THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL **September 1994, Vol. 4, No. 3**

From the Chair

References to Darwin have been appearing in discussions about space with remarkable frequency, but not in the context of some Spacelab life science experiment. Instead, there is a sober recognition within NASA and throughout the aerospace community that the space program must adjust to a radically new environment—or risk extinction. The great comet crash on Jupiter was a very public triumph for space science, with Hubble images on every front page. But listen to comments by NASA Administrator Daniel Goldin or Norman Augustine, chairman of the newly realigned Martin Marietta, and the comet is more likely to evoke images of the mass extinction of the dinosaurs. In Goldin's words, "the civil space program is hanging by a thread."

NASA's budget tells the story. Down for the first time this year since the end of Apollo, it is projected to be flat through the rest of the decade, with real buying power eroding by inflation. The challenge for NASA, and for the broader space community, is how to use this still considerable fraction of U.S. R&D expenditures in the wisest and most effective way.

It is clear that the Space Studies Board and its committees can and must play an important role in the process of adjusting to the new fiscal realities. Several recent Board reports, and all those moving toward completion, have been formulated in this spirit. The major study on the organization and priorities of space science in NASA described in this newsletter is particularly relevant. It will be more important than ever for us to pay attention to the full range of U.S. civil space activities, including those in NOAA and DOD, and to work toward more effective international cooperation.

As the new chair of the Board, I am particularly grateful for the excellence I have inherited from the former chair, Lou Lanzerotti. Its membership, staff, reputation, and impact are unsurpassed. This carries a daunting responsibility, which is shared by all those who serve as members and by the broader community they represent. We need to work together to assure that our enterprise emerges from these Darwinian times vital and robust—not a fossil of some bygone golden age.

Claude R. Canizares
Chair

Board and Committee News

Space science had a quiet summer after initial amazement during July at Senator Barbara Mikulski's success in maintaining NASA's appropriation in the Senate VA-HUD-IA bill. Earlier prognoses had been darkened by an outlay deficiency, compared to the House, of $316 million for FY95. In spite of this, NASA emerged from the Senate Appropriations Committee with $85 million less than its FY94 total, but $201 million higher than the Administration's request, and a whopping $441 million over the House figure. Both the space station and space science were fully funded, with only relatively minor adjustments made between space science accounts. Just before passage of the bill in the Senate, the station survived a new Bumpers amendment, whose 36 votes on August 4 were four fewer than it garnered the year before.

This promise of a satisfactory denouement of the FY95 space science budget cycle had to share the spotlight with the release on August 3 of the long-awaited OSTP report *Science in the National Interest.* Based in part on a high-level symposium held at the end of the preceding February, this report promised to articulate the Clinton Administration's policy perspective on science in much the same way that a much earlier document had spoken to national goals in technology. The new policy's five goals seemed to address the major areas of concern: it commits the nation to leadership in research and excellence in training both specialists and the general citizenry, and promises to improve the connections between research and national goals and between the major participants in the scientific enterprise. The statement was generally favorably received by the scientific community; for example, in a statement on behalf of the American Institute of Physics, Dr. Roland Schmitt said that the document modernizes national policy "constructively, comprehensively, and sensitively." The only missing element was a mechanism for increasing science's share of the GDP from 2.7 to 3.0% as recommended. This reservation clouded an otherwise positive reaction by Representative George Brown and spokespersons from academia and industry the day after its release at a hearing on the new policy by the House Subcommittee on Science.

In a footnote during the closing days of the quarter, the space research community got a glimpse of the dark side of the new information age. In a series of abrupt events, the Far Ultraviolet Spectroscopic Explorer (FUSE) appeared to be cancelled outright and then partly restored. On September 8, email suddenly announced that FUSE had been "cancelled," in a "major violation of the peer review process." Another message announced that "the process stinks," and that "we should scream." By the 13th, a calm and carefully-reasoned letter was being circulated over

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From the Chair

The NASA Advisory Council, on which I sit ex officio, has just issued a reassessment of the 1990 *Report of the Advisory Committee on the Future of the U.S. Space Program*, the "Augustine committee." This review responds to a request from NASA's Senate appropriations subcommittee to reconvene the original panel. Since that was viewed as unworkable, Administrator Goldin gave the job to the NAC.

The two most striking things about this exercise are first, how much has changed, and second, how much has not.

The NAC report enumerates the "enormous structural changes...in the world, in the United States, and in the environment surrounding NASA" since 1990. And these words were written a month before the fateful November election. In concrete terms, the Augustine panel had used a working assumption of 10% real growth in NASA's budget. This projection is already 60% above the current zero-growth figure and will grow to 160% above it by 1999.

Given such stark contrast between expectations and reality, it is truly remarkable that the Augustine Committee report still stands up so well. Quoting the NAC: "Virtually all the recommendations we find valid or partially valid, even in the greatly changed environment." Mr. Norman Augustine, who joined the NAC discussion for several hours last summer, gave his personal view that the panel's report would not have been substantially different if written today, a sentiment he had already articulated in Congressional testimony.

The reason for this resiliency, according to the NAC assessment, is that "the intent of the 1990 report was to force greater strategic thinking within NASA. That purpose is clearly unchanged." Furthermore, the NAC finds that "within [the] changed context NASA has responded very well" to the Augustine recommendations, though it also notes that "some improvements can still be made" and offers several recommendations of its own along these lines. The NAC's key recommendation is that "NASA should continue to be guided by the strategic spirit of the [Augustine] report...."

This is comforting news for the space research community, given the Augustine report's strong endorsement of scientific research as a guiding principle for NASA. On the other hand, it would be foolish to over-interpret the NAC's findings. And while the recent White House policy paper *Science in the National Interest* is strong on basic science, Administration priorities for NASA include foreign policy, competitiveness, and technology development. The science program itself is now stretching to encompass policy-driven initiatives in Earth observation as well as the young disciplines of life and microgravity sciences and applications–all within a flat budget.

So the NAC's endorsement doesn't change today's fundamental challenge for space research: we simply must keep finding new and creative ways to do excellent science with fewer resources. This includes both "working smarter" and making tough choices to maintain both quality and balance. Doing so will also give us credibility in continuing to broadcast the message articulated in the Augustine report, that "science gives vision, imagination and direction to the space program."

Claude R. Canizares
Chair

Board and Committee News

Space research faces a new world in 1995. With the end of 40 years of Democratic control in the House of Representatives and a corresponding turnover of leadership in the Senate, NASA and NOAA will be dealing with new committee chairs and members, and indeed even new committees. Rep. Bob Walker, the new head of the new House Committee on Science that replaces Rep. George Brown's Committee on Science, Space, and Technology, revealed the outlines of the future in a briefing on December 14. In short, Rep. Walker is a strong supporter of the space station and university research. He indicated an intention to continue Rep. Brown's war against earmarking, and an interest in pursuing the creation of a cabinet-level Department of Science. In a divergence from current policy, Rep. Walker questioned whether aspects of the Mission to Planet Earth and related programs might not be more political than scientific, and also expressed the preference for a stronger emphasis on basic science at NSF in the place of the current emphasis on applied science.

The funding picture remains unclear. Various tax cut proposals are in the air, as well as the Republican Contract with America and President Clinton's "middle-class bill of rights." The final outcome of many of these proposals could dramatically affect not only funding levels for individual programs in the discretionary portions of the budget, but even the existence of some performing entities themselves. One example of the latter is the suggested elimination of the U.S. Geological Survey. While Rep. Walker has said that he favors inflationary increases for the space agency, the effects of political turmoil as the Congress reinvents itself over the next few months are at present unfathomable.

• The Space Studies Board met on November 7-9 at the Beckman Center, in Irvine, CA. Chair Claude Canizares welcomed new members Drs. Martin Glicksman (Rensselaer Polytechnic Institute), Marcia Rieke (Univ. of Arizona), Janet

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From the Chair

Presidential Science Advisor Jack Gibbons recently assembled a group of science advisory committee chairs to hear about research programs and budgets from various senior officials. One of the first, the head of a major agency, opened by expressing his pleasure at meeting such an "austere group." This Freudian slip captured all too well the mood in the room.

Research, including space research, actually fared relatively well in the President's budget, considering the extreme pressure on domestic discretionary spending. In NASA, the FY96 request for the three offices that support science is essentially the same as in FY95: $3.8 billion, with another $0.5 billion for launch and communications services. The space science portion includes several long-awaited new programs, and the budget supports the Earth Observing System and a spectrum of life and microgravity programs. Of course, these constant dollars, eroded by inflation, are well below the desires of only a short while ago, so virtually every program has been restructured and down-sized to fit. And, in general, they do fit.

But there are two big question marks. One is the uncertainty about Congressional action; the other is in the budget itself, which shows sizable reductions for FY97 and beyond in the bottom lines for most agencies. For NASA, the budget request for FY00, for example, is $1.1 billion below the FY96 request, nearly a 20% drop in real buying power. These cuts, taken to finance the administration's middle class tax reduction, were inserted too late in the budget development process to allow the agencies to specify how they would be taken—that process is now underway.

Until last year, all the "cuts" in NASA's budget were really cuts in the rate of future growth. Now the ax is hitting real flesh and bone. Although the relevant subcommittee hearings have not suggested it as yet, recent conversations with Congressional staff indicate that Congress could slash still deeper. Administrator Goldin has stated his intention to cut infrastructure rather than hobble the agency by eliminating programs (the space station was explicitly "fenced off" from budget reductions by the White House). Headquarters will surely shrink, and activities at all the NASA centers are being scrutinized for possible consolidation or even elimination. The timescale for making these momentous decisions is a few months.

The Space Studies Board is working hard to fulfill its charter of providing carefully reasoned scientific advice to NASA on a timescale that matches the agency's needs. We responded quickly to Chief Scientist France Cordova's request for input on science at NASA field centers (letter reprinted below), are pushing to finish an assessment of Gravity Probe B, and have issued a short report on synthetic aperture radar by our Committee on Earth Studies. The Committee on Microgravity Research is responding to a list of questions raised by its *Opportunities* report. At the same time, we are continuing our longer term activities, including the major Future of Space Science study. Progress and status of these and other activities are described in this issue of the *Bulletin*.

These times are sorely testing all of us: NASA employees with decades of dedicated service, young postdocs dreaming of new discoveries, senior researchers who have waited much of their careers to perform highly-rated missions, and those in industry who are eager to continue supporting NASA and the research community. The outcome of today's profound changes will reflect as much our character as our wisdom.

Claude R. Canizares
Chair

Board and Committee News

In these pages a year ago, we wrote that "the post-Cold War evolution of the national policy and budget environment first heralded a year ago emerged more clearly." While it would be possible to assert that the budget environment is still headed the same way, certainly the policy climate for space and space research is being revolutionized. The downscaling pressures that NASA and other federal agencies faced a year ago continue to intensify, from the Administration's REGO-2, for example, and from the new Republican Congress. For research in general, potent forces are countermanding earlier pressures toward "strategic" research and reemphasizing basic research. Some formerly favored programs, such as the DoC's Advanced Technology Program, are being perceived as unwarranted intrusions by the government into properly private sector decision-making—"pubescent industrial policy," in the words of one Congressman.

For NASA, the big budget news during the quarter was the additional $5 billion in reductions for the outyears mandated in mid-January by the White House to pay for proposed tax cuts. In a very dramatic budget press conference on February 6, Administrator Daniel Goldin stated: "Make no mistake. When this is over, NASA will be profoundly different. We're going to restructure the Agency." Mr. Goldin made clear that his

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From the Chair

Active coordination and cooperation among the disciplines of space science have probably never been more important. When budgets were on the rise, planning efforts focused on the allocation of new dollars. The stability of base programs and ongoing activities was generally assumed (although with recognized optimism). Each community brought forth its highest priorities for a new start or an enhancement to the research base, relying on the strategies and studies of the Space Studies Board's discipline committees. The single internal NASA advisory committee dealing with space and earth sciences and applications could merge these by means of exercises like the famous Woods Hole "shoot out." They advised the single office in NASA responsible for all these activities, which was itself organized around disciplinary divisions. The result was an ordered queue of new starts of various sizes.

The emphasis in this process was on advocacy: by mission advocates to the disciplinary advisory committees, by committee chairs as discipline advocates at the next level, and by each NASA division director to the associate administrator. In every possible forum, the primary aim was to push the disciplinary agenda and jockey for a higher place in the queue. One consolation for those who missed the top rank was the expectation that the queue would occasionally jerk forward; sooner or later their turn would come.

Times have changed. The present environment is one of declining budgets, erosion of the research base, and tangible threats to ongoing programs. Responsibility within NASA for space science and applications is now divided among three offices advised by three internal committees. Reorganization of the Office of Space Science is likely to erase the disciplinary structures of the past.

Although advocacy, a key element of peer review, remains of great importance, these new conditions enhance the necessity for cooperation and consensus, within NASA and across the community. The agency has already moved toward this paradigm, with results that demonstrate its power. The close cooperation of the chief scientist and all three science associate administrators produced a compelling case for science during the Zero Base Review. The result was a recommendation by senior NASA management and a decision by the Administrator to look elsewhere in cutting $5 billion over five years. The science programs were virtually unscathed. Of course, the Zero Base Review now looks like just another round, albeit a major one, in the ongoing budgetary boxing match. At this writing, the NASA budget has just caromed through the House appropriations committee and the outcome is still highly uncertain.

