

device (a lighter and more compact version of the country's first ever device, tested in 1974), along with a 0.2 kt device and a 43 kt thermonuclear device. The distance separating the shafts of the two largest tests was 1 km. According to Chidambaram, the thermonuclear shot was not a "boosted" fission device, but used a fission explosion to trigger a fusion blast. The low yield was deliberate to avoid damaging a village 5 km from ground zero. Later, Chidambaram told an Indian TV interviewer that scientists could have produced a 200 kt thermonuclear device, but decided against it for strategic and environmental reasons. The two tests on 13 May had yields between 0.2 and 0.6 kt, said Chidambaram.

Soon after the tests on 11 May, the Incorporated Research Institutions for Seismology (IRIS) reported a single event with a magnitude of 4.7 (on the Richter earthquake scale), which equals a yield of about 20 kt, with an uncertainty factor of 2 or so. The prototype International Data Centre (pIDC), using reports from 62 seismic stations, identified a single event with body-wave magnitude (mb) of 4.7, and more detailed US Geological Survey (USGS) results, based on data from 125 stations, indicated 5.3 mb, suggesting a yield of 25 to 30 kt for the pIDC and 30 to 60 kt for the USGS. The seismic data indicate only one event, not three separate explosions on 11 May, though the 0.2 kt device was probably too small to measure. No signals were detected for the small tests on 13 May. The discrepancies in seismological yield might be explained by differences in the assumed constants in the yield relative to the Richter signals, the announced yield is incorrect or the data do not take the geology of the site into account. "Determining the yield of a nuclear test from seismic data is an art, not an exact science," explained David Albright, president of the Institute for Science and International Security in Washington.

The readings appear fairly consistent with India's claims, said Suzanna van Noyland of the Verification Technology Information Centre in London, though they are "ambiguous when compared with datasets of US underground tests [in Nevada] and Eurasian earthquakes." The simultaneous explosions explain why only one seismic event was seen by scientists around the globe. Indian officials claimed the three tests totaled 55 kt, but US weapons lab scientists put the combined yield at about 15 to 25 kt. The different values underscore the problem of monitoring nuclear explosions—a centerpiece of the Comprehensive Test Ban Treaty that India and Pakistan have so far

refused to sign.

At their press conference, the scientists refused to describe the types of fission materials or the components of the thermonuclear device.

Pakistan evened the score against India in a tunnel dug into the Ras Koh range in the Chagai region of desolate southwestern Baluchistan. Little effort was made to disguise Pakistan's preparations for the tests from satellite detection. Nonetheless, the statements issued after the five shots on 28 May were often confusing and contradictory. A. Q. Khan, an engineer regarded as the

father of Pakistan's uranium enrichment program and the Ghauri missile, said that the yield of the largest of the five devices was 30 to 35 kt and that the others were of small, low-yield weapons ideal for battlefield use. But seismic data from IRIS suggest that the total yield was in the range of 8 to 15 kt, raising widespread suspicion that Pakistan exaggerated both the number and yield of the tests. Notwithstanding, Khan said at a news briefing on 30 May that the tests went "exactly as planned and were as good as we were hoping."

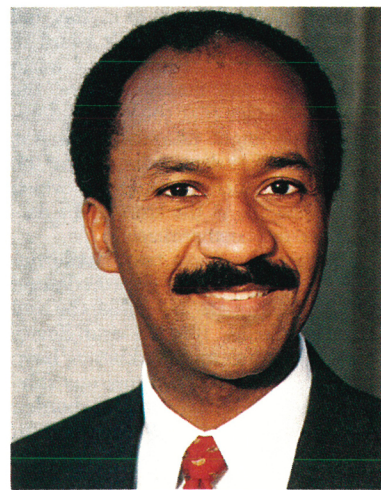
IRWIN GOODWIN

With Big Budget Increases Unlikely, OMB Head Scolds Scientists as Unhelpful

Despite the bipartisan support in Congress for science and technology funding increases in fiscal 1999 and the bonanza of scientific discoveries celebrated over the airwaves and in the headlines in recent months, most lawmakers now doubt that President Clinton's double-digit R&D requests will be passed this fall. In fact, except for such popular agencies as the National Institutes of Health and the National Science Foundation, the funding outlook for R&D is not much better than it was before Clinton's proposal. It turns out that science may be a victim of its own success. The pace of advances is so swift that not even many scientists can keep up with the fields, and Congress, which never had more than a handful of members who understood science, is beginning to argue that the nation's R&D may be moving too fast for its own good.

