stage using two powerful propulsion stages placed on either the shuttle or a Titan rocket.
- A new, more powerful version of a commercial upper-stage rocket being marketed by Orbital Sciences Corp in arrangement with Martin Marietta Corp. This could be used in a shuttle or atop a Titan booster.

If Ulysses and Galileo are to fly on the shuttle, NASA's revised timetable will delay their launch for years. Ulysses could be launched in July 1988. The next window for Galileo is December 1988 and then every 13 months later. Space scientists and NASA officials worry that with so many types of space launchers out of service at one time and all in need of repair and redesign, the queue for space will grow considerably and the Pentagon will preempt most nonmilitary launches, particularly when it gets to the point of testing components for President Reagan's Strategic Defense Initiative. The earliest launch for Galileo is probably late 1989, which means it would arrive at Jupiter in December 1994. If launched in January 1991, it would reach Jupiter, after orbiting Earth twice, by October 1995.

Thomas M. Donahue of the University of Michigan, who is an experimenter on the Galileo project, puts the problem plainly for space scientists: "I'm 65 years old. I'll be 71 or so when Galileo is ready to go up if it doesn't make it in 1987, so the shuttle sure makes a difference to me. . . . How can people devote their time to the space program when they need to produce research?"

Donahue, chairman of the National Research Council's Space Science Board, called last April for a "drastic change in [NASA] policy that would once more make expendable launch vehicles the primary system for launching scientific spacecraft." (See PHYSICS TODAY, July, page 112.) NASA's choice of the shuttle over expendable rockets has already had a devastating effect on space science, said the board. It was not unmindful of the cost of such a move, according to Donahue. "We address the question of whether we can do all that the nation's space program should do with the kind of resources that have been available for the last 15 years. We say that it may be impossible and recommend that the resources needed be provided to do this program right or not at all. Trying to skimp on a highly visible, prestigious activity on the frontier of technology inevitably leads to highly visible and damaging failure."

Academic frustrations. Jeffrey D. Rosendahl, NASA's assistant associate administrator for space science and applications, understands such concerns by academic scientists. The development cycle of such programs as the Hubble Space Telescope, the Advanced X-ray Astrophysics Facility, the Gamma Ray Observatory and several planetary missions is 10–20 years—two to four times greater than the 4–5 year cycle for a graduate thesis and postdoc-

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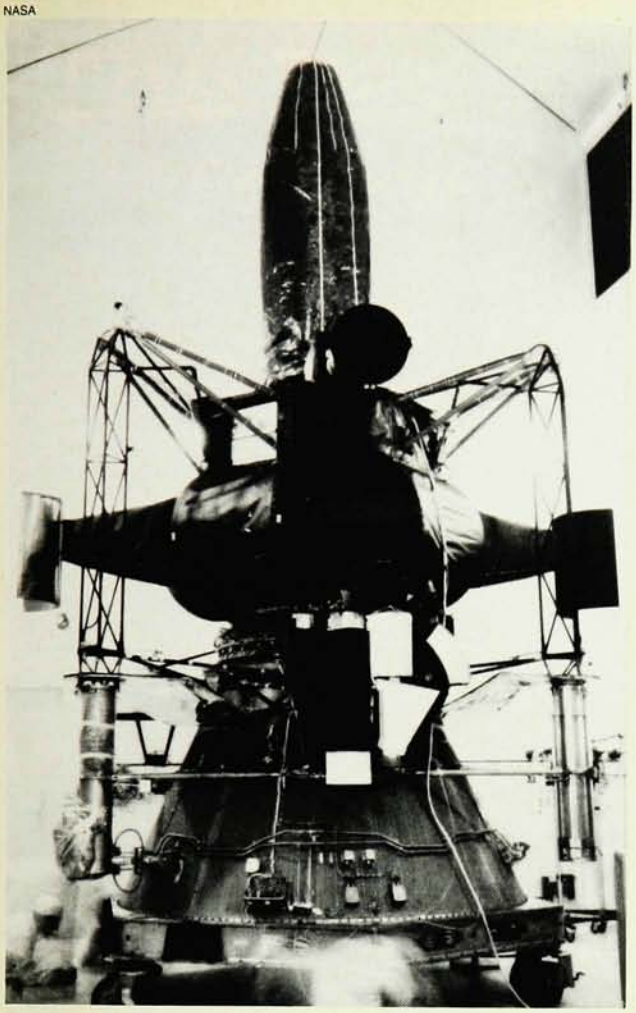

Galileo orbiter and its compannion probe undergoing testing at JPL in 1984. Originally, Galileo was scheduled for launch in 1986, to reach Jupiter in 1988. But the Challenger disaster and worries about the Centaur upper stage have delayed it, as well as other space-science projects.

toral research program. "There was a time when a student could plan an experiment, design the hardware, launch a mission, collect the data and evaluate the results for his thesis," says Rosendahl. "They had hands-on experience with all aspects of the research cycle." Now, though, a student's experience may consist of only one or two aspects of the space research cycle. "We've done all the easy things," he adds. "You can't put a Geiger counter in a 10-lb. satellite, fly it in six months and discover something new—at least not on the shuttle. I understand the frustration."