The Space Studies Board is completing a major study on the management of space science for the future that will address issues like coordination and priority setting. The need for this examination has only increased since it was commissioned by the Senate appropriations subcommittee and Administrator Daniel Goldin nearly two years ago, in the wake of NASA's reorganization of the space science offices. Administrator Goldin has requested that we accelerate its release, and the volunteers and staff have been working feverishly toward publication in early autumn.

When the new report is released, it should provide useful guidance to the agency and to the community itself. By necessity, it deals primarily with principles, goals and approaches, although it will include some quite specific recommendations. The exact balance between advocacy and consensus, of course, is something that can only be determined in practice by those participating in the process. The success of the space science enterprise over the next several years probably depends more on our collective effectiveness in this political arena than it does on brilliant insights or technical breakthroughs.

Claude R. Canizares
Chair

Board and Committee News

The Big Three issues during the second quarter were the Zero Base Review (ZBR), the budget resolution, and Shuttle-Mir. Begun during 1994, the ZBR gathered up and integrated the results of a number of agency management studies that spanned space shuttle operations, the field center system, and NASA's labor force. Key inputs were administration and Office of Management and Budget guidance and Reinventing Government-2 (REGO-2). A major driver in the exercise was identifying the extra $5 billion that the administration had decided in January to cut from the agency's five-year budget runout to finance a tax cut.

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From the Chair

At the end of September, John Armstrong, Daniel Fink, and I presented our new report, *Managing the Space Sciences*, to NASA Administrator Daniel Goldin and a small group of senior agency officials. This is the product of the "Future of Space Science" (FOSS) study originally requested by the Senate appropriations subcommittee late in 1993. The vast changes taking place throughout the public and private sectors in the intervening months might give one legitimate fears that the report would arrive long after the rationale for it had evaporated. In this case, the opposite is true; the report is probably more timely and relevant than if it had been ready the day it was requested.

Managing the Space Sciences addresses the conduct rather than the content of space research. In this regard it differs sharply from most of the Board's studies, which center primarily in a scientific arena that is more comfortable for academics and scholars. The main topics here are the organization of science in NASA and approaches to setting priorities and fostering technology development. The issues are imponderable, demanding judgment calls and political wisdom. The four FOSS panels accepted this challenge, and worked hard for consensus on clear, concise recommendations.

The three dozen volunteers who served on the FOSS panels, many of them also Board members, brought a wealth of experience with research management in industry, universities, and government. Since August 1994, there was a FOSS meeting or telecon every other week, on average, often involving interested parties both inside and outside of NASA. Overall project leadership came from John Armstrong, working with task group leaders Daniel Fink, Roland Schmitt, Anthony England, and John Hedgepeth, supported by the Board staff. After a special request from Mr. Goldin in early June, the team pressed the throttle still harder to produce the report in September, three months earlier than originally planned. The Board's executive committee, the NRC machinery for report review and approval, and the staff all responded to the challenge.

Managing the Space Sciences is written primarily for NASA and for those on Capital Hill who care about and fund space science. Mr. Goldin, his deputy, General Jack Dailey, Chief Scientist France Cordova, Deputy Comptroller Mal Peterson and representatives from the three science offices all showed genuine interest in our briefing and promised careful consideration of the numerous recommendations. I hope that many practitioners of the space sciences also take the trouble to read it. There are sections, especially those dealing with setting priorities across disciplinary boundaries, that speak as much to the community as they do to the agency. Success in implementing the suggestions will require the acceptance and cooperation of all the participants in space research. In the end, it is individuals and not abstract organizations that make things happen.

Claude R. Canizares
Chair

Board and Committee News

The third quarter of 1995 started out with a bang on July 10 when NASA's House appropriations subcommittee recommended a radical restructuring of NASA and its priorities. Only 5% below the president's FY96 request overall, their package provided for cancellation of Cassini and Gravity Probe B and closure of Goddard Space Flight Center, Marshall Space Flight Center, and Langley Research Center. At the same time, the shuttle, space station, Advanced X-ray Astrophysics Facility, and Earth Observing System (EOS) were untouched. But barely a week later, the full committee reversed the most radical provisions of the initial package, restoring all of the above cuts, but reduced EOS by $333 million. The accompanying committee report expressed satisfaction with the ability of the plan resulting from NASA's Zero Base Review to reach the long-range reductions foreseen at the end of 1994, but directed the agency to complete by March 31, 1996, a further study that would accommodate a new and larger retrenchment. The committee report suggested that NASA might have to consider closing centers or eliminating major programs after all, contrary to guidelines NASA had set for itself for the initial Zero Base Review. The bill passed the House on July 31 and attention shifted to the Senate.

The corresponding bill reported out of the Senate committee on September 13 was more favorable in many areas to space science. For example, some reduced funding was included for the House-zeroed Space Infrared Telescope Facility, greatly improving the prospects for a new start in the conferenced legislation, and the House cut in EOS was reduced from 22% of the president's request to essentially nil. As the September 30

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From the Chair

The first signals that reached the Jet Propulsion Laboratory from Jupiter indicating the apparent success of the Galileo probe's penetration into the giant planet's turbulent atmosphere set off whoops of jubilation and relief. The scene, replayed on CNN throughout the day, featured Administrator Daniel Goldin ebulliently trading high-fives with Associate Administrator for Space Science Wesley Huntress. Against the background of past problems, including the failed deployment of Galileo's main antenna, the victory was particularly sweet.

The successful event also focused attention, including a lead story in the science section of the *New York Times*, on the fact that large, multifaceted missions like Galileo are becoming rare, if not extinct. The emphasis in both space and Earth science has moved decidedly toward smaller, faster, cheaper spacecraft and payloads. The hope, of course, is that these will also be more frequent. Much of the impetus is related to budget and risk. It is easier to accommodate several small missions in a level budget than the sharply peaked spending profile of a single large mission. And numerous small missions diffuse the risk of random failures. There is also a presumption that multiple small missions will keep research disciplines more vigorous and return as much or more science per dollar as the large ones. This latter is still undemonstrated, however.

The Space Studies Board is initiating three studies that address important components of NASA's program in the post-big mission era. Each will be conducted by the Board but with significant input and participation of our six standing discipline committees.

One study deals with elements of risk, reliability, performance, and cost. It is being carried out by the Joint Committee on Technology in association with our partner, the Aeronautics and Space Engineering Board. A key question is what can we do at the overall level of program management, systems design, and mission architecture to reduce the costs of missions of all sizes while maintaining appropriate levels of reliability and performance.

The second project deals with international cooperation across the space sciences and applications. Focusing initially on U.S.-Europe collaboration, the Board's Committee on International Programs is teamed with our colleagues on the European Space Science Committee of the European Science Foundation to examine some specific case histories from the past and draw conclusions about the enablers and disablers of international cooperation.

The third study will address the perennially troubled components of the NASA science program dealing with direct funding of scientific research, the so-called Research and Analysis and Data Analysis portions of the budget. These items are often poorly understood within parts of NASA, much less on Capitol Hill. Even the strongest proponents of R&A need to rethink its role in the new environment of more frequent and smaller missions.

The Galileo orbiter is trickling data back to scientists living on a very different Earth than when this mission was first designed and launched. While the thermodynamic climate may have warmed only imperceptibly, the fiscal climate is categorically colder. As we near the end of the first quarter of fiscal year 1996 with lots of bickering but no federal budget, it is easy to predict that funding for space and Earth sciences and applications will not be rising for some time to come. We are going to live with less. Our challenge is to work smarter so that we can still maintain research programs of the very highest quality. We hope that these three studies will help achieve that goal.

Claude R. Canizares
Chair

Board and Committee News

Tuesday, December 19, symbolized in a single non-event much of the elation and frustration of the last quarter of 1995. There was to be a NASA press conference on early results of the Galileo entry probe, which had hurtled dramatically into the Jovian atmosphere two weeks before—if the government was open. But NASA wasn't, shuttered again for the second time in as many months, victim of the continuing conflict over appropriations between the Congress and the White House. While enough bills had been signed to exempt 600,000 federal workers from the latest lockout, the VA-HUD-IA appropriations bill was one of several that the President vetoed that week, closing the space agency. In fact, the vetoed VA-HUD-IA bill was itself the result of an unusual process whereby the House-

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NATIONAL RESEARCH COUNCIL **March 1996, Vol. 6, No. 1**

From the Chair

The NASA budget for FY97, just released by the administration, has good news and bad news for space science and applications.

The good news is that the programs of the three science offices appear to be well supported for the next fiscal year. Barring significant reductions in the Congressional appropriations process, this budget will keep a healthy level of activity in the space sciences, life and microgravity research, and Mission to Planet Earth into next year. Although there are no major new starts in the budget, there is a great deal of activity in every discipline. There are more launches than ever in space science, and many exciting results from Hubble and other missions are filling the journals and the front pages of major newspapers. The Shuttle-Mir program is in full swing and will be extended through 1998. The Earth Observing System is on track, now with only two years to go before the launch of the AM-1 satellite.

Just a few years ago, it would have been inconceivable to accomplish all this in FY97 with a NASA total of $13.8 billion (basically unchanged from FY96), while also continuing space station development, space shuttle operations, aeronautics and technology development. In his remarks at NASA's March 19 budget briefing, Administrator Goldin justifiably praised the agency for having "stepped up" to the challenge of making "sweeping changes at NASA" that allow it to accomplish "more for less."

The bad news comes when one looks at the NASA totals that are projected for the out-years, which decline in roughly three equal steps to reach $11.6 billion in FY00. This is far below current levels, even before one attempts to account for inflation. The FY00 figure is $1.6 billion below the projection in last year's request, which was itself below present levels and seemed extraordinarily constrained. Compared to last year's budget, an additional $3.2 billion would have to be removed over three years.

Four staffers from Office of Management and Budget and the Congress attended our Board meeting in late February, and each of them described the intense pressures working at both ends of Pennsylvania Avenue and on both sides of the aisle. Though specifics differ, everybody has a deficit reduction target that requires carving some hundreds of billions of dollars from domestic discretionary spending over the next five years. Part of the staffers' message was that this storm will not soon pass, although they also advised against sudden panic.

The open question is whether or not NASA will be forced to absorb these draconian numbers after having already reduced its previously planned expenditures by many tens of billions through the Zero Base Review, rescoping of missions, more efficient practices and some outright cuts. It is inconceivable that NASA could survive what would be a 25% drop in purchasing power over four years with anything like the current spectrum of programs. Even a more modest reduction is likely to have a profound impact on the space sciences, given the relative inelasticity of large portions of NASA's program, such as space station and shuttle operations.

Administrator Goldin has clearly stated an intention to remain optimistic and work with the administration on out-year funding. He deserves the strong backing of the space research community in these efforts. This is partly self-serving, but it is also consistent with the broad consensus that ultimately science and exploration are the long-lasting, high-value, and high-visibility products of the space program.

Claude R. Canizares
Chair

Board and Committee News

With snow days and furloughs receding, activity in Washington, DC, and in the space program gathered momentum. Space science experienced a brilliant moment in mid-February with the launch of three science missions in an eight day period: the Near-Earth Asteroid Rendezvous (NEAR) on the 17th was followed in midweek by the Tethered Satellite System (TSS)/USMP-3 shuttle mission, and the week was capped by the successful west coast launch of Polar, the last U.S. component of the International Solar-Terrestrial Physics program. On its way to asteroid Eros, the first Discovery mission NEAR sent back images of its first cruise phase target of opportunity, the Moon. Even the TSS, whose snapped cable was widely reported as a second failure for the unlucky Italian-U.S. collaboration, met an important mission objective in measuring a voltage of 3500 volts and a current of almost half an ampere before the break.

Two significant documents were released by NASA during February. The first, the new *NASA Strategic Plan*, clearly lays

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From the Chair

A terse announcement from the NASA Administrator near the time of the summer solstice abruptly halted the formation of all but one of the agency's planned science institutes. The science institute concept was born during the so-called Zero Base Review of 1994/1995, and planning began in earnest about a year ago. Administrator Goldin's clearly stated intention was to strengthen and improve the quality by "privatizing" major portions of the science activities at several NASA centers. As it happened, an orderly transfer of civil servants and their pensions to the private sector requires legislation which the Office of Management and Budget refused to seek. The one exception is the National Space Biomedical Research Institute to encompass activities now carried out at Johnson Space Flight Center because these are already conducted primarily by contractors. This one is going forward.

Many of us have expressed concern that the institute concept looked like one chapter of a larger NASA science plan which, however, has yet to be written. This would be NASA's implementation plan for achieving the goals and recommendations of the Space Studies Board's report *Managing the Space Sciences*, NASA's own *Strategic Plan*, and several other Space Studies Board, NASA Advisory Council and NASA Science Council findings. Unlike the current NASA enterprise strategic plans, which focus more on content of the science program, the missing plan would assess how the program gets carried out, where, and by whom.

The recent pressure to downsize NASA Headquarters exacerbates the urgency of these larger questions. For example, scientists at NASA centers have always been forced to lead split lives, acting sometimes as government officials and other times as members of their respective communities, sometimes wearing the striped shirts of referees and moments later appearing in the numbered jerseys of players. The proper balance of these contrasting roles is of major interest to the community and, of course, to the NASA scientists themselves, and is key to maintaining a strong and impartial peer review system. Another urgent issue is long-range technology development, whose future has recently been clouded by the apparent eradication of the Office of Space Access and Technology.

