saying it's necessary to apply more consolidated, more concentrated, more creative thinking about R&D, and about science and engineering and about the education that goes with it than in the past.

Q. You have spoken about Congress. What about the executive branch? What sort of procedure would be followed there?

A. Well, there is the President's science adviser. The science adviser doesn't oversee all the R&D and science education programs in the Federal establishment, but it oculd be his job if it were legislated.

Q. Looking back in the four years of your stewardship at the foundation, what do you see as your greatest accomplishment?

A. I think bringing some new directions to the foundation—placing engineering research in its portfolio and enlarging the spectrum of constituencies that the foundation serves, so that our mission is coupled to the aspirations and agenda of the nation. In the last few years the foundation has addressed broadening the participation in science and engineering among women and minority groups. The foundation is in the forefront of a movement to bring industry and academia together for their mutual benefit and to establish a relationship between the educational and research efforts of the states and the Federal government. And I've tried to push the foundation onto the center stage in national science policy by emphasizing the contribution it can make through science and engineering.

Q. In testimony before Congress, you have often made the point that science and technology are vital to our world trade competitiveness. Don't you consider one of your accomplishments pushing and pulling NSF into the modern world? Or at least the realization that science research is the centerpiece of high technology?

A. Well, I hope the realization existed before I came. You're right. I want to make sure the foundation gets recognized as the country's key institution not just in research and education but for its contribution to the country's economic success.

Q. What do you look back upon as your disappointments at the foundation?

A. Well, my disappointments always are that things don't move faster, obviously. You mentioned before that we hadn't made headway on the doubling of the NSF budget. That was a major disappointment last year. We came close, but close isn't good enough.

IS THIS ANY WAY TO ADVISE PRESIDENTS ON SCIENCE AND TECHNOLOGY PROBLEMS?

A President can get advice about scientific issues or technological concepts simply by asking whomever he wants whenever he wants it. Once the advice is gotten, the President can accept, reject or just ignore the counsel, no matter how clever, credible, cautious or compelling. Neither the laws of physics nor the rules of reason seem to prevail when the main tenant of the White House wants an answer that's not in line with prevailing scientific wisdom.

Do Presidents really care? Not so you'd notice, if the actions and decisions of recent Presidents give any indication. In 1972 President Nixon sacked his science adviser and scrapped the whole office because he didn't like the advice he got on two pet projects—deployment of antiballistic missile defenses and construction of a supersonic passenger plane. In another instance, President Reagan didn't consult either his official science adviser, George A. Keyworth II, or the White House Science Council before announcing to the nation at the end of a television talk in 1983 that he was launching the Strategic Defense Initiative, soon to be dubbed "Star Wars." If he had, Keyworth and some council members later confided, they would have advised him to call the whole thing off.

Science advice to the White House, so it appears, is based on Machiavelli's 16th-century maxim: "A Prince- . . . should always take counsel, but at such times and seasons only as he himself pleases, not when it pleases others."

Many scientists would prefer a better way to reach into the Oval Office. So, with the elections approaching on 8 November, they and their fellow science policy makers are offering plenty of advice about how the next President ought to arrange to receive counsel. Their campaign is intended to win the attention of the two Presidential candidates so that a White House science advisory office will be in place when the new Administration takes over on 20 January.

Clearly, this year's all-out effort is traceable to the widespread criticism of recent science advisers and of the White House Office of Science and Technology Policy, which has been accused, among many wrongs, of playing politics with science—a practice that began long before the Reagan years.

The first blow for better Presidential science advice came on 13 February at an all-day session during the annual meeting of the American Association for the Advancement of Science in Boston. Among the participants were H. Guyford Stever, who learned how to wend his way through the Washington political maze as director of the National Science Foundation while he served as President Ford's science adviser, and Lewis M. Branscomb, who has been director of the National Bureau of Standards and vice president for research of IBM and is now a professor at Harvard's John F. Kennedy School of Government as well as science maven to Michael Dukakis, the Democratic Party's Presidential candidate. This forum was followed four days later by an unprecedented hearing at which five former White House science advisers testified before the House subcommittee on science, research and technology. Both occasions were opportunites to deplore the current state of advice to the President on science.

Since then the debate has proliferated. Early in this year's primary elections the Federation of American Scientists asked each of the Democratic and Republican candidates for their views on science advice and received responses only from three also-rans. In June, with the field narrowed—to Vice President George Bush, the Reverend Jesse Jackson and Dukakis—the federation tried to organize a science policy symposium on Capitol Hill, only to discover that there was little interest. Some scientific and engineering organizations have written the candidates about their concerns. The American Physical Society, for one, sent along a resolution adopted by its council in May, calling on "the next Administration to put into place a prestigious and influential science advisory office to address the opportunities that science and technology offer for the 1990s."