That's why space researchers want to emphasize the usefulness of rockets and even balloons as means to an end, rather than put all experiments on the shuttle. Testifying in May on behalf of space scientists, Glenn Mason, a physicist at the University of Maryland, told the Senate Commerce, Science and Transportation subcommittee on space that "the shuttle must be reserved for those missions which require manned flight and the rest should be flown on unmanned expendable launchers.... There is no reason why the shuttle should be used by Ulysses, Galileo and other such missions."

Burton Edelson, associate administrator for space science and applications at NASA, wholly agrees. "Of the free flyers," he says, "only two must be launched on the shuttle—the Hubble Space Telescope and the Gamma Ray Observatory. There are others still in development—the Upper Atmosphere Research Satellite and Cosmic Background Explorer—for which a shuttle launch is preferable. All the rest can be launched with ELVs." The Space Telescope, Edelson asserts, is NASA's highest scientific priority and should be on the second or third flight of the shuttle in 1988 "as a symbol to the scientific community and the rest of the world that space research is paramount."

He acknowledges that the Pentagon has its own priority list, on which the Space Telescope would be lower down on the launch manifest—possibly fifth or sixth. Edelson expects a tussle over the shuttle's manifest for early flights. "What the DOD wants to fly are missions with little visibility," he says. "On the other hand, NASA needs to let the world know it's back in business."

Capital discord. The agency wants to do that, but has been paralyzed by a lack of decisions about replacing the Challenger, adding expendable rockets to its fleet and restructuring its own organization. One of the key decisions came on 15 August when President Reagan announced the lost shuttle would be replaced and NASA would stop launching commercial satellites. Even these decisions caused immediate discord. The long-awaited decision on a fourth orbiter, said Reagan, "will bring our shuttle fleet up to strength and enable the United States to safely and energetically project a presence in space. Without the fourth orbiter, NASA's capabilities would be severely limited and long-term projects for the development of space would have to be either postponed or even cancelled. A fourth orbiter will enable our shuttles to accomplish the mission for which they were originally intended and permit the United States to move forward with new, exciting endeavors like the building of a permanently manned space station."

What's more, while the space agency currently has 44 contracts to launch commercial or foreign payloads of various types from the shuttle, the President ordered NASA to stop that activity. "NASA and our shuttles can't be committing their scarce resources to things which can be done better and cheaper by the private sector," said Reagan. "Instead, NASA and the four shuttles should be dedicated to payloads important to national security and foreign policy and, even more, on exploration, pioneering and developing new technologies and uses of space."

Money matters. Reagan's remarks raised several questions, especially for the fate of space science. The new shuttle and spare parts are expected to cost about $2.8 billion over the next five years, but thus far the White House has budgeted only $272 million to NASA to start construction in fiscal 1987 (which begins on 1 October), leaving decisions on how to pay for the remaining $2.5 billion for the future. Fletcher says he is "hopeful" and does not "anticipate that a large amount of that will come out of NASA's budget"—though he admits there are "no guarantees." However, Reagan's spokesman, Larry Speakes, suggested that the funds would come from a combination of sources: money unspent during NASA's lengthy hiatus in space launches (which Fletcher told a Senate subcommittee on 5 August would leave about $425 million in the agency's till), existing NASA programs (excluding Reagan's pet space station) and other government agencies (though not the Defense Department).

Fears were soon expressed on Capitol

Hill that NASA would end up footing the whole bill for the new shuttle by gutting space science. Three prominent Republican senators—Slade Gorton of Washington, John C. Danforth of Missouri and Jake Garn of Utah, all heads of influential committees that oversee space programs—criticized the President's plan as "entirely too vague" on funding and questioned whether that meant space-science projects would be "cannibalized."

At a news conference, Fletcher attempted to allay concerns in the Congress and science community that space science might be cut back to help finance the replacement orbiter. "We expect that a large fraction of shuttle launches in the future will be scientific missions," he said. "We plan to keep the scientific missions at about the same level percentagewise of the NASA budget." He admitted, however, that delays were certain for all payloads during the next two years, as the agency works its way through the manifest of military and scientific cargoes. It is even possible, Speakes told the press corps after the President's statement, that as many as 15 of the 44 commercial and foreign payloads awaiting shuttle launchings may "go up"—though not for years and in an order to be determined by an interagency working group, dominated in all probability by the Pentagon.