A complicating factor is the departure over a period of a few months of three of NASA's four senior science managers. The Associate Administrators for Life and Microgravity Sciences and Applications, Dr. Harry Holloway, and for Mission to Planet Earth, Dr. Charles Kennel, as well as the Chief Scientist, Dr. France Cordova, have reached the ends of their promised assignments and are returning to academia. Each deserves the real gratitude of the community for outstanding service during difficult and often turbulent times, as does Associate Administrator for Space Science, Dr. Wesley Huntress, who we are thankful is staying on.

So the sudden demise of the science institutes could be seen as an opportunity to redirect some of the momentum behind this effort and make use of what was learned to devise a cost-effective and sensible science management plan for the new NASA. Despite the change in science leadership and the very steep learning curve which the new science management team must climb, these issues deserve prompt and thoughtful attention. The Space Studies Board stands ready to help.

Claude R. Canizares
Chair

Board and Committee News

As the dog days of another Washington summer rolled in, space scientists could rejoice in some successes, mourn some failures, and continue to puzzle over the future. To start with, the budget picture, at least in the short term, was adequate overall. The long-awaited budget for FY96 was finalized nearly seven months late when President Clinton signed the FY96 Omnibus Appropriations bill on April 25. At $13,903 million, the FY96 appropriation for NASA represented a modest decline from FY95's $14,064 million (exclusive of the special $400 million National Aeronautics Facilities line). The final version of the FY96 package actually added $83 million to the earlier conference bill for NASA Science, Aeronautics, and Technology.

As the second quarter of 1996 ended, progress was being made on the FY97 spending plan. On June 26, the House passed the VA-HUD-IA appropriations bill, signaling a further decline in overall NASA spending to $13,604 million. Science

Recently Released

•*Space Studies Board Annual Report—1995*

http://www.nas.edu/ssb/ssb.html

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From the Chair

The concept of biodiversity took on vast new meaning this summer with the announcement of possible evidence for relic biogenic activity in a meteorite of Martian origin. The results were made public in a press conference presided over by the NASA Administrator and attended by the Director of the National Science Foundation, whose agency co-sponsored the research. The multidisciplinary team of investigators, led by Dr. David McKay of NASA Johnson Space Flight Center, presented a tutorial review of physical and chemical evidence which, when taken all together, supports their conclusion that primitive life existed on Mars some 3.6 billion years ago. All the presenters urged caution about this interpretation, and one outside expert stressed that the extraordinary claim of prior life on Mars should not be accepted until the non-biogenic alternatives have been fully exhausted.

The impact of these findings was tremendous. The President and other major political leaders made statements, front page stories appeared in virtually every newspaper, and cartoonists and talk show hosts irreverently worked the topic into their material. NASA immediately began a reassessment of its plans, and the White House announced a space summit at which administration and congressional leaders will discuss future directions for the nation's space program. A pre-summit symposium will bring together a group of scientific experts to brief the Vice President on major questions in space science and to assess NASA's overall program in these areas. The Space Studies Board is an active participant in the planning and execution of this event.

The Board and its committees have long considered the search for life's origins a major scientific goal. By happy coincidence, a report titled *Review of NASA's Planned Mars Program* was published within days of the press conference, with recommendations that are very relevant for current planners. Similar strategies have been or soon will be completed in other areas of space science, and will form the basis of discussion for the upcoming symposium. This provides a heritage of deliberations about scientifically sensible approaches to future study, including the necessary precursors to sample return from Mars.

Outside of tabloids and late-night TV, the discussion following NASA's announcement has been decidedly measured and balanced. Some of this may be driven by scientific prudence, but it is surely also a recognition of present budget realities. Unbridled euphoria leading to grandiose new projects is neither warranted by the evidence nor likely to be very well received by congressional appropriators. The *New York Times* even editorialized suspicions that the whole thing might be a carefully timed attempt to enlarge the NASA budget—a charge the agency flatly denies. The symposium and summit give NASA and the community an opportunity to map out the high road.

The meteoritic evidence is actually only one part of an accelerating interest in cosmic biodiversity. Recent successes in establishing the existence of extra-solar planetary systems, after many years of tantalizing but inconclusive hints, are likely to be multiplied many fold. NASA's new origins program has laid out a roadmap for the detection of Earth-like planets. Back in the solar system, the Galileo spacecraft has returned some remarkable images of Jupiter's moon, Europa, which bolster earlier indications of possible ice-flows. These pictures, which arrived shortly after the Mars announcement, were less heralded but are similarly provocative as indicators of possible biogenic conditions elsewhere in the solar system. In this case, new evidence is forthcoming when the probe makes a much closer encounter with Europa this fall.

Whatever the outcome of more detailed study of the putative microfossils in this particular meteorite or from other investigations, the public reaction reminds us of what is probably the most profound potential impact of basic research. For the past several years, scientists have walked the halls of government reminding policy makers that basic research is the prerequisite for applied research and development leading to new technology and new products. The events of August show that basic research also has the power to completely alter the human psyche. Although many scientists have been convinced for years that statistical considerations alone demand the existence of pre-biotic conditions and biogenesis someplace else in the vast universe, the difference between evidence and hypothesis means everything to scientist and layman alike.

Recently Released

•Letter Report on Internet Access to Astronaut Data
•Review of NASA's Planned Mars Program
•Letter Report on Scientific Assessment of NASA's Solar System Exploration Roadmap

http://www.nas.edu/ssb/ssb.html

Imagine the reaction if McKay and other experts had indeed found the conclusive proof which removed existing doubts about prior life on Mars.

The Martian microfossils, if confirmed, carry two messages of great importance to human civilization. One, that life on Earth is not unique but ubiquitous, must affect our world view as monumentally as did the findings of Copernicus or Darwin. This, of course, is what filled most column-inches in the press. The other message, however, is the observation that life, shortly after it emerged on Mars, is likely to have perished or at least been driven deep underground during some unspecified global change on the planet over three billion years ago. At a time when our own species is just beginning to contemplate the possibility of its collective mortality, evidence of the mass extinction of all species on our next-door neighbor planet would change forever the way we think and the way we live.

Claude R. Canizares
Chair

Board and Committee News

As all space researchers know, the third quarter of the year is high noon for the budget process in Washington. There couldn't be a more striking contrast than between the FY97 process this year and the situation one year ago. Last year, contentious was the mood; this year it's been nearly collegial. At least for the VA-HUD-IA bill, where NASA's appropriation is to be found, the path through the Congress to the White House was orderly and uncontroversial. President Clinton signed it into law on September 26, well before the fiscal year deadline.

Taken on the whole, NASA did well compared to the Administration's request of $13.8 billion, experiencing a reduction of only $100 million to $13.7 billion. But while a predictable outcome can be seen as a favorable one in the budget game, the result did contain some surprises.

As the bill made its way from House to Senate to conference, several adjustments were made in the Science, Aeronautics, and Technology (SA&T) account, where space research funds are book-kept. First, the House took $300 million out of the Administration's $1.4 billion request for Mission to Planet Earth (MTPE). The Senate version gave it back, but provided that the SA&T account be reduced by $100 million overall, at NASA discretion. This unspecified cut was reduced in conference to $95 million, but a series of "unfunded mandates" were inserted in the form of earmarks for a total of $69 million. In the end, MTPE suffered a specified cut of only $5 million for the GLOBE education project. Program managers within the SA&T account now need to identify $164 million in reductions in ongoing and planned programs. This might not seem like a lot out of a total SA&T budget of nearly $5.8 billion, but most programs have already been squeezed hard and avoiding real damage as these cuts are made will offer a real challenge to NASA executives.

The classical space sciences progressed in many areas, including the playback of fascinating new Galileo images of Europa (which indicate past or even present existence of liquid water), possible evidence in an Antarctic meteorite of ancient life on Mars, and the launch of the Fast Auroral Snapshot Explorer (FAST). At the same time, the space laboratory sciences were confronted by new planning and budgeting challenges. Difficulties experienced by the space station as it struggles to stay within the flat multi-year budget cap, imposed after its last reconfiguration several years ago, have forced a rethinking of existing science utilization plans. Because of the development problems, additional funds are needed, and these funds have been found in the research and utilization dollars contained within the $2.1 billion fixed yearly space station budget. Appropriation report language specifically provides for "general transfer authority of up to $177 million" across the firewall that was to have shielded these resources from being diverted to development costs. While space station development managers argued that without adequate resources to build the station there would be nothing to utilize, the proposed transfer of these funds leaves the laboratory science programs with multi-year gaps in flight opportunities and potentially very late delivery of crucial outfitting like the centrifuge and related equipment.

Another major development at the end of the quarter was release of the Administration's long-awaited National Space Policy. Divided into major "guideline" sections for Civil, National Security, Commercial, and Intersector issues, the space researcher's attention is naturally drawn to the first. Here the policy provides for focusing R&D on "space science to enhance knowledge of the solar system, the universe, and fundamental natural and physical sciences; Earth observation to better understand global change and the effect of natural and human influences on the environment; human space flight to conduct scientific, commercial, and exploration activities; and space technologies and applications . . . ." The Civil section goes on to elaborate, endorsing the International Space Station, project demonstrations for next generation launchers, space and Earth science, and technology. The subsection on space and Earth science is strongly weighted toward solar system studies: of four goals specifically cited, three deal with planets and other bodies in our own and other solar systems and the last supports the Earth Observing System. Neither space life sciences, materials and fluids research in microgravity, nor astronomy or cosmology are specifically mentioned. Further on, in the Intersector section, guidelines are provided for international cooperation, and outer solar system researchers will be heartened to note the provision that the Department of Energy "maintain the necessary capability to support space missions which may require the use of space nuclear power systems."

The Space Studies Board did not meet during the third quarter; its Executive Committee and most of its discipline committees and task groups did, however. Brief accounts of these meetings follow.

- The Executive Committee of the Space Studies Board and some additional Board members met at the J. Erik Jonsson

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL **December 1996, Vol. 6, No. 4**

From the Chair

For probably the first time in its long history, the Indian Treaty room in the White House complex was filled with talk of space science for nearly three hours last month. The occasion was a symposium presided over by Vice President Al Gore and attended by eighteen scientists, two religious leaders, and public TV's Bill Moyers. NASA Administrator Daniel Goldin and several other senior officials also took part. The discussion centered around a white paper and briefing book, *The Search for Origins* (*http://www.hq.nasa.gov/office/codez/updates.html*), prepared for this occasion during a workshop in October attended by a still larger group under the joint auspices of the Space Studies Board and NASA's Space Science Advisory Committee. Dr. Anneila Sargent, chair of NASA's Space Science and Applications Committee, and I were co-leaders of the activity.

The principal charge to the October workshop from Presidential Science Advisor John Gibbons was to assess major questions in space science today. Over the course of three days, the diverse workshop group of astronomers, planetary scientists, and biologists, many of whom had never met before, came to the realization that their several scientific disciplines were converging on a core theme of "Origins." Last summer's announcement of possible evidence for past life on Mars, which catalyzed the symposium, is only one of many recent results that trace key events leading from the Big Bang to the emergence of life.

One important note is that our definition of Origins includes, but goes well beyond the one heretofore used at NASA, where the term referred to one of four "science themes" in the Office of Space Science (OSS). In our usage, Origins connects exobiology and the search for planets to the origin of structure in the universe, the origin of galaxies and stars, the origin of the chemical elements, solar and stellar influences on planetary habitats, and so forth. The key finding of the workshop was that so many different fields spanning all four OSS "themes" (and possibly more) are converging toward this core question. At the same time, there was ample recognition that the Origins concept does not encompass every important problem of current space science—which is why strategic planning and peer review must continue to set programmatic priorities.

There were also other areas of broad agreement that I communicated to the Vice President in my opening remarks:

- First, that answers to many of the questions are within our grasp, and we can expect the next steps to yield major progress over the coming years;
- Second, that it is not one, single, big step that is needed, but a portfolio of more moderate steps that will advance us sequentially, simultaneously and synergistically across the wide scientific frontier of this quest. The recent launch of Mars Global Surveyor and the upcoming Hubble servicing mission are two good examples;
- Third, that the current space science program is basically already going in the right direction to give us the answers we seek. We need to keep the momentum, keep pressing forward, and, of course, maintain coordination with other agencies and with international partners; and
- Fourth, but by no means last, is the realization that this quest can capture the public imagination like no other. The wide impact of even the tentative reports about the Mars rock last August, we believe, demonstrates the power of this question to engage the public.

Through most of the symposium, Mr. Gore seeded the conversation with a series of well-informed questions, ranging from sharply focused queries about the relevance of complexity theory or about early life-forms based on RNA to the broader philosophical and religious implications of possible life on Mars. In a statement issued to the press at the conclusion of the symposium, he characterized the discussion as "exhilarating and thought-provoking." I think that all the participants would agree—not only because of the event itself, but also because in the process many of us had achieved a new understanding of the connections between our various disciplines, the compelling power of this unifying theme, and the potential for substantial future progress.

