Balancing the Right Stuff

Solar physicist Yohei Yamauchi dreams of finding a permanent job in his field. But his boss at the New Jersey Institute of Technology in Newark recently told him that NASA was cutting the modest grant supporting his work analyzing data on the solar corona, leaving the 38-year-old Japanese-born researcher scrambling for another position. A scientist at another research institute who would like to hire Yamauchi is instead laying off a postdoc because of the same budget constraints.

Yamauchi’s straitened circumstances are a sign of a quiet crisis in NASA’s science program that poses a formidable challenge to Michael Griffin, who took over last week as NASA’s new administrator. Space agency managers are now chopping more than $400 million out of the 2005 science budget to cover congressional earmarks and shuttle overruns. That means cutting grants, turning off satellites, and postponing nearly a score of planned missions. And the situation is likely to grow more dire in the coming year, as shuttle costs continue to rise and NASA pushes ahead on programs designed to send humans to the moon and eventually to Mars—all on a budget slated to remain nearly flat.

“There is the potential for serious damage to the future of science at NASA,” says Lennard Fisk, a geophysicist at the University of Michigan, Ann Arbor, who chairs the National Academies’ Space Studies Board. Fisk, who led the agency’s science program during the Administration of President George W. Bush’s father, was one of 17 prominent scientists to sign an unusual manifesto the day before Griffin’s Senate confirmation hearing urging NASA to retain its broad-based science program while it pursues the human exploration of the moon and Mars. “The balance between the two modes of exploration, human and robotic, is now threatened,” the manifesto states.

Griffin—who spoke with some of the concerned researchers a few days before that hearing—echoed that concern at the 12 April hearing. “We as a nation can clearly afford well-executed, vigorous programs in both robotic and human space explo-

“We Can Do the Program That the President Has Proposed”

Calling him “a rare combination of scientist, engineer, and manager,” Senator Barbara Mikulski (D–MD) gave voice to the thoughts of colleagues on both sides of the aisle in speeding Michael Griffin through a Senate confirmation process that took all of 1 day. “He is a rocket scientist—thank god we’ll have someone who understands what it is all about!” she proclaimed about the new NASA administrator during his hearing on 12 April.

That understanding will be put to the test as the 55-year-old aero-space engineer faces a slew of tough decisions (see main text). Sources close to Griffin predict sweeping changes by this summer in NASA’s senior management, including new chiefs of science, space flight, and legislative and public affairs. Their boss has already received White House approval to send a shuttle mission to service the Hubble Space Telescope if he deems it to be safe, they add. During the hearing, Griffin laid out his views on several pressing issues facing the agency.

Here are excerpts from his testimony:

• **On the space station:** “A human space-flight program focused only upon the completion of the space station and the servicing of that station with the shuttle does not qualify as a goal which is worth the expense, the risk, and the difficulty of human space flight. ... The president is pledged and I ... am pledged to bring the space station to a level of completion consistent with our obligations to our international partners.”

• **On balancing human and robotic programs:** “If we continue to receive the president’s budget allocations, we can do the program that the president has proposed. We know that we can do it because we’ve done it. The Apollo years are often looked at as a period when the expense, the risk, and the difficulty of human space flight. ... The president is pledged and I ... am pledged to bring the space station to a level of completion consistent with our obligations to our international partners.”

• **On the Hubble Space Telescope:** “I would like to take the robotic mission off the plate. ... And so I believe that the choice comes down to reinstating a shuttle servicing mission or possibly a very simple robotic deorbiting mission. The decision not to execute the planned shuttle servicing mission was made in the immediate aftermath of the loss of Columbia. When we return to flight, it will be with essentially a new vehicle, which will have a new risk analysis associated with it and so forth. At that time, I think we should reassess the earlier decision.”

• **On a new human launcher:** “Two nations [China and Russia] have now put people into space since the United States has last done so. I don’t like that. The program that NASA has outlined so far features a new crew exploration vehicle—we can call it what we will—and it nominally comes online in 2014. I think that’s too far out. President Bush said not later than 2014. He didn’t say we couldn’t be smart and do it early. And that would be my goal.” —A.L.
ration as well as in aeronautics,” he said. He noted that NASA during the 1960s was not solely focused on the Apollo moon program but had vibrant planetary, earth science, and aeronautics efforts. “We can do it again,” he insisted. The next day the Senate confirmed him as the agency’s 11th chief.

