ERICH BLOCH: ON CHANGING TIMES AND ANGRY SCIENTISTS AT NSF

In August, Erich Bloch will begin his fifth year as director of the National Science Foundation. Although the director is appointed by the President for a statutory six-year term, none of the last four has served longer since H. Guyford Stever, who held the job from February 1972 to August 1976. In Bloch's four full years he has overseen more changes at the agency than all the agency's other leaders combined in the past two decades.

Indeed, not since 1968, Leland Haworth's last year as director, has NSF taken on so many different programs and been subjected to so much criticism. In that year Congress increased NSF's responsibilities to include applied research, social sciences and international functions, at the same time hiking its annual budget to around $400 million. This year's budget is $1.7 billion, but the foundation has expanded in so many directions, each requiring large outlays, that some of the traditional programs, such as physics, chemistry and astronomy, have been hard pressed. While committing the agency to new functions and curtailing some old ones, Bloch has earned more cheers and calumny than any of his eight predecessors, going back to NSF's founding in 1950.

Bloch has a remarkably high profile for an NSF director. His predecessors were essentially backroom boys, not noted for controversy or celebrity. Bloch is different. He enjoys testifying before committees of Congress and speaking to scientific societies, university groups and professional forums. He sometimes doesn't even wait for a question period to display his combativeness. At a joint meeting of the American Association of Physics Teachers and The American Physical Society last January he deliberately provoked turmoil by suggesting that NSF might stop funding high-energy physics because another agency, the Department of Energy, was already providing most of the money for the field (PHYSICS TODAY, March, page 41).

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Erich Bloch: A feisty fourth anniversary.

He also enjoys battling with news reporters. At the informal, no-holds-barred press conferences he calls at the end of the monthly National Science Board meetings, Bloch exchanges jabs with reporters and occasionally flattens one with a punchy question of his own. When he was at IBM, which he joined in 1952 after being trained as an electrical engineer at the University of Buffalo, he earned a reputation for his scrappy and self-confident managerial style.

Bloch's entire professional career was at IBM, where he was engineering manager of the company's STRETCH supercomputer system in the 1950s and early 1960s and later headed the firm's solid-logic technology program, which developed the microelectronic technology for IBM's System 360 mainframe computer. In 1981 he became vice president of technical personnel development.

Soon afterward, Bloch's no-nonsense approach to problems attracted George A. Keyworth II, then President Reagan's science adviser, when they met at meetings on industrial policy and technical education. An aide to Keyworth at the time recalls, "Jay immediately resonated with Erich's ideas, and when the subject of filling the vacant position of deputy director at NSF was discussed, Bloch's name always came up." Keyworth convinced White House officials that Bloch would be ideal for the job, even though Bloch was a registered Democrat. "Everyone knew the NSF job required competence, not ideology," says the former White House executive. While Bloch was being screened for deputy NSF director, a process that he wasn't aware was going on, Edward A. Knapp, the agency's direc-

tor, announced his resignation to return to research at Los Alamos. Keyworth convinced Bloch to head the foundation.

The choice of Bloch was faulted by many scientists. He became the first NSF director without a PhD. Though not the first engineer to run NSF, he had no experience as an academic. He had virtually no boosters in research circles.

Stocky, with jet-black hair and an intense gaze, Bloch is a pragmatist who is described by NSF staffers as running the agency with an iron fist. "He is fully in charge," says one. Bloch's champions say he has shaken NSF from its staid complacency, reordered its priorities amd boosted its budgets by his shrewd linkage of research to the politically trendy issue of industrial competitiveness. His critics argue that he is a heretic from the NSF orthodoxy of supporting academic basic research, as revealed in Vannevar Bush's 1946 holy writ, *Science—The Endless Frontier*. Both of these views of Bloch were represented more than a year ago in an article in *The New York Times* Sunday business section under the headline "The NSF's Maverick Chief Pushing Ivory Tower Scientists into the High-Tech Race."

Born in Germany in 1925, Bloch and his family fled Nazism for Switzerland in the late 1930s. There he studied at the Federal Polytechnic Institute in Zurich; he completed his bachelor's degree at the University of Buffalo in 1952.

In the following edited interview with PHYSICS TODAY's Irwin Goodwin, Bloch reveals his vision of NSF place in the world of science and technology as well as other matters of Washington science policy.

Q. When you were appointed director of NSF in 1984, there was considerable agitation among university scientists that you did not come from their community. Your predecessor, Ed Knapp, who was uplifted from Los Alamos, suffered the same criticism. What was your reaction, or did you ignore the complaints?