Clinton's increases were neatly assembled in the \$31 billion Research Fund for America (RFFA), which was designed to raise the Federal investment in non-defense R&D to \$37.4 billion in 1999, a boost of \$1.8 billion, or 5.1%. The plan would bolster Federal support for academic research to \$14.5 billion, or 6.1% (PHYSICS TODAY, March, page 71).

But spending limits contained in last summer's agreement to balance the Federal budget, along with the declining likelihood that Congress will pass legislation providing for a tobacco settlement—which the White House had counted on yielding as much as \$65 billion over five years in annual payments from cigarette manufacturers—make enactment of RFFA improbable. Indeed, the increases Clinton had urged Congress to appropriate would clearly exceed the spending limits of last year's Balanced Budget Act. Without the tobacco windfall, lifting the budget caps would require making use of the projected budget surplus,



RAINES: 'More' is not the right answer.

estimated at \$39 billion this year by the White House and as much as \$60 billion by the nonpartisan Congressional Budget Office. The catch in this is that the President has promised to apply the surplus to jack up the Social Security trust fund.

A few months before Clinton's budget request was sent to Capitol Hill, a bipartisan group of senators, led by Phil Gramm, a Texas Republican, introduced the National Investment Act of 1998 (S. 1035), which would authorize Congress to double the funding of all civilian science and precompetitive technology over the next ten years (see PHYSICS TODAY, December 1997, page 49). The proposed legislation was quickly backed by 103 science and engineering societies and more than 40 research universities.

The bill has been endorsed by 17 of the Senate's 100 members, but when it was discussed before the science, space and technology subcommittee of the Senate Commerce Committee, the measure was greeted with skepticism

by the chairman, Bill Frist, a Tennessee Republican who was a heart transplant surgeon before running for office in 1994, and the senior Democrat, John D. (Jay) Rockefeller IV of West Virginia. After the hearing, each expressed criticism of the sums involved and stated that they would "most likely" introduce a new bill "tied to indices" such as the rate of inflation or growth in GDP.

On the House side, lawmakers voiced doubts that such measures had any chance of passing Congress this year. Wisconsin Republican James Sensenbrenner Jr, chairman of the House Science Committee, labeled it an "unrealistic exercise" and California Democrat George E. Brown Jr, who headed the science committee before the Republicans took over in 1995, called it "a basic scam by a few senators who are sloganeering and neglecting the real issues, like our aging population, our uneducated youth and the disparity between rich and poor in the country."

The Senate's effort was attacked by Franklin D. Raines, a Harvard-trained lawyer and investment banker who was director of Clinton's Office of Management and Budget until a month later, when he rejoined the Federal National Mortgage Association (known more familiarly as Fannie Mae) to be its designated chairman. In one of his last public speeches, at the annual R&D colloquium of the American Association for the Advancement of Science in April, Raines scolded scientists and engineers for not rallying immediately to Clinton's proposed RFFA. "I don't believe I've seen very much in the way of letters and testimony saying that the President has got it right, that we ought to look at research across the board with a long-term plan," said Raines. "Even with the strong support [for R&D] in the President's budget, no one should be under the impression that there's going to be an unlimited amount of funds for research. The elimination of the deficit doesn't mean double-digit increases across the board."

Raines then posed five questions on what scientists might do to help government policymakers and lawmakers raise their commitment to R&D. First, "how large a scientific enterprise does this nation need? 'More' is an inadequate answer. . . . Wish lists do not fund programs. Strong justifications, tough choices, good performance and aggressive follow-through until enactment into law do."