Claude R. Canizares
Chair

- Letter Report on National Space Biomedical Research Institute (October 10)
- Letter Report on NASA Mars Sample Return Mission Options (December 3)
- *The Search for Origins: Findings of a Space Science Workshop* (executive summary)
- *Assessment of Recent Changes in the Explorer Program* (executive summary)
- *Radiation Hazards to Crews of Interplanetary Missions: Biological Issues and Research Strategies* (executive summary)

http://www.nas.edu/ssb/ssb.html

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL

March 1997, Vol. 7, No. 1

From the Chair

The President's budget request for FY98 provokes what Gilbert and Sullivan might have called "modified rapture." Reversing a four year trend of ever decreasing outyear projections, the current NASA budget would decline only slightly from $13.7B in FY97 to $13.2B in FY00 and then stay fixed. While not expansive, this is far better than last year's projected decline to $11.6B by FY00.

The biggest sigh of relief came from the space scientists. Because expenditures for things like space station, shuttle operations and the Earth Observing System (EOS) are roughly fixed for the next several years, the sharp reductions forecast in last year's budget totals spelled serious trouble for space science. This danger prompted Senator Barbara Mikulski to call for a space summit between the Administration and Congress. In contrast, the new budget has space science increasing a tiny bit over the next five years. This means that funds currently going to finish the development of the major missions, Cassini and the Advanced X-ray Astrophysics Facility, will become available for new missions starting in FY98.

The space science budget specifically highlights enhancements to the broadly defined Origins program, which deals with the origin of the universe, planets, and life. Origins was identified as a core theme at the Vice President's space science symposium last December, which the Board helped organize. Included among other important elements is a start for the Space Infrared Telescope Facility, development of interferometry on the ground and in space, a regular program of exploration of Mars leading to sample return in 2005, an enhanced exobiology program, and a variety of technology development efforts to enable future missions.

The budget of Mission to Planet Earth (MTPE) also grows slightly in the current request, allowing EOS to proceed on schedule, Landsat development to continue, and a series of PI-class Earth System Science Pathfinders to be initiated. The first two of these missions have just recently been selected.

The situation for the Office of Life and Microgravity Sciences and Applications (OLMSA) is much more problematic. The OLMSA budget line itself will continue falling for another year, from $300 million in FY96 to $214 million next year, reflecting the ramp-down of shuttle-based flight programs. It then climbs to around $250 million through FY02. But this is not the whole story, because a substantial piece of OLMSA funding is contained in the International Space Station (ISS) program budget. Last summer, NASA announced the need to divert much of these utilization funds to solve problems in ISS development, promising to return them in later years. This widening gap between the waning shuttle program and the eventual utilization of station is causing great concern in the community.

Furthermore, one cannot forget that a level budget means something close to a 20% decline in buying power over the next five years, causing great pressure even in space science and MTPE. The hope and expectation are that the efficiencies and new technologies of the faster-smaller-cheaper approach to space research will more than compensate for this decline. In other words, space research productivity must grow at least as fast as inflation. Achieving this is still a major challenge for NASA as well as for industry and the university community. EOS and its data system are again being scrutinized, for example. It is essential to recognize that some budget items will be resistant to productivity improvement, particularly those that are largely constrained by brain power, like research and analysis (R&A) and data analysis. Flat-lining every subcategory will not be prudent management.

On balance, the current budget request is a clear message from the Administration that NASA is not in free fall and that its research programs are part of what the President called an investment in "the age of science and technology." If Congress supports the request, not just this year but over the next several years, we might be entering a new phase of stability in which more energy can be put into scientific excellence and productivity and less into budgetary skirmishes and replanning exercises.

Claude R. Canizares
Chair

Board and Committee News

As usual, the space science news of the first quarter in Washington is dominated by the budget story. As Board Chair Claude Canizares noted above, this year the news was good, as the precipitous decline in NASA's outyear forecast disappeared in favor of a nearly flat profile for the agency as a whole. While the glass may not have been 100% full—as some observers noted that the gentle downward slope did not account for inflationary

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL **June 1997, Vol. 7, No. 2**

From the Chair

At this writing, the rover Sojourner is creeping across the surface of Mars to examine a bear-shaped rock nicknamed Yogi. The Pathfinder mission was meant to chart a new course in faster and cheaper planetary exploration, which it seems to have done admirably. This return to Mars closes a hiatus of two decades. What remains to be seen is whether it may also renew interest in ending the still longer hiatus in human exploration beyond low Earth orbit.

The good news for advocates of human exploration is that public interest in Pathfinder, now aptly named Sagan Station, is high. The bad news is that tolerance for large government expenditures is still very low. Past attempts like the Space Exploration Initiative and the Human Exploration Initiative, burned on the political launch pad, never leaving the ground.

The challenge for advocates of human exploration is to extend the Pathfinder concept to human space flight. Of course, it is far easier to be innovative and take risks when the cargo is a robot. The near-disaster faced by astronaut Mike Foal and his Russian crewmates on the crippled Mir is a reminder of the dangers of space travel and of our society's low tolerance for risking the lives of astronauts.

Historically, transitions from one major space program to another have been difficult. The transitions from Apollo to Shuttle and from Shuttle to Station were both wrenching, with significant negative impact on the agency and on activities like space science. The impossibility of starting a major human exploration program on the heels of the space station may be a blessing, even for those eager to get on with it. What would make sense is a modest program of innovative scientific and engineering research that would enable human exploration at significantly reduced cost. Rather than defining a timetable for returning to the Moon or setting sights on a crewed mission to Mars, this should be the long-term goal of a moderate level-of-effort program, the "go-as-you-pay" philosophy that the Augustine Committee wisely recommended at the beginning of the decade.

Congress has been cool to talk of human exploration and suspicious of even small studies of future possibilities, perceiving them as the noses of a herd of giant camels lurking just outside the tent. If the success continues with Pathfinder and next with Mars Surveyor, which is due to begin mapping the red planet this fall, and if Mir maintenance and space station development are kept in hand, this might be the time to begin modest, rational planning for future human exploration.

Claude R. Canizares
Chair

Board and Committee News

"Steady as she goes" seemed to be the watchword in the space program during the second quarter of 1997. The FY98 budget request, characterized on February 6 by Administrator Daniel Goldin as "stable funding for the next five years," made positive progress in the Congressional approval cycle. Even though NASA's total request was 1.5% below the FY97 appropriation, a dip in the space laboratory sciences proposed was compensated by small increases in space science and Mission to Planet Earth (MTPE), so that the science total was essentially flat.

On May 13-16, the Office of Space Sciences (OSS) held its scheduled strategic planning retreat in Breckenridge, CO; Board Chair Claude Canizares and several committee chairs attended for the first day in order to report NRC science priorities to the gathering of NASA officials and members of OSS's advisory committees. After the departure of Board representatives, retreat participants worked to develop an updated OSS strategic plan for the next five years. The Board has been formally asked to assess a draft of the plan, and will take it up at its next meeting on July 16 at the Johnson Space Center in Houston, Texas.

As part of the first Mission to Planet Earth biennial review, the review's external panel was briefed in early June on NASA's plans to rephase the capabilities of the Earth Observing System Data and Information System (EOSDIS) and to retain the baseline spacecraft plan for the CHEM-1 mission. Contractor progress on the EOSDIS and the possibility of breaking the CHEM-1 instrumentation complement among smaller spacecraft had surfaced as issues due to critical recommendations developed earlier in the year by the MTPE office's internal advisory committee.

As the generally tranquil quarter drew to a close, there were dramatic events aloft. A lengthening list of problems for the Mir space station was headlined when a departing Progress resupply

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From the Chair

The third quarter began with a thump as the diminutive Mars Pathfinder bounced to rest on a rubble strewn plain, mid-latitude on Mars. After a brief delay while mission controllers gingerly unloaded the shoebox-sized rover from the open petals of the descent module, the world was fascinated by a stream of images as the rover, named Sojourner, crept around the surface imaging and sampling rocks with its alpha-proton-x-ray spectrometer. Perhaps even more remarkable than the technical and scientific feats of the mission was the inauguration of a new era of truly public exploration of space. Web users around the world accessed promptly posted images and reports on numerous mirror web sites; according to NASA, a record hit total was set on July 8, when 47 million hits in a single day doubled a previous daily record from the 1996 Atlanta Olympic Games. At the end of September, having depleted its batteries and exceeded its original 7-day primary mission design by nearly three months, Sojourner set out on an extended walk-about on solar power alone to continue imaging the landscape. Meanwhile, overhead, Mars Global Surveyor made Mars orbit on September 11 and began making ground-breaking magnetometer measurements as it aerobraked its way into a circular orbit.

The new strategy for "smaller-faster-cheaper" flight missions based on innovative technology has always acknowledged a dark side—acceptance of increased risk of failure. The unhappy reality of this tradeoff was experienced when Pathfinder's brilliant success was offset by the disappointing failure of the Lewis Earth observation technology satellite. The payload consisted of two high performance imaging spectrometers intended to advance both scientific and commercial applications of Earth remote sensing. Conceived as a testbed for new procurement approaches and a host of new technology subsystems, Lewis was successfully launched on August 22 by the Lockheed Martin LMLV-1 launch vehicle and entered a nominal circular orbit. During checkout four days later, however, the spacecraft went into a slow spin that allowed its batteries to discharge. Despite repeated attempts to contact the spacecraft, it reentered on September 28.

During the last month of the quarter, controversy erupted over continued U.S. participation in the shuttle-Mir program. According to plans, astronaut Michael Foale was to be replaced on the Mir space station by another U.S. astronaut. Questions arose, however, about the wisdom of sending another American to the aging space station, which over recent months had experienced a partial depressurization and a series of fires, oxygen system failures, and main computer outages. The dispute came to a head in early September with release by the NASA Inspector General of a report that NASA was overlooking safety issues in its desire to complete the full shuttle-Mir series. During a House Science Committee hearing on September 18, Inspector General Roberta Gross expressed concern about the independence of the program's formal safety review and about a perception that legitimate reservations within the agency might have been suppressed by management commitment to program goals. Although several outside witnesses at the hearing shared her concerns or felt that enough goals of the program had

been achieved to warrant its discontinuation, NASA assured the committee that all safety issues had been fully considered. On the morning of September 25, after weighing supportive findings of four separate safety reviews, Administrator Daniel Goldin announced the decision to proceed, and astronaut David Wolf lifted Mir-bound into space on Atlantis later that day.

Several other events during the quarter deserve note. Launched on August 1 on a Pegasus XL, the Sea-viewing Wide-Field-of-View Sensor (SeaWiFS) began delivering long-awaited ocean color data. These data will be used for environmental and ecology studies of the ocean. The mission is also significant because of its innovative funding and management arrangement. SeaWiFS is a commercial enterprise, flying on an Orbital Sciences Corporation spacecraft that was not specified or funded by the government; NASA only specified and agreed to purchase certain data, if available. SeaWiFS is to provide successor data to the Coastal Zone Color Scanner of a decade ago.

Investigators of the ESA-NASA Solar and Heliospheric Observatory (SOHO) announced the discovery of plasma currents beneath the surface of the Sun. Resembling jet streams on Earth, these currents may help explain the familiar, but still mysterious, phenomena of solar cycles and solar activity. Ultimately, improvements in our understanding of solar variability could lead to progress in dealing with its consequences for communications and power distribution networks on Earth.

The Near-Earth Asteroid Rendezvous (NEAR) spacecraft, like Mars Pathfinder a member of NASA's new family of small Discovery missions, detected a strong cosmic gamma-ray burst. Designed to perform geochemical measurements at the asteroid Eros on arrival in 1999, NEAR's instrumentation was upgraded in-flight with new software to be able to detect and report gamma-ray bursts. This capability is significant because of the extension of the triangulation baseline that NEAR's trajectory adds to other gamma-ray detectors in low-Earth orbit; the longer baseline, which allows better determination of the direction to bursters, may help researchers identify these mysterious objects and subsequently understand where and what they are.

Closer to home, readers may remember that the Board sent Associate Administrator Arnauld Nicogossian, of NASA's Office of Life and Microgravity Sciences (OLMSA), a letter on July 8 expressing concern about the prospect of a protracted hiatus in flight opportunities for the space laboratory sciences during the years of International Space Station assembly. In a letter of reply on August 7, Dr. Nicogossian related planning underway to mitigate this problem. According to this planning, NASA is contemplating flying three additional shuttle research missions in the timeframe 1998-2001. These "transition" missions would begin in October 1998 and feature a commercial pressurized carrier module offering 55% allocation to NASA objectives. Two additional flights would follow, with expanded opportunities for research in life and microgravity sciences.

Claude Canizares
Chair

The Space Studies Bulletin
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From the Chair

In 1993, the NASA Advisory Council issued a report of its Task Force on NASA-University Relations. This group, on which I served, was chaired by Steven Muller, former president of The Johns Hopkins University. Of course, there is a great deal that was, and is, right about the partnership between NASA and universities, which, together with industry, are the major participants in the civil space enterprise. But the Task Force found "widespread, though not universal, agreement within NASA and throughout the related university community that serious strains have become apparent in the NASA-university relationship." Some of the strains seemed endemic, having been noted by other groups that considered this topic over the previous 30 years. Others could be attributed to understandable differences between the goals, needs, and styles of research universities and a large government agency. Differing perceptions often seemed to loom as large as specific tangible issues.

It is fair to say that the report did not engender wholesale changes in NASA-university interactions. This is partly because such issues are very resistant to attack, but also because of an accident of timing: the recommendations were delivered just as Administrator Daniel Goldin was taking charge and initiating wholesale changes to the agency, many of which are still underway. Some changes, of course, also alter the NASA-university relationship directly, as in the case of the establishment of a National Space Biomedical Research Institute, or indirectly, as in the reassignment of some responsibilities from NASA Headquarters to field centers or moving the bulk of technology funding into the Office of Space Science. On this latter topic, Congress included language in the 1998 NASA appropriations bill concerning the fraction of advanced technology development funds for which the outside community can openly compete, which clearly touches on NASA-university relations.