A. I never ignore anything. The argument showed, really, that my critics did not know me, number one, and, number two, that the community believed there was some kind of a requirement or agreement that only someone from an academic institution could qualify and serve as NSF director. The community also didn't realize that the world had shifted on its axis while they were in their ivory towers. In 1984 NSF was no longer just concerned with scientific research, as it had been when it was created in 1950. After World War II, the United States dominated the world of science and technology. This is no longer so. The relationship between academia and industry is different. No longer is research at arm's length from application in many fields—biotechnology, computers, materials science and many others.

Q. Despite this, there are many scientists who claim that NSF is strictly the preserve of academic research and consequently should not be involved in engineering or applications.

A. Well, if that concept is still around, those critics sure haven't read our statutory authority. Congress changed our original organic act in August 1986 to make clear that the foundation is not limited to science research and education but will henceforth initiate and promote research and programs in engineering as well. If the idea that the foundation supports only science still prevails, it will have to change. Many people resist change, of course.

If funding facilities would distort the foundation's priorities, it would have some dire consequences for researchers

Q. NSF's additional mission, it seems, has contributed to some misunderstanding about the agency. The scientific community—some parts of it at least—opposed the introduction of engineering centers, supercomputer centers and the prospective science and technology centers. At issue in the furor was—and continues to be—the balance of "big science" vs "small science." Many contend that the purpose of NSF is to provide research grants to individual investigators. The concept of centers, they argue, violates that principle. I remember you telling a group of physicists that "centers are not a gimmick; centers are not a way of increasing the NSF budget. Centers are one of the best ways of doing multidisciplinary research and training more scientists and engineers in a period when research costs are increasing rapidly. Centers are not a way of doing applied science."

A. That's correct. I have said that. Now what's your question?

Q. Despite all your assurances, some people out there fear that NSF's support of centers will result in less funding for individual investigators. How do you allay that fear?

A. I don't know if you can allay it completely—and maybe that's not necessary. I think we have to tell people just what it is that we are supporting—the proportion of the NSF budget that goes to centers as well as the percentages that go to individual disciplines, to research facilities and to science and engineering education at all levels. I recently discussed these different accounts with the governing council of the National Academy of Sciences. I showed the council that the total cost of the centers, including the Materials Research Laboratories, the Engineering Research Centers and the projected Science and Technology Centers, equaled less than 10 percent of the whole NSF budget. What's the big deal?

You made the point in your question that some people insist that the mission of the foundation is to support individual investigators. Our mission is to make sure we are supporting basic science and engineering. That's our mission, and whatever is the best way of doing that should be pursued. It isn't likely that the best way is only individual grants or only centers. We need a balance among different research programs, approaches and procedures.

Q. Let's look at NSF's budget. In his 1986 State of the Union address President Reagan called for doubling the NSF budget in the next five years. That hasn't happened . . .

A. Well, the five years aren't over yet!

Q. . . . and Congress is not moving with much resolve to double your budget. President Reagan's request for a 19 percent increase for NSF in fiscal 1989 is likely to result in a 9 percent or 10 percent boost. Quite good considering the dire financial condition of the Federal government, but still short of a doubling. For 1990 the foundation is likely to seek a 13 percent or 14 percent overall rise over the 1989 budget. Where will the increases go? Are you possibly too farsighted—concerned with the future rather than with more immediate problems facing the foundation?

A. First of all, in an agency that is essentially concerned about the future, if we don't look to the future we would not be making the right decisions. A "one year at a time" approach to life in an agency like NSF—or, I'll make it more general, in most Federal agencies—is disastrous. Our

programs run for five to ten years. Our grants vary from one year to three years. If we were to operate wholly on a year-to-year basis, we would always be turning things on and shutting them off.

Some people are saying that NSF is not on the road to doubling its budget. I don't think there's anybody in Congress or in the Administration or anywhere else who would disagree that doubling our budget is central to the nation's future. They all agree with that. Unfortunately, this year the resolve in Congress wasn't there. But we're not going to give up on that goal. The Administration isn't giving up. I hope that the new Administration elected next November will take that on as an obligation.

Now let's talk about 1989. Your remark about 19 percent is not quite correct. That figure included $150 million as a single appropriation to be made at the start, in order to fund 12 to 15 Science and Technology Centers for their first full five years. Congress says it won't do that and instead proposes to fund the centers one year at a time. So without up-front funding to support the centers for five years, NSF is asking for a 13 percent increase for the fiscal year beginning on 1 October.

Q. And 13 percent over five years would just about double the NSF budget?

A. Right.

Q. One of the authorizing committees of Congress recommended that NSF get back into the business of funding university facilities and equipment, as it had done in the 1950s and 1960s. At the time this was central to building a case for larger appropriations for the agency. What are the implications for NSF of funding buildings and equipment on our college and university campuses?