But Griffin also said his top priorities are getting the shuttle back into orbit and building a new human launcher to replace it. He must contend with major aerospace companies, NASA centers, and key lawmakers committed to preserving the jobs that the space shuttle and space station provide, and a president who wants NASA to push ahead with new launchers, lunar bases, and human missions to Mars. And Griffin, unlike his predecessors in the 1960s, almost certainly will not receive budgets large enough to accommodate these competing interests. “He’s going to have to choose sides; he can’t make everyone happy,” predicts one former NASA administrator. Adds a longtime congressional aide: “He has got quite a challenge to figure out how to make the math work.”

**Best and worst of times**

Ironically, NASA’s science program has never been better funded. One-third of the agency’s budget—$5.5 billion—is devoted to science. That’s the largest percentage in agency history, notwithstanding new accounting methods that include overhead. Construction of sophisticated robots to examine Mars is under way, a large new space-based observatory to replace the Hubble Space Telescope is well along in the planning, a probe to Pluto will soon be launched, and a fleet of Earth-observing spacecraft is returning unprecedented quantities of data. A new lunar robotic effort is on the books, and science’s share of the NASA pie is slated to hit 38% in 5 years.

That is little solace to researchers such as Yamauchi, however, who are bracing for more bad news. NASA will soon announce a $160 million cut to its 2005 science budget, after making a similar reduction in December. Another $86 million goes to working on a robotic mission to the Hubble Space Telescope, for a total of $407 million. Later this month, an independent group of scientists will tell NASA which earth science missions should be shut down in light of the funding crunch. And this fall, another panel will determine which half-dozen or more of 13 orbiting solar and space physics spacecraft—including the famed Voyager probes—should be turned off. That advice follows NASA’s decision to postpone indefinitely work on most long-term missions that aren’t heading to Mars or the moon.

NASA science chief Al Diaz blames the squeeze on congressional decisions, called earmarks, to fund projects not requested by the Administration. “Every 2 years, these earmarks [divert enough money to] eat a mission,” Diaz told a NASA earth science and space science advisory committee science advisory panel on 31 March. “Earmark money clearly could have been used to fund Voyager and Ulysses”—two spacecraft currently on the chopping block. Less than a decade ago, such set-asides accounted for just a few million dollars in the science budget.

But many scientists say a far bigger threat to broad-based science at NASA is the rising cost of returning the shuttle to orbit and building the space station, coupled with the president’s call last year for human visits to the moon and Mars. “It is only going to get worse,” says Princeton University astronomer John Bahcall about raids on NASA’s science budget to accommodate human flight. “They will have to dig even more deeply in the science budget; it has only just begun to be mined.”

The roots of today’s woes were put down soon after the Columbia accident in February 2003, when NASA began the long and expensive job of fixing the shuttle. Meanwhile, the White House developed a long-term strategy for the agency that would finish the space station, shut down the shuttle, and send humans to the moon and Mars using a new launcher that would be ready by 2014. Bush said he would pay for the initiative by phasing out the shuttle in 2010 and abandoning the station several years earlier than originally planned. Although the science focus of the exploration effort would be the moon, Mars, and life science research aboard the space station, then—NASA chief Sean O’Keefe insisted that the overall science program would be protected.

But the Administration’s “pay-as-you-go” strategy for its exploration effort, accompanied by modest budget increases for the coming years, began to unravel quickly last year. Although Congress approved the full amount requested by the White House, the costs for getting the shuttle flying again continued to climb, to more than $700 million in 2005 alone, an amount not reflected in Bush’s original 2005 request. And Congress packed the NASA budget with pork, including $160 million in the science directorate alone. Meanwhile, cost estimates for robotic missions as well as new technology programs such as the Prometheus nuclear-power system were on the rise.

Confronted with an expensive war in Iraq and a swelling budget deficit, the White House asked for less money in 2006 than Bush had pledged to request just 1 year before. And many aerospace companies and lawmakers object to the president’s plan to shut down the shuttle in 2010 when a new human launcher would not be ready until 2014. They argue that the 4-year gap is too long. In his confirmation hearing, Griffin
pledged to try to speed up construction of that new human launcher, which would undoubtedly cost tens of billions of dollars. Griffin has previously proposed converting the shuttle from a human launcher into a cargo vehicle, which could also entail a major investment.

Yet neither earmarks nor the human space flight program fully accounts for NASA's science crisis. The Columbia accident occurred as the research community was selling NASA on a new generation of planetary, astrophysics, and earth science missions. To pay for those new programs, the agency planned to spend $1 billion more on science in 2006 than has been requested by the White House.