One observation of the NAC Task Force that remains valid is that NASA and the universities are strongly interdependent, each relying on the other for items essential to their wellbeing (like a well-educated workforce for NASA and sponsorship of research at universities), and to that of the nation's scientific and technical capability. In these times of limited resources, it is especially important that the partnership work as well as it can. This, in fact, is the law. NASA's charter, the Space Act of 1958, mandates the agency to achieve "the most effective utilization of the scientific and engineering resources of the United States."

At our fall meeting, the Space Studies Board discussed various aspects of the NASA-university interaction, with participation by Edward Stone, director of the Jet Propulsion Laboratory, and Alfonso Diaz, deputy director of Goddard Space Flight Center. We are now working with NASA to identify specific issues that could benefit from further examination, including the one raised by Congressional appropriators. The Board's 1995

report, *Managing the Space Sciences*, touched on some relevant topics but many of us feel that more focused attention is warranted, especially in the context of the changes at NASA. So I intend to keep this topic on our agenda and would welcome any thoughts or comments.

Claude R. Canizares
Chair

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL

March 1998, Vol. 8, No. 1

From the Chair

The President's budget for fiscal 1999 has much for space scientists to be happy about. First, it is balanced. Whatever one's view of deficit spending, this certainly eases the budget's reception in Congress. Second, the spending plan includes a "21st Century Research Fund," with increases across the R&D agencies. Third, although NASA's budget actually declines slightly in 1999, it is significantly above some earlier projections and remains so for the next several years.

The news is best for the Space Science Enterprise. For the first time in recent memory, the budget projections appear adequate to support the spectrum of missions called for in the latest strategic plan for exploring the solar system and the universe. The Office of Earth Science numbers are, like those in space science, roughly unchanged from the present year, but they fall below last year's projection. The budget for the Office of Life and Microgravity Sciences and Applications (OLMSA) is at least restored to its 1997 level after a dip in the current year, and then rises slightly.

There are, of course, things to watch and worry about, even beyond the usual concerns about how the proposals will fare during the Congressional appropriations process. Like other parts of NASA, the three science offices and the research communities they serve must achieve significant efficiencies in development and operations costs in order to live within their proposed means, which at best will just keep up with inflation. Mission costs for space science have already been substantially reduced, but the ability to conduct the key programs in their strategic plan depends on the adequacy and efficacy of current allocations for technology development. Efficiencies necessary to meeting the goals of Earth science, particularly implementing the next phases of the Earth Observing System using much smaller spacecraft, seem plausible but are yet to be fully established. Most problematic is the situation in OLMSA. Financially, the program seems to lack reserves. Two shuttle flights, one later this year and another two years after, are all there is to fill the gap in research opportunities until space station can be effectively utilized, an eventuality that continues to creep further into the future.

Station woes could, of course, have serious consequences for the entire agency. The increased costs already identified have taken a major toll on the budget for Aeronautics in this year's submission, and continue to squeeze OLMSA, which sits in the same budget category as the station. So far, the hits on space science and Earth science have been relatively modest. The question is how the agency, the administration and the Congress will handle the next wave of cost growth, which now seems almost inevitable and which could amount to several hundred million dollars per year for some years to come.

In November, 201 members of the House signed an extraordinary letter to Speaker Gingrich expressing strong bipartisan support for NASA. They called NASA "the symbol of our nation's preeminent scientific leadership in the international community. NASA makes important investments that probe the boundaries of our scientific, medical and engineering knowledge, as well as motivates and inspires our children and educators." Let us hope that this spirit will prevail throughout the budget process and the wrangles over space station.

A few weeks ago, I had the privilege of attending a lecture by Stephen Hawking at the White House, one of the Millennium evenings organized by the First Lady. Hawking's talk was an inspirational evocation of the promise that science and technology can hold for the next millennium. When my turn came to say a few words to the President at the subsequent reception, I thanked him for his investment in research, including space research, in this year's budget. He replied that he saw it as a beginning and hoped a strong economy would permit further investments next year.

The President's budget, his remarks and the bipartisan Congressional letter are heartening signs that the impact of our research and our efforts to communicate it to the public and our elected officials have not gone unnoticed. But this is no time for complacency. We must continue to set both lofty goals and thoughtful priorities, to produce the kind of cost-effective research results that justify the levels of public expenditure we receive, and to disseminate those results widely and responsibly.

Claude R. Canizares
Chair

Board and Committee News

In his column in the December 1997 *Bulletin*, Interim Director Norman Metzger referred to the past year as "a watershed year," and indeed it was. And of course, 1998 promises to be no less exciting. We have already seen the successful orbital operations of Lunar Prospector, which have yielded remarkable new data about water in the polar regions of the Moon. We can look forward to launches of the Transition Region and Coronal Explorer (TRACE) to join SOHO to study

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NATIONAL RESEARCH COUNCIL

June 1998, Vol. 8, No. 2

From the Chair

Reproduced below is the foreword written by Dr. Claude R. Canizares (Board chair) and Profs. François Becker (European Science Foundation's European Space Science Committee [ESSC] chair through November 1997) and J. Leonard Culhane (current ESSC chair) from U.S.-European Collaboration in Space Science, *a joint report of the Space Studies Board's Committee on International Space Programs and the ESSC. The report was released on June 30.*

Photographs of Earth from space show no political boundaries, reminding us that national distinctions are manmade. But the agencies responsible for those pictures, other missions to Earth orbit, and probes to deep space are inevitably national or multinational. Each has its own set of constituencies, procedures, capabilities, and limitations.

There are great benefits from finding ways those entities and their respective research and industrial communities can act cooperatively, as has been amply demonstrated by many successful examples of international cooperation in the space sciences. Beyond the cultural enrichment that comes when people of different nations work together for a common goal, those benefits include the potentially richer scientific yield from shared expertise and broader political and financial support.

Joint activities between the National Aeronautics and Space Administration in the United States and the European Space Agency or individual European national space agencies have resulted in some of the world's most successful space science missions, and more joint efforts are being planned. But inevitably, some attempts at transatlantic cooperation are more successful than others. Sometimes difficulties arise as they would in any large, complex technical undertaking, whether national or multinational. At other times, however, the additional complications of internationalism itself can cause or exacerbate those difficulties.

We believe that improving the likelihood of successful U.S.-European cooperation is a worthy goal that can enhance the space programs and benefit the peoples of all participating nations. This benefit is clearest in the case of the International Space Station, the largest multinational undertaking of its kind. Its success depends entirely on the cooperation of the United States, Europe, and the other major partners. We think improving international cooperation can also enhance more modest space missions that study Earth, explore the solar system, or probe the cosmos.

This joint report is itself an exercise in international cooperation. The Space Studies Board of the U.S. National Research Council and the European Space Science Committee of the European Science Foundation are charged with advising their respective space enterprises. Our charters, procedures, and operating styles are not identical. Yet we have a long history of fruitful interchange and a shared vision of science as a global activity, and this understanding provided a natural context for this study.

It is our hope that this report will help make future cooperative ventures in space science more successful than ever. Some of the conclusions may be relevant for those planning international ventures in other areas as well. We plan to continue our joint dialogue and hope to extend our deliberations to include colleagues in other major space-faring nations. We are confident that the spirit of shared human inquiry that has characterized science throughout history will continue and grow stronger on the high frontier of space research.

Board and Committee News

On June 27, 1958, some three months before the formation of NASA, a group of 17 scientists assembled in New York for the first meeting of the Space Science Board. Over the next four months, the new Board initiated the process of open solicitation and competitive peer review for selection of research investigations in space science, defined the role of the Principal Investigator in such investigations, established the first set of discipline committees to carry out the work of the Board, and sketched out the first "decadal strategy" for the space sciences.

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL

September 1998, Vol. 8, No. 3

From the Chair

NASA passed it's 40th birthday this October 1. For a person, turning 40 is a notable milestone, a time of celebration and of introspection. The joys and satisfactions of four decades of growth and accomplishments are often tempered by a good measure of mid-life crisis. In its own way, the agency may be experiencing some of the ambivalence which many people feel when greeting the onset of middle age.

There is certainly much for NASA to celebrate. John Glenn's imminent return to space is itself a symbol of the most intrepid and heroic events of our history in space. What was most remarkable about Glenn's first orbits of the planet nearly 37 years ago were that they happened at all. The same is true of his repeat flight in space at an age when many find challenge in a flight of stairs. The space sciences, epitomized at present by the continual discoveries of Hubble and our renewed exploration of Mars, have grown into a mature and well established enterprise. Earth observations from space are in a more formative stage but promise to make major contributions to civilization through understanding of global change. The emphasis on smaller missions with shorter development times is injecting youthful vigor into many parts of the agency.

Other aspects of NASA are more problematic. In contrast to a renewed alacrity in space and earth sciences, the manned program is enmeshed in the largest and longest program in the history of the agency, the International Space Station. Beyond the sheer scale and complexity of this endeavor are the troublesome dependencies on Russian contributions of key hardware and logistical support and on our own aging shuttle fleet. The current schedule for station construction and support, one sure to change, shows a steady barrage of launches averaging 18 a year for five years. Even at this rate it will be 2003 before significant research can be done there. Meanwhile opportunities in life and microgravity sciences will remain limited.

Public support of space is hardly as robust as it was 40 years ago, as symbolized by the relative indifference to NASA's birthday in the press. Many attribute this inattention to changing national interests after the end of the cold war, which in those early years gave urgency to space progress. But NASA is suffering more than other research agencies in terms of public support and budget. The diffuse and poorly understood goals of our current space program must be a factor. One wonders if the orbital equivalent of ground breaking for space station will change that, and whether the change will be positive or negative.

The Space Studies Board celebrated its own 40th earlier this spring, the first meeting of the board having preceded the formation of NASA by three months. Whether justifiably or not, we seem to be entering our own institutional middle age with reasonable equanimity. In reviewing this past year, we have published 11 reports on a wide range of topics. More than 180 scientists took part in activities of the board, its committees or task groups. (It was particularly satisfying that Dr. John Simpson, one of the original members at that first meeting in 1958 ended another three year term at our anniversary meeting this June). A recent review by our parent Commission at the National Research Council gave us generally positive marks for effectiveness and timeliness, while also suggesting areas for improvement.

It is unclear to me whether or not the Board can help articulate a sharper vision of the space program. As a tentative start, we do plan spend some time at our next meeting sketching possible futures for space research in, say, the year 2025. This is beyond the current planning horizon but near enough to discourage the wildest kind of speculation. I am well aware that none of the distinguished panels and commissions that attempted to formulate goals and visions for space over the past two decades has had lasting impact. But until one of these is more successful, it is likely NASA will continue to feel the acute malaise of its middle-age.

Claude R. Canizares
Chair

Board and Committee News

Program Highlights

The past quarter was notable both for the continued flow of new scientific developments and for its share of drama and suspense, some of which was unique and some of which was recurring. In space science, we saw Galileo yield new insights about the origin of Jupiter's rings and new hot volcanic vents on Io, while Mars Global Surveyor produced new data on a deep layer of dust on Phobos, and analysis of Lunar Prospector data led to improved estimates of substantial water ice deposits at the Moon's poles. ESA's Infrared Space Observatory detected a new population of primeval galaxies in the early universe; HST

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THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL

December 1998, Vol. 8, No. 4

From the Chair

The first elements of the International Space Station are now in orbit. The launches that got them there also launched a new epoch for NASA, one that is likely to be as distinct as the Apollo or Shuttle eras and as different from either as they are from one another.

The sheer scale of the Station as a multi-national endeavor, as a flight project and as an orbital structure dwarfs anything that preceded it. Consider, for example, the 87 U.S. and Russian launches and nearly 1000 hours of space walks required during the five year construction period, or the 360 foot wingspan and nearly half million kilogram mass of the final assembly. No one who has walked around and through the full-sized mock-up at Johnson Space Center can fail to be impressed with the magnitude of this undertaking.

Awesome as these features are, they fail to capture some of the more subtle factors that might be even more important for the future of the space agency. These include the magnitude of ongoing space station operations for at least the next two decades, the heightened vulnerability to an aging shuttle fleet, the imperatives for assuring adequate future launch capability for crews and cargo, the risks associated with technical or programmatic difficulties, reliance on international partners and need for uninterrupted public and political support. All in all, the constant attention demanded by having such a major asset in Earth orbit, magnified manyfold, of course, by the expectation that it will be permanently inhabited, introduces a continuing and sustained level of urgency sure to affect the entire agency. And all this is happening at a time of declining NASA budgets.

At its best the station could become what the proponents suggest: a triumph of engineering on the high frontier, a model of international cooperation, a useful laboratory for some aspects of physiology, biology, physics and technology, and the place where we learn enough about long duration space flight to enable future human exploration of the solar system. One might even see the beginnings of some commercial ventures. At its worst, according to the detractors, the station could become a technical, programmatic and budgetary nightmare with limited scientific returns, causing divisions among the partners and indifference or antagonism from the public. The truth will surely lie somewhere between these two extremes, but it is hard not to think of the sacred white elephants, given as gifts by the King of Saim to obnoxious courtiers in hopes the cost of upkeep would ruin them.