A. First of all, it would give us another job—a very difficult one because the money that Congress talks about doesn't make a dent in the enormous pent-up need.

Q. The 1986 White House science office report on upgrading research at universities spoke about spending at least $4 billion per year over the next ten years to restore and upgrade facilities and equipment. Doubling NSF's budget would result in $3.2 billion in 1993 for everything—hardly enough for funding facilities too.

A. My concern with the facility money is that it comes out as a zero-sum game for the foundation. And if that's what it is, it would hurt research tremendously. I don't think we can have this. Equally important, we have said all along that our priorities involve the support of people through science or through centers or through educational programs and so forth. Our second priority is instrumentation, and after that, facilities—bricks and mortar. If funding facilities would distort our priorities, I think it would have some dire consequences for research.

Look, I've lived in bad buildings all my life in industry. Even in the business world things are not always as they are cracked up to be, and buildings were always last. You tried to protect your investment in people first, then in instrumentation.

Q. Once NSF has an annual budget of more than $3 billion per year, wouldn't the agency have the kind of visibility that might make it vulnerable to Congressional pork barrel antics? Do you see that as a danger?

A. Yes, that is a danger. But you can't have it both ways. If a budget of $3 billion is justified to bring science and engineering and education to the state they should be in our country, then you have to face the consequences. One other thing: Up to now we had the support of our two appropriations committees in keeping pork out of the foundation. We have depended on the political sense and personal forcefulness of the two committee chairmen—Senator William Proxmire and Representative Edward Boland. Now both of them are retiring from Congress. I hope that the new chairmen in the 101st Congress are going to continue protecting NSF from political pressure for pork, which could wreck our merit review system. The *sine qua non* of NSF is scientific and engineering excellence. That must remain inviolate. Once special interests or pork is allowed in, then I don't know what happens to the quality of our science, our engineering and our researchers.

I hope the 101st Congress will continue protecting NSF from political pressure for 'pork,' which could wreck our merit review system

Q. Do you see a future for education funding in NSF?

A. Sure. The education budget at the foundation resembles a fever chart over the years. But in the last four years education has done better than research.

Q. Does NSF get enough innovative ideas for education? Education seems to be in a depressed state in this country. To use a four-letter word to describe the situation, education is in a "funk." We are not attracting enough young people into science and technical fields. We're not attracting enough women and minority students into those fields. What can the foundation do?

A. Well, let me say first that the foundation by itself cannot solve this problem. We do not pretend we can. The best we can do is focus on the problem, put some demonstration projects in place and then hope that if the projects work out, other Federal agencies, along with private and state organizations and local school boards, will continue to support the best ones. The foundation will spend roughly $120 million on pre-college educational projects this year, while states and localities will lay out billions of dollars.

Now when I say "education," I'm going beyond what is in NSF's science and engineering education directorate and looking at the education capabilities and programs of the foundation. We have the responsibility to advance capabilities along the whole educational pipeline. I don't think any other agency, whether state or Federal, has that mission.

So, can we solve the problem? No.

Q. Are there any brilliant new ideas to apply to the nation's educational problems?

A. You know, it doesn't necessarily take brilliant new ideas. What is needed is a focus on the best ideas. There are a lot of good ideas around. Any improvements or reforms in education start with the existing base and then building on that. There are new delivery tools around today, computers and videocassettes and so forth, that we certainly can utilize. We are also trying to make sure that we are upgrading some of the teaching materials in pre-college as well as in undergraduate science and mathematics education.

Q. The National Science Board is completing a five-year planning exercise for the foundation. During the course of that, the board is revisiting its responsibility under the 1950 organic act for the overall health of science and technology in the US—an obligation that goes well beyond NSF. Should the Science Board undertake its statutory obligation?

A. Obviously, I am highly in favor of this. In fact, what led the Science Board to think about it were the

conclusions of a special task force I headed this year. The task force, consisting of people from inside and outside NSF, was asked how to position the foundation in the 1990s. One of their major recommendations was that the board take on an overall evaluation of science beyond NSF.

Q. Do you see this role for the Science Board as a possible way of dealing with the widely held perception that the President lacks sound, bottom-up advice on science policy?

A. No, I don't think one has anything to do with the other. The Science Board cannot deal with day-to-day issues that confront the executive agencies or the White House science staff. The board can't even deal with day-to-day matters as they apply to the NSF. And they shouldn't. It's a policy board, so it has to be highly selective in what it takes on. Moreover, it examines things that are of pervasive and prolonged impact.