Fisk maintains that those achievements, rather than the president's exploration vision, are largely to blame for the current mess. Diaz's predecessor, Ed Weiler, "was too successful," says Fisk. "He sold programs that required a growth in funding for science that is not now attainable."

Crossing the Rubicon

NASA officials refuse to say exactly how they will allocate the final round of 2005 cuts—a total of $160 million—but the impact is already being felt at U.S. institutes and universities. "I personally elected not to cut ongoing programs and not introduce delays or eliminate strategic programs," Diaz told the NASA advisory panel. "It is impossible to figure out a more surgical way; the problem is our flexibility is gone. Missions have grown in size and funding has not." The chief victims, he said, will be operations of existing spacecraft, grant programs, and longer-term plans to build earth science and astrophysics probes.

In NASA's astrophysics division, for example, managers are struggling to cope with costly technical troubles on spacecraft slated for launch in the next few years along with cuts imposed from above. Anne Kinney, the division leader, late last year squeezed $100 million from her 2005 budget of roughly $1.5 billion to cover earmarks, general reductions, and returning the shuttle to flight. In the past month she has had to find another $58 million in reductions—a task made harder by the fact that the budget year is already more than half over. Two-thirds of the reductions will be assigned to missions and one-third to research and analysis programs. "As long as I've been here, we've never cut research," says Kinney. "We are crossing the Rubicon."

The impact was immediate. The same day that Diaz spoke to his scientific advisers, NASA announced it would cancel this year's solicitation for 5-year, $100,000 grants that allow budding astrophysicists to pursue a broadly framed scientific issue.

“For young researchers like me, these long-term programs are absolutely vital,” says one grantee, Bryan Gaensler, a 31-year-old assistant professor at the Harvard-Smithsonian Astrophysical Observatory in Cambridge, Massachusetts.

Kinney says she had little choice. "Why ask 200 people to send in proposals if you can only accept five?" she adds. NASA is canceling another annual grant program that funds work on data archives from older missions. The agency also put on hold other efforts like the Explorer programs, which fund modest missions from a variety of disciplines at a faster pace than the usual NASA projects. That outrages many space scientists. "This is the lifeblood of innovation and creativity in our discipline," says Fawwaz Ulaby, an electrical engineer at the University of Michigan, Ann Arbor, and member of NASA's new science advisory committee. "Our community has been saying that the Explorer program is absolutely critical, so that we have some agility to respond" to new research questions.

Diaz also intended by this fall to turn off seven of 13 operating solar physics missions—including the Voyagers at the edge of the sun’s influence—to save a total of $21 million. The probes represent the bottom half of a 2003 ranking of scientific usefulness. But under pressure from the advisory panel, he recently agreed to conduct an extensive outside peer review this autumn before terminating any missions. That extension, warns NASA manager Paul Hertz, puts further internal pressure on the science budget.

Down to Earth

Earth scientists hope that their work on a National Academies’ decadal plan—an interim version was slated for release this week—will help them persuade the White House and Congress not to abandon their troubled discipline. It will be an uphill struggle. Berrien Moore, a biogeochemist at the University of New Hampshire in Durham who is a co-chair of the decadal panel, calls NASA's current approach “a going-out-of-business sale for earth sciences.”

He notes that only one of a half-dozen missions planned for launch is clearly going forward. NASA, for example, plans to abandon the Glory mission to study aerosols, a mission championed just last year by former NASA chief Sean O'Keefe, who pledged to speed up launch to 2007 or 2008. "Now we have gone from acceleration to cancellation,” Moore adds. Some planned missions are indefinitely postponed; others were left with money to build an instrument but without funding for a spacecraft to fly on.

Nor are existing satellites safe. Mary Cleave, who heads the earth science division, predicts that an independent review of several missions to be finished this month will lead to the termination of some of them. At
Fishers are worried about the economic impact of Mars exploration. And Diaz notes that a momentum,“citing the ambitious plans for lunar and Mars exploration along with space station life sciences.

Diaz’s policies haven’t gone over very well in the space and earth sciences communities. “This is probably just not good budget strategy,” says Fisk. Faced with similar constraints in the early 1990s, Fisk chose to scale back efforts to build large spacecraft to protect more fragile smaller missions, existing spacecraft, and the network of scientists who depend on NASA grants to analyze data. “You can’t just fund the flight programs, which mostly funnel money to industry,” he adds. Researchers have yet to grasp the severity of the issue, and Diaz is worried about their reaction. “There is a firestorm coming, and the community does not always respond in an organized way,” says Fisk.