However this plays out, those first space station launches have set in place long term management and political challenges to NASA's leaders, to their government overseers, and to the whole space community—challenges that are at least as tricky as the technical ones faced by the engineers and astronauts responsible for construction and maintenance. For better or for worse, this mission is now underway.

For it's part, the Space Studies Board continues to follow attentively the plans for conducting research on space station and to put forward recommendations aimed at making sure that it is of high quality (although the Board has always maintained that the research returns are not in themselves sufficient to warrant the cost of the facility). The recently released report, *A Strategy for Space Biology and Medicine in the New Century,* is a notable example of the Board's advice on priorities and principles for research in space laboratories. Furthermore, NASA has just requested that we consider possible institutional arrangements for conducting the overall research program in the most effective manner. Our hope is that reports such as these will help address at least a few of the challenges that lie ahead.

Claude R. Canizares
Chair

Board and Committee News

Program Highlights

The fourth quarter of 1998 was marked by a number of milestone events for the space sciences. Among them was the launch of Deep Space-1, the first of the New Millennium Program series of missions to validate advanced flight mission technologies. DS-1 will serve as a test bed for a dozen new technologies, including solar electric ion propulsion, autonomous optical navigation and spacecraft operations systems, and miniaturized instrument systems for use during an asteroid flyby in July 1999. On Dec. 5, the Submillimeter Wave Astronomy Satellite (SWAS), one of the first three Small Explorers selected in 1989, was launched to begin its mission to exploit the 0.5-0.6 mm wavelength band to study star formation regions in our galaxy. The SWAS team involves investigators

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THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL

March 1999, Vol. 9, No. 1

From the Chair

Reproduced below is a statement prepared for presentation to the Subcommittee on Space and Aeronautics of the House Committee on Science on February 11, 1999. Also participating in that hearing were the NASA Associate Administrators for Space Science, Earth Science, and Life and Microgravity Sciences and Applications.

Mr. Chairman, Ranking Minority Member, and members of the committee. I am an astrophysicist from MIT, and I appear today in my capacity of as chair of the Space Studies Board of the National Research Council.

Last October, the Board published a report entitled *Supporting Research and Data Analysis in NASA's Science Programs*. Your invitation indicated that my testimony should focus on this report, which articulates the role of the Research and Data Analysis programs in NASA and suggests ways to improve them.

The Research and Data Analysis, or R&DA, portion of NASA's science activity is generally much less visible than missions with well-known names like Hubble or Galileo. But they are no less important to the conduct of NASA's research.

It is obvious that without the missions there would be no data from space, and research progress would grind to a halt. But without the R&DA programs there would be no effective missions, and little scientific return. Part of R&DA supports the work that provides the scientific underpinnings and often some key enabling technologies for NASA's missions, and part of it supports the scientific process that transforms the raw data from a mission into understanding, insight and discovery.

The R&DA programs are primarily aggregations of numerous investigations by individuals or consortia both inside and outside NASA. Each one is generally modest but the total is a significant fraction of NASA's science expenditures, altogether about 40%. The projects include work in theory and computation, ground-based or sub-orbital research, technology and instrument development, analysis of mission data, and education including training the next generations of space scientists and engineers. This diffusion and multiplicity is both a strength of R&DA and one reason for its diminished visibility. In addition, a significant fraction of R&DA funding covers some large infrastructures like the Data & Information System for the Earth Observing System, EOSDIS.

Let me give you just a few examples of the breadth and scientific impact of R&DA:

-- On the well-known Antarctic "ozone hole:" R&DA programs supported high altitude observations that were key to explaining the mechanisms that are destroying atmospheric ozone.

-- Life on Mars: the galvanizing, though still controversial, announcement of possible circumstantial evidence for life on Mars came from R&DA-supported analyses of meteorites found on Earth.

-- Human physiology: R&DA-supported studies on laboratory rats in microgravity on Spacelab gave new insights into the workings of the gravity sensors of the inner ear, findings which should be clinically relevant to treatments for vestibular disease.

-- Technology: two of the four scientific instruments on NASA's upcoming Chandra X-ray Observatory were built in my center at MIT using unique, advanced technologies first developed with R&DA support.

Despite these contributions and many more like them, for many years the science community has been concerned that the quality of NASA science was being compromised by what appeared to be a growing imbalance between flight projects and R&DA investments. At the same time NASA's laudable move toward smaller, faster, and cheaper missions places new demands upon R&DA, since some of the activities previously funded by more lengthy flight projects will now come from the research base.

Evaluating budget trends for R&DA proved to be difficult. Adjusting for inflation, the aggregate expenditures in all categories grew significantly from FY91-98, but most of that is due to the growth of EOSDIS and to some accounting changes. More to the point, the traditional Research & Analysis, or R&A, account which represents a key element of NASA's grants program fell by 22% over the same period. Moreover, R&A, as a fraction of NASA science-related funding fell by 35%. As for individual investigator awards, the task group found a wide range in grant size, and a 25% decline in the size of a typical grant to a level that appears subcritical for even a lone researcher.

These trends were consistent with the perception that the several components of NASA's R&DA activities are in general not optimally balanced and may offer opportunities for increased efficiency.

In terms of recommendations, the task group did not presume to say what the right balance among R&DA programs should be. Rather, it did recommend that NASA's science offices should themselves revisit these issues. The science

• **A Scientific Rationale for Mobility in Planetary Environments, pg. 6**

http://www.nas.edu/ssb/ssb.html

offices should use various means to improve their overview of the R&DA activities, periodically evaluate their efficiency and the balance, and do this in the context of their existing strategic plans.

The thrust of these recommendations also touches on your second question regarding ways NASA might ensure that each individual mission's potential is fully utilized.

As general principles, the Space Studies Board has consistently held that the best way to assure high quality research is first, through use of the peer review process, and secondly by keeping authority for primary science allocation decisions at NASA Headquarters. I believe that the gentlemen from NASA here share these principles.

In closing, let me note that the very first objective of Title I of the National Aeronautics and Space Act of 1958 is "the expansion of human knowledge of the Earth, and of phenomena in the atmosphere and space." Meeting that objective over the past 40 years has been a major triumph for NASA and the space science community at large. I am confident that with proper stewardship, the current plans of the agency can deliver to the nation and the world even more remarkable discoveries that expand our understanding, excite and inform the public, inspire and educate our children, and contribute to the well-being of the planet.

Thank you for the opportunity to appear before you and for your attention.

Claude R. Canizares
Chair

Board and Committee News

SSB Highlights

With the beginning of a new year, one can always look forward to the budding of spring flowers, flagging commitments to New Year's resolutions, and great expectations for a new budget for the next fiscal year. At first glance, and at a macroscopic level, the federal budget outlook is rosy, with expectations of growing budget surpluses over the next five years. Closer inspection, however, shows that the projected surpluses depend on assumptions about major Social Security reforms and on federal government access to portions of tobacco settlement funds recently negotiated between the industry and a number of states. Furthermore, it is not obvious that NASA or other R&D agencies are slated by the Administration to be beneficiaries of any of the projected surpluses. Finally, the Congress still is bound by budget "caps" established several years ago, and that has already posed a problem for the allocation to the appropriations subcommittees. Budget Committee allocations for General Science, Space, and Technology (where one finds NASA, NSF, and parts of DOE) have a $1 to 2 billion shortfall in FY2000 compared to the President's request. Similar shortfalls are evident in the allocation for Natural Resources where NOAA's budget rests. In the face of such a set of cautionary notes, "steady as you go" sounds like a pretty good mantra for space research budgets in the coming year.

The overall federal R&D budget proposed by the Administration calls for a 3% increase over FY1999, with an emphasis on basic research. NASA is projected for an overall decrease of 0.6% below its FY1999 total and accounts for Science, Aeronautics, and Technology would fall by 4.1% largely to cuts in aeronautics. The budgets of the Office of Space Science and the Office of Earth Science are proposed to grow by 3.7% and 3.2%, respectively. In a move to provide budgetary resilience against possible further problems with Russia's contributions to the International Space Station (ISS), the ISS budget would increase by 7.7% over FY1999. Reflecting likely delays in the installation of research hardware on ISS, the proposed budget for the Office of Life and Microgravity Sciences and Applications would drop 2.8% below FY1999 levels.

At the NSF, the total budget is proposed to grow by 5.8%, corresponding to one of the most substantial increases amongst R&D agencies. Within the NSF Research and Related Activities account, biological sciences would grow by 4.5%, physics by 3%, astronomical sciences by 2.9%, geosciences by 2.6%, and materials research by 2.1%. At NOAA, the President's request represents an increase of 12.9% over the last year. The National Environmental Satellite, Data and Information Service (NESDIS) is proposed to receive a 4.8% increase, the major portion of which would be for an increase in funds for NOAA's share of the National Polar-orbiting Environmental Satellite System being developed jointly with the DOD.

Appropriations hearings have already been occurring at a brisk pace. Thus one is tempted to hope that FY2000 may well begin unencumbered by having many agencies operating und a continuing resolution or funded under some sort of catch- omnibus appropriations bill similar to the one that resolved budgets for large portions of the government last year. Seasoned pragmatists, however, are not so optimistic.

In the actual space research arena there has been much to celebrate or anticipate and a few sobering events to contemplate as well. NASA's Office of Space Science is progressing through a series of 11 launches in the 12-month period from November 1998 through October 1999. Seven of those have already been accomplished successfully, although the premature opening of the telescope door led to loss of the Wide-field InfraRed Explorer mission in March before any data could be collected. Coming over the next several months are launches of a Boston University student Explorer for ionospheric and solar EUV studies in April, the Far Ultraviolet Spectroscopic Explorer in May, the Chandra Advanced X-ray Astrophysics Facility in July, and a recently scheduled Hubble Space Telescope servicing mission in October.

NASA's Office of Earth Science also expects a particularly busy year with 10 launches planned in 1999. They include Landsat-7, Quickscatt, GOES-L for NOAA, and the Earth Observing System AM-1 platform all in the first half of the year. These missions will be the first of 26 planned Earth-observing missions between now and 2002. The Office of Life and Microgravity Sciences and Applications reports excellent progress in its efforts over the past few years to build a cc research community through its competitive, peer-reviewed grants program. The program now has more than 700 principal

THE SPACE STUDIES BULLETIN

A Newsletter of the Space Studies Board

NATIONAL RESEARCH COUNCIL **June 1999, Vol. 9, No. 2**

From the Chair

In less than a week from this writing, Space Shuttle Columbia is scheduled to launch the Chandra X-ray Observatory, formerly known as the Advanced X-ray Astrophysics Facility. Chandra is the third of NASA's "Great Observatories," joining Hubble Space Telescope and the Compton Gamma Ray Observatory. Space Infra-Red Telescope Facility or SIRTF is to follow in a few years as the last.

Although Chandra is smaller and cheaper than the original AXAF design or than Hubble, it is still very much a major mission. It fills the shuttle bay, is the heaviest payload to be lifted by the shuttle, and its total cost assuming a 5-10 year lifetime exceeds $2B.

It was also a long time in coming. Chandra was the highest priority astronomy mission for the 1980s according to the NRC's astronomy survey committee chaired by George Field, and in some sense its heritage goes back to the 1970s. I was selected as an instrument principal investigator on this mission in 1984 (which came to suggest Orwellian connotations). At that time launch was projected for 1991, seven years away—it remained seven years away for the next seven years. Then it was fixed, until last year when some technical problems added another 10 months to the schedule.

In this regard, Chandra might be held up as an example of what is wrong with such large missions, and why NASA has recently emphasized smaller, faster, cheaper programs. But it is also an example of what is right. Without doubt, large missions are costly, often take too long to develop, and concentrate risk. But Chandra's exquisite X-ray optics and instruments will provide unprecedented power to study black holes, exploding stars, galaxy clusters and quasars. Its imaging and spectral capabilities exceed those of earlier missions by 100 to 1000, and it can provide large amounts of data to astronomers all over the nation and the world for many years, possibly more than a decade. By virtue of the things that make it expensive, Chandra will be like Hubble in having an impact commensurate with its cost.

Small missions have their own strengths, primarily timeliness, ability to target specific scientific objectives, modest cost and risk. In terms of total impact and even some measure of science-per-dollar, however, it is likely that larger missions may prevail. Plausibly, a sound strategic plan requires a mix of mission sizes rather than a preponderance of only one or the other. The smaller ones provide essential vigor and agility, the larger ones enable major leaps forward, with moderate missions in between. Of course, the optimal mix will depend on the prevailing scientific imperatives of each discipline, and so could vary over time. The fact that NASA itself has largely replaced the "smaller, faster, cheaper" mantra with "faster, cheaper, better" suggests a similar recognition.

Recent language in the 1999 NASA Appropriation from the relevant Senate Subcommittee expressed concern that the pendulum may have swung too far toward small missions in the space and Earth sciences, and directed NASA to contract with the NRC to study this matter. The SSB has accepted the task and is engaged in a fast track effort to assess the degree to which the objectives of the existing science strategies can be met by missions of various sizes. By making maximum use of existing science strategies and the expertise of our discipline committees, we are planning an expedited study to be released early in the coming year.