Doubts at JPL. In fact, space scientists learned in July that new weight restrictions on existing orbiters as well as the planned new one mean that neither the Comet Rendezvous Asteroid Flyby mission nor the Cassini orbiter of the planet Saturn can be launched from a shuttle. These, along with Voyager, Galileo and Magellan, are the offspring of JPL, which Caltech runs for NASA. The doubts about NASA's science program has filled JPL scientists with frustration and fear. "Would you commit yourself to 10 years of uncertainty?" asks Moustafa T. Chahine, JPL's chief scientist. While none of the lab's space scientists have left yet, Chahine is certain some will do so before year's end. What is needed to avoid that situation, he argues, is a strong commitment from NASA headquarters that planetary science will not be undervalued or underfunded.

At the Goddard Space Flight Center in Greenbelt, Maryland, its director, Noel Hinners, admits that researchers have dealt with uncertainties before. Keeping scientific and engineering teams together for two or three years without providing interesting new work is tough enough, he says, but the prospect of layoffs is "devastating to morale."

—IRWIN GOODWIN

Washington Ins and Outs:

Key changes at pentagon and OMB

On 15 August Gerold Yonas left the Strategic Defense Initiative Organization, where he had been both chief scientist and acting deputy director since August 1984. Yonas gave up the job of acting deputy last April, with the arrival of Gordon A. Smith, former corporate vice president of Fairchild Industries and a director of its subsidiary, Fairchild Space Co. As deputy to SDI's director, Lieutenant General James Abrahamson, Smith will be point man for the technical aspects of the "Star Wars" program. At Fairchild, Smith, who has a PhD in physics from George Washington University, ran the Leasecraft program, developed to place platforms in Earth orbit for commercial satellites. Leasecraft was grounded when the Challenger space shuttle exploded.

Yonas joined SDI in August 1984 on a two-year hitch from Sandia National Laboratories, where he had been in charge of pulsed-energy sciences since 1972 (PHYSICS TODAY, October 1984, page 59). Instead of returning to Sandia, though, he decided to become vice president of Titan Corp in La Jolla, California, an advanced electronics R&D firm. One of Titan's lures for Yonas is the company's work in pulsed power technology, which occupied him at Sandia. Of Titan's total of $97 million in sales last year, $12 million was in SDI projects. Federal law forbids anyone with Defense Department responsibilities for procurement and acquisition from representing corporate projects before Pentagon officials after leaving government. Though it is not entirely clear that he had such duties while at SDI, Yonas says he will "abide by the law 100%" by heading Titan's efforts to expand its high-technology products into commercial applications.

Leo Young, director of Research and Laboratory Management in the Pentagon, has joined the Star Wars program, though his new title has not yet been invented, awaiting the reorganization of SDI headquarters promised by General Abrahamson. In the Pentagon since 1981 and before that a physicist at the Naval Research Laboratory, Young is respected and trusted by academics and is a staunch defender of basic research and academic freedom. His chief aim will be to sweeten the soured relations with university scientists, who are in the vanguard of attacks on SDI.

In July the Defense Department named Young's successor: Ted Berlincourt, who earned a PhD in physics from Yale University and after a stint at NRL devoted his career to the management of scientific research. He was director of the North American Rockwell Science Center, chairman of Colorado State University's physics department and for the past 14 years director of mathematical and physical sciences at the Office of Naval Research. He moved to the Pentagon basic research post on 18 August. Berlincourt's formal title, like Young's, has not been designated.

Hugh F. Loweth, deputy associate director for energy and science in the White House Office of Management and Budget, retired in June and immediately went sailing. He joined the Bureau of the Budget, as it was then called, in 1951 as a budget examiner. His introduction to science budgets came in 1955 when the National Science Foundation, then in its infancy, began planning for the International Geophysical Year (1957-1958).

Known in Washington science circles as "Mr. Budget," Loweth developed an insider's insight to science policy-making over the past three decades, closely watching every White House science adviser. Loweth considers Jerome Wiesner, President Kennedy's man, the adviser with the best connections to the Oval Office. "People in the White House were very comfortable with Wiesner," says Loweth, "perhaps because he linked science and education, and made both sets of issues so real and relevant." According to Loweth, Eisenhower frequently called on James R. Killian Jr and George Kistiakowsky "to provide a necessary balance to the kind of advice he was getting from the military–industrial complex."

His decision to retire came as a surprise to many at Federal agencies and in OMB, though Loweth asserts he started considering it two years ago. "It became clear to me that science was entering a period of diminishing returns in Washington," he explains. "Under Gramm–Rudman–Hollings, the budget would suffer a serious crunch and science would be a victim. It's been my observation that the science community cannot save government funding for science research without the help of allies from outside its own borders. It's going to require the pressure of political and industrial interests as well as public opinion to make the situation come out right."

—IRWIN GOODWIN□