Q. So it's unlikely to take on technology questions involving, say, the Stealth bomber or false research reporting in the biomedical field.

A. I would think not. That's not what it should be doing. It certainly should be concerned with broad questions of scientific balance and funding. It might even consider setting program priorities in science when scientists and Congress know that every new idea can't be funded. By the way, I'm not suggesting what it should take on. That's up to the board to decide. The board has to come to grips with that.

Q. Do you think the scientific community would welcome decisions by the board on research priorities?

A. No, no. It's not decisions that the board can make. It can express judgments and recommendations, concerns and warnings.

Q. Issues such as the Superconducting Super Collider or AIDS research, are those the kinds of projects the Science Board would deal with?

A. I wouldn't think those would come before the board. It could consider broad priorities among major kinds of projects, not how good one project is by itself against another. The board isn't likely to assess a particular program or investigate the progress of a particular project. The board would be out of its element when it undertook something like that.

Q. What is your view of scientists trying to rank and balance priorities among fields?

A. Well, that's a very difficult question. But let me not talk about scientists, but about the scientific community. There's no doubt in my mind that over the next five to ten years we are going to be in a constrained financial environment, so that priority setting will be much more important than it has been in the past. In the past, if you didn't get funds for a large project one year, well, you got money the next year. Did you always get everything you asked for? No, but you got enough so that you never were forced to make some tough decisions.

Choices will be made about where the money goes—to NASA or to NSF—just because we happen to be in the same appropriations bill. And don't think for a minute there's not a one-for-one trade-off. There is.

If the scientific community doesn't get its own house in order and is unwilling or unable to set priorities, then the priorities will be set by somebody else. Or, what's worse, nobody will do it. In that event, the science agencies may receive subcritical allocations so that their projects or programs will lack the resources to do a competent job. As a consequence, people will look back ten years from now or five years from now and lament that American science and technology have lost ground compared with the rest of the world. That's the specter that hovers over research.

The situation now in science is that the chemists have their own special interests, the physicists have their own interests, the astronomers their own and the biologists have theirs. And within those disciplines there are subinterests and subgroups, and they're squabbling among themselves.

Q. Do you have some advice?

A. First of all, as a minimum, what the community could do is set priorities within a specific discipline. There are a few disciplines that have done that successfully. Astronomy, for example. NSF funded the Very Long Baseline Array radiotelescopes because that's what astronomers themselves decided was the most important new instrument. If they hadn't agreed on the priority for the VLBA, I don't know what would have happened. We couldn't do that and three other things. We only could do one. So the astronomy community deserves high marks for making hard choices.

Mathematicians also have done that. They could have chosen many things, but they opted for more graduate students. That was a deliberate choice on their part because they decided they had to rebuild mathematics from the bottom. We followed their advice, and as a consequence the NSF budget the past three or four years shows how we protected mathematics when it bumped up against our budget restraints.

Now it's very difficult for individual scientists to set priorities among disciplines. I think that's asking for too much. I don't think we should ask that. But there are some ways of setting such priorities. For instance, within the foundation we make decisions daily between one discipline and another. I think the various NSF advisory committees must help us to do that. Many times the tough choices are made within a directorate—among, say, mathematics and physics and chemistry and materials science and astronomy, which happen to all be in one directorate. The advisory committees help us make some of these decisions, but it's up to the foundation to make the final management decisions.

> In this era of austere Federal budgets we are becoming accustomed to steady support or maybe cutbacks

It also happens that when the foundation budget is up for consideration, some scientists will march up Capitol Hill to feather their own disciplinary nests to the detriment of all the others. So it's important that scientists help the government to establish priorities and to live with the choices that are made, even if it's to the detriment of one discipline.

Q. Some advisory committees have been rather brutal in their criticism of the foundation and of you in particular about the priority setting . . .

A. We expect that.

Q. . . . in materials sciences, say.

A. I didn't ask them to approve our decision to reduce the funding allocations in solid-state physics or materials research theory.

Q. Along with the outcry from several outstanding researchers, such as Philip Anderson and Robert Schrieffer, there is concern from a wider constituency on campuses that perhaps the foundation made a wrong decision in setting its priorities, particularly when the foundation has emphasized its support of high-temperature superconductivity.

A. Look, I think some individuals have not taken the time to under-

stand what goes on. They see bits and pieces. They see anecdotal details but they don't see the entire picture. In 1988 we increased our support for superconductivity over 1987 by a significant amount. We are spending something like $15 million now. So criticism that NSF cut that program just isn't true. We clearly made some mistakes. In 1987 some of our program officers were too optimistic about the proposed 1988 budget, and they spent some money in 1987 that came due in 1988.