The first organized response is the 1500-word manifesto timed for Griffin’s confirmation hearing. It is the brainchild of Nathan Schwadron, a 36-year-old space physicist at the Southwest Research Institute in San Antonio, Texas, who says he began to worry last fall that NASA’s science program—and entire disciplines—were in jeopardy. The document argues that Bush’s exploration vision shouldn’t be confined to the moon or Mars. “Should other forms of space exploration be canceled or curtailed to make this new, but limited, exploration vision possible? We think and hope not,” says the paper. “It is critical that we continue to explore broadly.”

Schwadron and others say that they are sympathetic to a revamped human space flight program, but that they want to ensure a broader definition of exploration. “It’s not the turning toward exploration, it is the turning away from science that’s the problem,” says Yale University astronomer Meg Urry. “Some of the most successful science at NASA is languishing, such as the search for dark energy, arguably the biggest revolution in physics in a century.” Scientists like Schwadron and Urry applaud the new goals for the human space flight effort, but they don’t want NASA’s diverse research portfolio to shoulder the costs.

NASA managers insist that the president’s vision is fundamentally friendly to science. “Science activities are built into the foundation of the exploration vision,” James Garvin, NASA’s chief scientist, told the American Astronautical Society at a 29 March meeting in Greenbelt, Maryland. He argues that exploration “is a scientific journey,” citing the ambitious plans for lunar and Mars exploration. And Diaz notes that a series of “road maps” being assembled will lay out the long-term direction of science and be completed in time to influence the 2007 budget submission this fall.

As he settles into his ninth-floor offices overlooking the Potomac River in downtown Washington, D.C., Griffin must decide how to balance the fiercely competing needs of the traditional space-flight program, the president’s new vision, and science involving more than the moon or Mars. The agency’s present course, Schwadron predicts, could eventually force a third or more of the people in solar and space physics out of the field. Astrophysicists, biologists, astronomers, and earth scientists express similar concerns. And younger researchers eager for a stable future are getting skittish.

Scott MacIntosh, a solar physics postdoc at the Southwest Research Institute, can’t ignore rumors that the guest investigator program that funds his work may disappear. “I have a background in medical imaging, so I might try to do more cross-disciplinary work,” he says. And MacIntosh is in no position to gamble about his future: “I’ve got a young kid and another on the way.” NASA’s ability to cultivate a new and diverse generation of space scientists like MacIntosh and Yamauchi may hinge on whether Griffin has the right stuff to execute a difficult balancing act.

—ANDREW LAWLER

Ecosystem Management

California Tries to Connect Its Scattered Marine Reserves

Researchers hope that new funds, better management plans, and the latest science will help them establish the largest network of marine protected areas in the U.S.

The 1800-kilometer California coastline supports a spectacular diversity of marine life. So does a sea floor that plunges just offshore to nearly 2600 meters, with sea-grass beds and kelp forests giving way to submarine canyons and deep rock reefs. Add in seasonal winds and complex ocean currents that churn up nutrients for thousands of species from sharks and tuna to squid and rockfish, and the result is an incredibly rich ecosystem—and one of the most productive fisheries in the nation. Can the two coexist? Those working on a new state effort to create a network of marine protected areas (MPAs) hope that the answer is yes. But it won’t be easy.

Once upon a time, the bounty of the sea accommodated both fishers and conservationists. But over the past 2 decades, fish catches have fallen by more than half. An MPA network would set aside part of the ocean to prevent the total degradation of this habitat, foster marine diversity—and perhaps maintain a sustainable fishing industry. The vision is grand. Not only would the network be the largest such system in the nation, but its success “would be a wonderful model” for a national system, says Jane Lubchenco, a marine ecologist at Oregon State University in Corvallis. And last week the group reached its first major agreement: choosing the location of a pilot project.

Location, location California set up its first MPA in 1957, a 35-hectare area near La Jolla in San Diego county. Since then, 104 areas have been added in a piecemeal and uncoordinated fashion. Despite this effort, MPAs cover less than 0.3% of state waters—not enough to make a difference in helping fisheries recover, scientists say. And none of the reserves protects species or habitats in deeper water.

In 1999, California tried to address the problem with the Marine Life Protection Act...