Second, "how do we set our priorities in the nation's R&D enterprise? Because resources are not unlimited, choices have to be made. They will be made by policy officials and elected officials who are not specialists. How will those officials be informed about the right choices?"

Third, with people at the White House level asking how the success of Federal programs could be measured, Raines considered it necessary to evaluate the outcomes of research programs. The Government Performance and Results Act requires this, but some scientists seem to scoff over the idea that research is measurable. "Productivity should not be a dirty word in science," said Raines. "We need not do things the most expensive way because that's the way they've always been done before."

Fourth, how can government-university partnership be evaluated? "The idea of support [too often] has the connotation of entitlement," he observed. "I think we need to have a real discussion of the relative roles of the Federal government and the research universities, such as peer review versus earmarks. Are earmarks fair game? Science itself is often a high-tech version of old-fashioned pork-barrel politics."

Finally, how can the American people be "engaged in the excitement and wonders of science?" Most people cannot devote time to keeping up with discoveries and need help in understanding the latest research findings, which are sometimes contradictory.

Moreover, the importance of the research to the public is often unclear and unexplained. "There are fields where the connection [to society] is very hard to show. . . . [For example] the public is never going to understand high-energy physics."

In the question period, Raines warned that "the battle [in Congress] over priorities" in expenditures for public housing, water projects, veterans benefits and other domestic matters that are in the same budget area as R&D "is not going to be very pretty." He also repeatedly called on the research community to engage the White House on priorities. "If you think our priorities [for NIH or NSF or the space station, say] are wrong, you should engage us. But the incremental dollars cannot go to special interests in the science communities."

Raines's talk displeased some in the audience. The malcontents maintained that his accusation about inaction over Clinton's budget was untrue. Science societies had backed the President in letters and e-mail to Congress. Raines's five points were harder to deal with. Most required answers that were difficult or impossible to come up with.

IRWIN GOODWIN

Physicist Rush Holt, a Senator's Son, Seeks New Jersey Seat in Congress

In his effort to become the second PhD physicist in Congress, Rush D. Holt Jr, who has been assistant director of the Princeton Plasma Physics Laboratory for the past nine years, defeated Carl Mayer, a wealthy lawyer in Princeton, New Jersey, to win the Democratic nomination in the state's 12th Congressional District. Holt won the primary election with 10 055 votes (63%) to Mayer's 5860 (37%), though Mayer outspent Holt by a whopping margin. Mayer's campaign cost about \$550 000, much of it his own money, while Holt spent \$150 000.

Holt, who was endorsed by party leaders in the three counties of the 12th District, will now vie for the seat in Congress held by Michael Pappas, a conservative freshman Republican. Pappas won in 1996 with 50% of the vote in a three-way race. Though the district traditionally is moderate Republican, Pappas usually votes with most of the Republican Class of 1994, who disdain "big government" and want to reduce the budgets of many nondefense agencies. As a sign of how seriously both major parties viewed the district's last election, Bill Clinton and Bob Dole came to speak for their respective candidates. This time, Demo-

crats have targeted the district as a close race—one that may help them win back the House of Representatives, which Republicans captured in the 1994 midterm elections.

Holt earned a master's degree and PhD in physics from New York University, taught at Swarthmore College from 1980 to 1988 and spent the year 1982–83 as an American Physical Society Congressional fellow in the office of Representative Bob Edgar, a Pennsylvania Democrat. In 1988–89, Holt was a science specialist at the State Department, working mainly on arms control problems, before he joined the Princeton Plasma Physics Lab.

In his campaign, Holt is emphasizing his science background as well as his concerns about political and environmental issues. His career would enable him to bring to the House, he tells audiences, "technical expertise that is so rare in Congress and political expertise that is so rare in science." The only other PhD physicist in the House now is Vernon Ehlers, a third-term Michigan Republican who formerly taught at the University of California, Berkeley, and at Calvin College. Ehlers, now vice chairman of the House Committee on Science, is completing