It will be very interesting to see how each discipline asseses its optimum mix of missions and how these compare to current agency plans. Meanwhile, if all goes well in the next several weeks, Chandra's data will soon start streaming into workstations around the world. Whatever frustrations I have felt in the many years it took to get to this point, this is the time to revel in the rich scientific return from the sizeable investment of people and money that got us here. This is one big mission whose time has finally come.

Claude R. Canizares
Chair

As we went to press, the science community was saddened by the news of the death of Representative George S. Brown. NAS President Bruce Alberts hailed Brown as "....A consistent, strong supporter of science throughout his 35 years in Congress....he worked diligently to protect the scientific enterprise, helping it to become a critical driver of our nation's economic prosperity and well being."

http://www.nas.edu/ssb/ssb.html

THE NATIONAL ACADEMIES

The Space Studies Bulletin

Volume 10, Issue 3 September 1999

From the Chair

A year ago NASA passed a significant milestone, its 40th birthday. This year marks another, namely the end of a decade, century and millennium. Any of these events might have provided an occasion for introspection and speculation, for looking backward to assess where we've been, and forward to ponder on where we should be going in space.

In fact, despite numerous millennial references in political speeches, soap commercials and TV talk shows, the century that gave us the first powered flight, put men on the moon and sent spacecraft beyond the outermost planets is ending with very little discussion of the significance of these events or of what should be done in the next century to build on them. Not only the public, but even the space community itself seems too preoccupied with daily concerns to spend much time philosophizing about past, present or future.

Some long-range thinking is taking place. NASA Administrator Daniel Goldin has been goading various scientific groups to think bold thoughts and invent radically new approaches to space research. He recently admonished a group of astronomers and physicists to stop hugging Hubble, for example, and he continues to trumpet the ascendance of biology in an agency dominated by the physical sciences. In response several groups are trying to define futuristic grand challenges that could serve as navigational beacons for research and guide technology development over the next few decades.

Valuable as these may be, current planning is primarily along disciplinary lines. Whereas the space program was once dominated by a single theme, the race to the moon, it is now and is likely to remain an assemblage of diverse programs united by a common launch infrastructure (which is itself in need of millennial thinking).

This may be a sign of maturity—the number of research areas that benefit from space continues to grow, and space activity impinges increasingly on everyday life through communications, weather prediction, and the ubiquity of GPS. The Air Force talks of becoming an "Air and Space Force," and spending on commercial space activities has surpassed total government spending and is projected to increase rapidly, recent bankruptcies notwithstanding.

But familiarity can breed contempt, or at least indifference. Many benefits of space activities are taken for granted by the public, as exemplified by the unnamed (and probably apocryphal) Congressman who questioned "why we need weather satellites when you can get weather maps on

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Board Director's Column

In the June 1999 edition of this newsletter, we commented that the federal budget appropriations process appeared to be in for "a long hot summer." Little could we have guessed that the budgets for NASA and NSF would be threatened with unprecedented cuts that could lead to widespread reductions to research grants programs and outright cancellation of a number of key research and technology programs. First the House of Representatives passed an appropriations bill for FY2000 that would have dropped NASA by $1 billion below its FY1999 level, reducing science and technology accounts by 12% overall and imposing cuts of 17% to Earth science and 27% to the space science program. The same bill proposed to cut NSF by $25 million below the FY1999 levels or $275 million below the FY2000 request. After several weeks of vigorous arguments on behalf of the R&D budgets by members of the scientific community, the Administration, and some members of Congress, the Senate acted to propose, instead, that the FY2000 levels be funded at the level originally requested by the Administration.

Under the Senate bill, the NSF would receive a 6.8% increase above FY1999 for a total of $3.9 billion. The NASA budget provided for a total of $13.6 billion, including the requested levels

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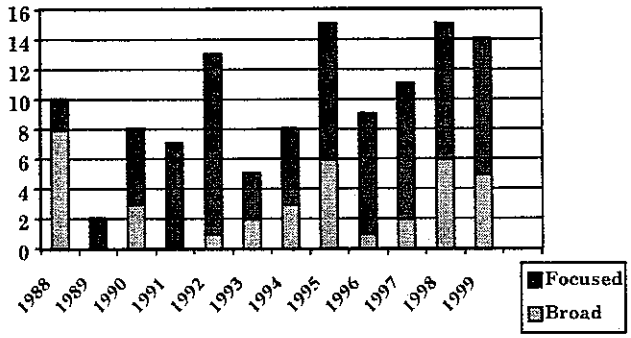
INSIDE THIS ISSUE

Readership Survey Enclosed

The Space Studies Board is gathering feedback about the interest in and readership of its newsletter and reports. We would like you to participate in this survey by completing the enclosed questionnaire. The information you supply will be used for our in-house purposes only and will help us better assess the needs of the space science community as they relate to the particular products of the Board, and how we can deliver a more informative and timely newsletter. We thank you for your support of the Space Studies Board and its activities.

Space Studies Board Report Trends, 1988-1999



Joseph K. Alexander, Director
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From the Chair

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TV?" This year's budget cycle, which proved even more bizarre than usual, revealed the tepid level of support for space research in the naion (see Director's column). To be sure, NASA has few real enemies—no one is actively opposed to space exploration. But it also has few fervent champions. So the budget cuts in the House were not made out of malice. But when appropriations exceeded allocations, NASA was seen as a politically acceptable place to store the red ink, at least until a handful of NASA's most devoted supporters were able to correct the problem in the House-Senate conference. The scientific community rallied to help, but I suspect there was little outcry from the general public.

So the combination of a rather indifferent public and a heterogeneous space community is not likely to give rise to a unified vision for the nation's space enterprise. At best we might end up with a pastiche of visions and strategies which taken together will constitute our plan for the future. One hopes that public outreach and education are strong components of any plan. Every year is a budget year, and the more that people are aware of what space activities mean to their lives and to the advance of science, the easier time we will have in securing its future.

Claude R. Canizares
Chair

Board and Committee News

Space Studies Board

SSB held its 128th meeting on June 22-24 at the John H. Glenn Research Center (GRC) at Lewis Field in Cleveland, OH. A main focus of the meeting was on the research work of the Center, including briefings and tours. One of the original NACA centers, GRC is NASA's center of excellence in turbomachinery; it also leads the agency's work in microgravity fluid and combustion science. There were presentations by GRC staff Gerald Barna, Director of Space Science, Drs. Howard Ross, W. Dan Williams, and Valerie Lyons. Members participated in tours to the drop tower, communications and power and propulsion laboratories, and the fluids and combustion facility. Also briefing the Board was Dr. Simon Ostrach, director of the National Center for Microgravity Research on Fluids and Combustion, who described the center's programs conducted under a cooperative agreement between NASA, Case Western Reserve University, and USRA.

The meeting included a report on the recent successful trilateral workshop in Japan and a talk by Prof. Atsuhiro Nishida, director general of the Institute of Space and Astronautical Science (ISAS) in Japan. Other discussion items included updates on ongoing studies of the Board's standing committees. An update was also provided on the Committee on Human Exploration (CHEX) which had a pre-planning meeting scheduled for mid-July for a possible workshop on cultural anthropology aspects of human exploration and development. Reports on the Task Groups on Institutional Arrangements for Space Station Research, on the Space Station Biotechnology Facility, and on Europa Contamination Protection were made. Dr. Roberta Balstad Miller reported on plans by the Steering Group on Space Applications and Commercialization and the positive response from several agencies to proposals for a series of three workshops.

Dr. Mark Abbott, chair of the Committee on Earth Studies (CES), made a presentation on Remote Sensing and Earth Science in 2030: Trends and Sources of Innovation, and Dr. Alan Title made a presentation on new solar physics research results from TRACE and SOHO.

Members discussed plans for implementation of three studies requested by the Congress on: the mix of space research mission sizes for Earth and space science, maximizing the use of space station for research in life and microgravity sciences, and studies related to NASA's Astrobiology and Origins programs. Plans for follow-up actions on other potential projects also were discussed. A proposal for an activity on NASA-University-Industry partnerships will be modified and some groundwork will be done with agencies. A meeting will be arranged with the new NASA chief scientist, Dr. Kathie Olsen, and a few Board members to discuss plans for an education activity.

Preliminary approval was given for the CAA report, *Federal Funding of Astronomical Research.*

The Board's Executive Committee met September 8-10 in Woods Hole, MA, to look at the effectiveness and impact of the SSB, approve the US-Japan-Europe workshop report by the Committee on International Space Programs, and the Board's committee structure and membership and plans for the coming year.

The Board constituted an ad hoc Steering Committee on the "Assessment of Mission Size Trade-Offs for Earth and Space Science Missions" which met at Woods Hole, MA on September 8-10. The ad hoc committee will respond to a Congressionally-

THE NATIONAL ACADEMIES

Space Studies Bulletin

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From the Chair

There is a story about how Sam Walton, the late founder of Walmart, was a man of few words. When asked to what he attributed his success, he replied "Good decisions." And how had he learned how to make good decisions? "Bad decisions."

Learning from mistakes is something much on the minds of NASA and the space research community. The back-to-back failures of both Mars missions this fall, followed several other losses earlier in the year (see column by SSB director Joe Alexander). It is likely, as the media were quick to note, that these problems have something to do with NASA's emphasis on conducting missions "faster, better and cheaper" than in the past. The real question is what in the present approach needs fixing. What is it that went wrong and how much needs to be changed to make it right in the future?

The confusion over metric vs. imperial units that doomed Mars Climate Orbiter might well have been caught in a program with more comfortably funded checks and balances, and the same might be said for the problems with the explorer satellites, TERRIERS and WIRE. We may never be sure what happened to Mars Polar Lander, but this too was a lean program with limited budget and ambitious schedule. A review panel led by Tom Young, a hero of the space community who can be counted on to get to the bottom of the issue, will be reporting within a few months.

It is likely that in all these missions, extreme pressures to deliver a minimally capable payload with tight constraints on both cost and schedule led to increased technical risk. After all, that is part of the "faster, better, cheaper" philosophy, since achieving very high levels of reliability inevitably means incurring very high costs (though high costs do not guarantee high reliability). The challenge is managing risk along with the other variables and keeping it at acceptable levels. Another problem is that what might be acceptable risk in a technical, cost/benefit analysis may be politically unacceptable. As one former NASA official once opined, "faster, better, cheaper will succeed only when the agency starts rewarding managers for cheap failures."

To me, the biggest danger is that the system will over react to these failures and swing the pendulum too far away from the "faster, better, cheaper" philosophy. In the most extreme scenario, high levels of risk aversion could add significant multiples to the cost of every upcoming science mission and reduce the renewed vitality that more frequent missions have brought to space research. We should

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Board Director's Column

The deluge of retrospectives and calendar milestone commentaries that flooded our consciousness in the closing weeks of 1999, should give any writer (or reader) pause. So also should the rather extraordinary mix of events that marked high and low points in space research during the year. But fools rush in, as Alexander Pope said, and so this writer will fearlessly try to draw a few lessons from the recent past.

That past saw the often delayed but finally successful launches of Landsat-7, Chandra, Terra, and the HST servicing mission. Other successful flights included the launches of Stardust, QuickScat, FUSE, and the ESA XMM telescope aboard an Ariane 5 rocket. Tempering those and other successes were launch failures of two Titan-4 rockets, an Athena-2, a Delta-3, two Protons, and a Japanese H2 vehicle. Perhaps even more painful for the space research community were the in-flight failures of Mars Climate Orbiter, Mars Polar Lander, two Deep Space-2 Mars penetrators, and the WIRE and TERRIERS missions. In August federal S&T budgets were threatened with fearsome cuts, especially at NASA, but members of Congress who were favorable

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remember that there have been many more successes than failures this year, and the latter, though costly in lost dollars and missed science returns, represent a small fraction of NASA's research expenditures. More useful would be to take the lessons we learn from these unfortunate occurrences and make marginal improvements in selected areas of technical and risk management. We need to nurture an effective faster-better-cheaper implementation approach in the context of a balanced portfolio of mission sizes. (The Board's upcoming report on the size mix for Earth and space sciences will address these issues.) Or in a few words, "Emulate Sam Walton".

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Board Director's Column

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to those programs were able to work nearly miraculous solutions in the final days of the appropriations process.

One might ask whether there are any common themes or underlying messages in this collection of events. Some are obvious, but they may be worth repeating, and remembering. First, this ***is*** rocket science. Space research is complex, it is difficult, and it has inherent risks. Since all of the easy things have been done, or may not be worth doing, new efforts require new tools and innovative approaches.

The challenge, though, is to see where to draw the line in terms of saving older proven methods and where to replace them. For example, the government assessment of the string of U.S. launch vehicle failures concluded that manufacturers were tempted to cut corners on some testing and quality assurance practices and to substitute approaches that were less robust.[1] We may be learning that, regardless of whether the issue is the changing roles of government and industry in launch vehicles or the changing approach to science missions, the conscious act of defining acceptable risks—both in terms of how much and what kind—is critical.

The inherent complexities of space activities probably also figure into the explanation for the past year's nearly disastrous budget story. In spite of the popular fascination with dramatic results from HST, Galileo, or TOMS, neither members of the public nor legislators readily understand the purpose of data-analysis grants, or advanced instrument technology funds, or definition studies of next-generation observing systems. If the funding needs, the societal benefits, and the nature of the inherent risks aren't clear to decision makers, then the rationale for continuing funding becomes ephemeral.