Q. A promissory note?

A. A promissory note, right. We're not going to do that again, that's for sure. At the moment of truth we had two choices: We could have funded all the ongoing projects per the promissory notes, but there would have been nothing left for new investigators. We decided that was the wrong thing to do for the foundation and for science. So, to avoid the wrath of the whole community, we did the right thing by taking the second choice. We reduced some grants, including those of several long-established scientists, below our projected figures. We are now suffering the brickbats.

Q. The Astronomy Advisory Committee recently expressed concern about the foundation's intention to close down a few older radioastronomy centers, such as the Haystack and Owens Valley observatories, in order to operate the VLBA when it is completed. How are you dealing with this?

A. Look, I don't think it has anything to do with astronomy. It's a general kind of problem. In an environment where you have to watch your dollars, as we have to, and where the increases are not what they should be, you still have to do new things. And in order to do new things, you have to give up some of the old ones, not because they are bad—that's not the point. If you don't move forward, then you retrogress.

Q. Last January you dropped a "Blochbuster," if you'll forgive the pun, at a meeting of physicists. Your listeners were shocked when you suggested that the foundation should stop supporting particle physicists because another agency, the Department of Energy, had a high-energy physics program that is much bigger and more pervasive than the foundation's. The reaction from particle physicists could have been predicted. What led to your "modest proposal"?

A. Well, what led to it was the same concern that I have expressed about priority setting. The point I wanted to make in that speech is that we cannot judge the health of a particular discipline by the amount of money NSF gives it. We need to look at the total funding for each discipline and set priorities accordingly. If NSF provides only 5 percent in a particular field and 95 percent comes from other agencies or states or commercial companies, we at NSF should take that into consideration when we ask ourselves whether we should continue to fund the 5 percent or increase our support or decrease it.

You know, this strategy goes counter to some of the traditional ideas that have been around—that scientists shop around in several agencies for the best deals. Well, that's proper in an expansionary government universe, but that's not okay in a steady-state or contracting system. That's why I think we need priority setting across the whole science and engineering universe.

Q. So the problem you were dramatizing in high-energy physics is the same for chemistry or biology or mechanical engineering, isn't it?

A. Absolutely. I took the example of high-energy physics because people from that discipline were in my audience that morning. If I were speaking to biologists I probably could have proposed to transfer our programs to the National Institutes of Health, which started about the same year as the foundation from similarly modest beginnings and now has a $6 billion annual budget—more than three times our own. What I wanted to impress the audience with is that setting priorities will be a fact of life from here on.

If the scientific community doesn't get its own house in order and is unwilling or unable to set priorities, then the priorities will be set by somebody else—or worse, nobody will do it

Q. Even before the current budget crunch, some science policy pundits in Washington had suggested that the basic research program at the Department of Defense should be put into a different agency, possibly NSF.

A. I don't agree with that. I think the Department of Defense needs basic research. My complaint is that they have not put enough money into basic research over the last few years. I've made the point over and over: DOD is not paying for what it's getting. The Defense Department also isn't putting enough money into education, although it depends heavily on technical people. So I am dissatisfied with the balance of the Defense R&D budget—the balance between fundamental and applied research and the amount that goes for graduate fellowships.

Q. Is it fair to say, then, that what you approve is a great diversity of support for basic research and education?

A. Yes, among all the agencies. I would never want to see all of basic research being supported by the NSF. On the other hand, I don't think scientific research should be a *laissez faire* system in which there are big overlaps, where one hand doesn't know what the other one is doing, where things are not being looked at in totality, where trade-offs can't be made, where fads get big dollars for political or social reasons. I'm not for that either.

Q. To balance the books in science are you advocating a Department of Science?

A. No. I've never advocated a Department of Science. I don't believe in organizational solutions. We cannot reorganize our way out of this dilemma. The idea of a Science Department has been floating around Washington for 20 years or so. There's not much enthusiasm for it.

I think there has to be more of a focal point for sciences, both in Congress and in the Administration. It has to be in both. There are 9 out of 13 appropriations bills that have something to do with R&D. That's a few too many. We're never going to change that—at least not in the near future—so there has to be something else, where at least once a year Congress looks at the totality of the science and engineering budget or the R&D budget.

Q. What kind of a procedure do you advocate?

A. I don't know, but you could think, for instance, of a joint committee made up of the various appropriations committee chairs conducting a hearing on the subject—a kind of strategic review of science and technology issues. It would focus the Administration on the totality of the problem.

Q. What would happen to the three or four authorization committees in Congress?

A. I don't know. Maybe they would participate, too. I don't necessarily suggest this as a solution, but I'm

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