The first salvo against the White House's existing science advisory apparatus came from two of the nation's

most prestigious and influential scientists, John Bardeen of the University of Illinois and Hans Bethe of Cornell. In an op-ed article appearing in *The New York Times* on 17 May 1986, the two Nobel Prize-winning physicists deplored science advice to Presidents since 1972 as "remarkably haphazard." As a consequence, they wrote, "the nation is embarked on vast programs based on the misconceptions that we have an unlimited supply of scientific talent and that there need be no relationship between cost and benefit." As a case in point they cited the way President Reagan launched the SDI without consulting either his own adviser or the White House Science Council, which had completed a study of missile defense technologies just before the "Star Wars" speech (see PHYSICS TODAY, July 1986, page 45).

A year later, on 27 April 1987, Jerome B. Wiesner, the former MIT president who became science adviser to President Kennedy, continued the barrage during an address at Washington's Cosmos Club. In it he connected the "disintegration" of the US space program and the descent of US industry in world markets to the demise of the long-lamented President's Science Advisory Committee, better known as PSAC.

The most concentrated assault has been mounted by William T. Golden, a Wall Street lawyer who was asked by President Truman in 1950 to recommend an administrative framework that could help Truman make scientific and technical decisions. Golden proposed a full-time adviser working in association with a Presidentially appointed part-time committee of distinguished scientists. This concept was opposed by the heads of the Atomic Energy Commission and the Department of Defense. Even so, Truman decided to accept Golden's idea, but he kept the advisory panel out of the White House, placing it instead under the director of the Office of Defense Mobilization, General Lucius Clay. Clay wasn't the least bit interested. The panel languished until the Soviet Sputniks, when President Eisenhower resurrected Golden's plan, appointing James R. Killian Jr of MIT as his special assistant for science and technology and reorganizing the panel into PSAC.

By all accounts, the period that began with Killian and PSAC in 1958 and ended with Nixon's petulant dismissal of Edward David Jr as his special assistant was the "golden age" of White House science advice. Golden insists that "our country has been the poorer" since, under a mélange of advisory arrangements. He supports his case in a collection of 85 essays from practitioners, politicians and others in the tiny field, all assembled in *Science and Technology Advice to the President, Congress and Judiciary* (Pergamon Press, 1988).

Science advice in the White House Oval Office was initiated by James R. Killian Jr (upper left inset) in 1958. Clockwise from Killian: the most influential Presidential adviser, Jerome Wiesner; the man who proposed the job to President Truman, William T. Golden; and the two Nobel Prize winners who first deplored the current situation, John Bardeen and Hans Bethe.

The essayists, who range from William O. Baker (Rockefeller University) to Alvin W. Weinberg (former director of Oak Ridge National Laboratory), reach a consensus, but are not unanimous, about the need to strengthen the Presidential science and technology decision-making process. Most favor reestablishing the Eisenhower scheme of an in-house adviser and a committee of outstanding experts, similar to PSAC. There are other views. Frank Press, President Carter's science adviser and now president of the National Academy of Sciences, suggests elevating the position to Cabinet rank, possibly as a Secretary of Science without portfolio. Keyworth opts for a full-fledged Department of Science with a Cabinet secretary at the helm.

In one of the most thoughtful essays, David A. Hamburg, president of the Carnegie Corporation of New York, examines the science adviser's job and sets down, first, what it is not: "1) a lobbyist for the scientific community, 2) an uncritical salesman for the President's policies, or 3) a wizard who personally covers all of science and technology in depth." He goes on to state that "to do the job well, the science adviser must develop: 1) a relationship of trust, mutual respect and open communication with the President, 2) a wide-ranging set of study groups to focus on important questions at the highest level of quality, 3) an ability to tap into the scientific community and its institutions in an ongoing, broad-based way—both in government and outside it, and 4) an earned reputation for integrity with no possibility of precooked answers to technical or policy questions."

The strongest case in Golden's book for the importance of Presidential science advice is offered by the only recipient of such counsel, Gerald Ford, who signed the law restoring the White House science office in 1976. "Presidents don't like surprises," he writes. That may be the best argument for putting scientific knowledge and understanding at the service of the Presidency.

—IRWIN GOODWIN ■