In the environment described above, in which complexity and risk are fundamental, complacency is an enemy. One can never afford to be complacent either about attending to the details of technical challenges or about articulating and communicating about the rationale, risks, and benefits of the programs. The good news appears to be that most observers agree that things aren't fundamentally broken. Corrections may be in order, but major overhauls don't seem to be called for. To be sure, there are a number of troubling questions to be addressed—such as have new approaches to space systems design and management tried to move too far and too fast; are we seeing effects of burn-out or loss of corporate memory in key project positions; and why were congressional budget knives turned so abruptly toward space research in 1999?

The Space Studies Board seeks to contribute constructively in this period of change in a number of ways. For example, two new study reports are slated for release in the first quarter of 2000 that examine, from a scientific perspective, issues regarding trade-offs for different mission sizes for Earth and space science missions.[2] That topic may be addressed further in the Board's upcoming review of the new strategic plan for NASA's Office of Space Science and in the Board's upcoming report on implementing the integration of research and operational Earth observing satellite systems, to cite two other examples.

The SSB has had a long-standing role in developing and articulating the scientific rationale for space research programs; SSB "strategy reports" provide one means to communicate about the complexity and the value of space research. As these pages have noted before, a major current operational goal for the Board is to improve and enhance the dissemination and communication of its work, not only to federal agencies and the scientific community but also to the wider community of stakeholders, including the interested public. We invite readers' ideas and support in pursuing that goal.

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[1] <See *Department of Defense Assessment of Space Launch Failures*, http://www.af.mil/lib/misc/spacebar99.htm.>
[2] <*The Role of Small Satellites in NASA and NOAA Earth Observing Programs* and *Assessment of Mission Size Trade-offs for Earth and Space Science Missions*>

THE NATIONAL ACADEMIES

Space Studies Bulletin

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From the Chair

Over the past year the Space Studies Board, and especially its Committee on International Space Programs, has grown concerned about the impact of evolving implementation of export control regulations on the conduct of international space cooperation. The increased stringency of controls on the movement of scientific and technological information and hardware could have serious effects on. In the most extreme scenario, the regulations could have dire consequences on all university based space research, since the regulations also apply to foreign nationals within the U.S. who are not permanent residents, such as graduate students and post-docs.

The problem is rooted in provisions introduced to deal, appropriately, with the dangers of arms proliferation. This is done, in part, by controlling the transfer of items on the U.S. Munitions List, which covers all spacecraft components and, more broadly, all related technical data. These controls are implemented under the International Traffic in Arms Regulation (ITAR), which now applies strict controls on transfer of data, as well as hardware. There is an explicit exclusion for aspects of the International Space Station program, and a more general exclusion for data associated with "fundamental research" that is considered "in the public domain."

Two recent changes appear to have exacerbated the situation. First, licensing authority has been transferred from the Department of Commerce to the Department of State, which applies the stricter ITAR and whose limited staff is already overloaded. Second, NASA has placed the burden of meeting the administrative requirements for seeking ITAR license approvals on its "contractors", including universities, and NASA has remained silent on the question of how exceptions for fundamental research are to be interpreted. For example, is a proprietary proposal from a university to NASA covered by the fundamental research exemption? The effects of these changes on commercial spacecraft companies has also been widely discussed in the media -- the impact on universities has not and is only now being realized.

The repercussions in the university community have already been serious. For example, there are worries that foreign space partners will show reluctance to contemplate long-term cooperative projects with the U.S. This is understandable if even technical discussions with scientists from other countries to explore possible cooperation could easily be in technical violation of ITAR unless a prior license

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Board Director's Column

The first quarter of the year has been a time to reflect on the lessons from recent space mission failures, to look forward with new optimism toward prospects for future programs and budgets, and to take one last look at the SSB's work over the last year. We will touch on each of those items briefly below.

Mission failure reports

During the first quarter there were at least six reports released to examine aspects of recent NASA mission problems and their implications for the agency's efforts to achieve increased flight frequencies, streamlined project management, and lower mission costs (the "faster-better-cheaper" paradigm). The first was from the Space Shuttle Independent Assessment Team, chaired by Dr. Henry McDonald, released March 7. Two more were made public March 13: the Mars Climate Orbiter Mishap Investigation Board report, led by Arthur Stephenson, and the Faster, Better, Cheaper Review, led by Tony Spear. The last two, and most anticipated,

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is obtained. Other current or potential impacts include licensing delays and mission schedule slips, impediments to proposal preparations with foreign partners, complications in administration of non-U.S. graduate students, and so on. Some universities, including my own, hold strongly to the principle of an open campus and would simply have to refuse grants or contracts that seek to limit participation by students or staff on the basis of nationality.

The SSB has no argument over the need for a sensible regime to control sensitive technology. But something needs to be done to address what I expect are the unintended consequences of the changes in export control. NASA could help in the short term by working with the universities to clarify the rules and exemptions, preferably in a way that preserves the openness of fundamental research. A more global approach would be for all the relevant agencies to come to a common agreement similar to that promulgated in 1985 by President Reagan through his National Security Decision Directive 189. This asserts that national interest is best served when "to the maximum extent possible, the products of fundamental research remain unrestricted." NSDD 189 was issued in response to similar controls that had begun to appear in some federal grants and contracts nearly 20 years ago. It states clearly, that "where the national security requires control, the mechanism for control of information generated during federally-funded fundamental research in science, technology and engineering at colleges, universities and laboratories is classification." In the intervening years, this approach seems to have worked well for both the government and the university community. Reaffirming its principles in the context of fundamental research in space would seem the best way to deal with this issue.

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Board Director's Column

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were the reports of the Mars Program Independent Assessment Team, headed by A. Thomas Young, and the Mars Polar Lander Failure Review Board, directed by John Casani, both released on March 28. In addition, the SSB released *Assessment of Mission Size Trade-offs for Earth and Space Science* in prepublication form on March 15. The executive summary of the SSB report is reprinted later in this newsletter.

Several common themes have emerged from these investigations and evaluations. For example, the reports often suggested that there has been too much emphasis on meeting schedule and cost, that problems weren't communicated, and that fundamental management and engineering principles were not always followed. Further, an inadequate system of checks and balances neglected to draw attention to the signals of trouble, when mistakes could have been fixed. Young's recipe for success is experienced oversight, sufficient testing, and independent analysis.

The SSB report looked more broadly at criteria for making decisions about mission size. A major finding of the study is that a mixed portfolio of mission sizes is crucial in virtually all Earth and space science disciplines to accomplish the research objectives of those programs. The report views the "faster-better-cheaper" paradigm as a set of principles (including but not limited to streamlined management, flexibility, and technology infusion) that are independent of the size or scope of a mission. In short, the "faster-better-cheaper" approach need not be applied solely to "smaller" missions. With appropriate care, those principles can be matched to the science objectives and requirements of any mission. The report also commented that the technology cornerstone of the faster, better, cheaper paradigm has often been confused with science-based mission objectives.

NASA has yet to fully evaluate the recommendations and make improvements in the programs and their management. For this reason, the Mars 2001 lander has been canceled and the instruments will be flown in 2003. In addition, a new architecture for the Mars program will be implemented.

FY01 budget proposals

Members of the space research community could not help but react enthusiastically to news about the administration's FY2001 budget proposals. Overall federal R&D budgets were slated for a 7% increase with NASA, NSF, and NOAA looking at requests for growth over FY2000 of 6%, 17%, and 19%, respectively. Within the NASA totals, the science, aeronautics, and technology account was targeted for growth of $348 million over FY2000, with major portions of that growth allocated to solar system exploration missions including the Mars Surveyor program, a "Living with a Star" initiative in solar and space physics, restoration of the New Millennium technology validation program, and enhancements in life and microgravity sciences. To be sure, submission of the budget request to the Congress is only the first step in a long and often unpredictable process, but early

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From the Chair

On June 30, 2000, I completed my sixth and final year as Chair of SSB. In some ways it seems ages ago since Lou Lanzerotti handed me the gavel—when again it was only yesterday.

Six years ago there was an acute sense of urgency surrounding NASA, engendered by revolutionary changes sweeping through the agency. The launch of the initial ISS element was in the distant future, the concept of a broad program focusing on Origins was awaiting the galvanizing announcement of possible evidence for past life on Mars, and EOS, still envisioned as a long series of large platforms was slowly building steam. It was only in 1996 (the year of Mars rock publicity) that I could perceive a diminution in the turmoil. In 1997 and 1998, events like the success of Mars Pathfinder, the Shuttle/MIR rendezvous and the inaugural ISS launch suggested that, though far from equilibrium, the space program was beginning to settle into a new epoch. The launch of the Chandra X-ray Observatory (my own pet project) and Terra were among the real successes of 1999, but the failure of two ambitious low-cost missions to Mars showed that NASA's transition to new ways of doing business still needed adjustment. NSF and NOAA, the other agencies we regularly advise, had their own sets of issues throughout this period, such as the balance of ground- and space-based research in astronomy and the integration of research and operational requirements for Earth observations.

I am proud of the role the Space Studies Board has played in this history. Altogether, the SSB, with its committees and task groups, issued 56 reports and 24 letter reports during this period. More important than the quantity is what I believe to be the very high quality and impact of our products. That positive view has been confirmed on several occasions in recent years by NRC reviews of our "customers" in the research community, the agencies and on Capitol Hill. Our reports are often cited in planning and policy documents and in congressional language.

For me it has been a great privilege to work with the many hundreds of dedicated volunteers and dozens of talented NRC staff who deserve the vast bulk of credit for the Board's accomplishments. I extend my heartfelt thanks to all of them. I never cease to marvel at the tremendous level of commitment that so many are willing to make in the public interest, and this holds for the civil servants who received the reports as well as those on our panels who wrote them. I must single out the two superb SSB Directors, first Marc Allen and more recently

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Joseph Alexander, both of whom brought extraordinary talents to this very demanding job. My concurrent *ex officio* service on the NASA Advisory Council was, itself, fascinating and rewarding.

My successor, Dr. John McElroy of the University of Texas, brings tremendous experience and ability to the Board and will lead it with distinction. With the increasing importance of space activities to more scientific disciplines, the private sector, and policy makers grappling with issues like global change, the diversity and significance of the Board's reports will also increase. Although the mood at the onset of the new millennium is decidedly more optimistic for space research than it was in 1994, exploration and discovery on the high frontier will always present great scientific, technical and management challenges. I am confident that the Board will continue to help the community meet those challenges.

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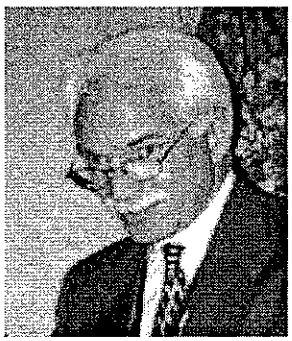

Board Director's Column

The end of the second quarter of 2000 represents much more than any minor calendar milestone for the year. Indeed, it marks the conclusion of a remarkable period of service to space research by retiring SSB chair Claude Canizares. During the past six years Claude has provided extraordinary leadership for the Board during a time when NASA has been undergoing dramatic changes, the research community has been adjusting to new ways of doing business, and the science itself has experienced both breakthroughs and setbacks.

A look at the breadth and depth of SSB activities during Claude's tenure gives one measure of his impact. From July 1994 to June 2000, the Board published over 50 regular reports, covering the full range of scientific and programmatic issues in space science and technology, plus two dozen quick-response letter reports to provide guidance on specific questions from NASA, NSF, and NOAA. Included in these reports were five major science strategies—for space physics, space astronomy and astrophysics, space biology and medicine, microgravity for human space exploration technologies, and ground-based solar research.

One important highlight was the 1995 report *Managing the Space Sciences,* a major congressionally-mandated study of the roles and responsibilities of NASA headquarters and the field centers, alternative organizational structures, research prioritization, and technology development for the space sciences. Other highlights include *Review of Gravity Probe-B*, an in-depth scientific review of a controversial space mission conducted in record time, and *Supporting Research and Data Analysis in NASA's Science Programs*, a broad-ranging assessment of strategic and programmatic aspects of NASA research grant programs. His leadership also has had an impact on issues of international cooperation in space research through the publication of an in-depth assessment of U.S.-European cooperation in space science (U.S.-European Collaboration in Space Science, conducted jointly with the European Space Science Committee) and initiation of tri-lateral interactions between the SSB and counterparts in Europe and Japan.

Perhaps the most notable effort of the SSB during the Canizares years was the 1996 workshop on "Origins." Following the announcement of possible evidence of fossil microorganisms in the martian meteorite ALH84001, the Office of Science and Technology Policy and NASA asked the Board to help convene a diverse group of scholars to consider major questions and future directions for space science. Participants at that workshop converged on the theme of "origins" as an organizing conceptual framework for much of space science. The workshop findings were presented to Vice President Gore in a symposium at the White House, and he described the event as "exhilarating and thought-provoking."

In addition to possessing scientific and policy expertise, serving as SSB chair—or in any other role as a volunteer on NRC boards and committees for that matter—requires a major commitment of time and energy. Claude chaired all Board meetings during his 6-year tenure, participated actively as a liaison member of the NASA Advisory Council, testified several times at congressional hearings, and made countless trips to Washington to meet with agency, congressional, and NRC officials about SSB business.

I think I speak for all members of the SSB, its committees and staff, and colleagues across the space research community in saying that we owe Claude R. Canizares an enormous debt of gratitude for his solid leadership, expert judgement, and tireless service as chair of the SSB.

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