

CONVERSATION WITH ALLAN BROMLEY: REFLECTIONS ON EXITING CENTER STAGE

From his corner third-floor office in the Old Executive Office Building, D. Allan Bromley looks across the west wing of the White House, where President Bush's closest advisers and staffers are located. In recent weeks Bromley also has been able to see workmen assembling the enclosed wooden grandstands from which the next President, Bill Clinton, his family and friends, along with members of Congress and nominees to his Cabinet, will watch the lengthy parade of bands, floats and marchers celebrating the inauguration on 20 January. That day will complete the term of President Bush and his Administration, which means that Bromley will exit the center stage he has occupied for nearly three and one-half years as Assistant to the President for Science and Technology and director of the White House Office of Science and Technology Policy.

Bromley's successor in the new Clinton Administration was designated last Christmas Eve—the first time a science adviser has been nominated before Inauguration Day. Like Bromley, the next science adviser is a physicist—John H. Gibbons, who is serving an unprecedented third six-year term as director of the Office of Technology Assessment, a nonpartisan agency of Congress that provides comprehensive analyses of issues involving science and technology.

After leaving the White House, Bromley is unlikely to fade into history. He is returning to Yale University to occupy his old chair as Henry Ford II Professor of Physics. There he will certainly speak out *urbi et orbi* on science policy matters and perhaps write a book on his experiences in Washington. During a conversation that took place on 16 December with Irwin Goodwin of *PHYSICS TODAY*, Bromley spoke candidly about his triumphs as well as his trials and tribulations at the White House. In the following interview, edited and abridged from that conversation, Bromley discusses his differences with White House officials on such issues as technology policy and global climate change; his advocacy of higher



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Bromley and President Bush: Promises were made to improve R&D investment in the nation's interest.

budgets for individual investigators and his opposition to go-it-alone approaches by the US government on big science projects; and his displeasure with "pork barrel" legislation by Congress and with the hyping of major R&D projects like the Superconducting Super Collider and the space station. He also describes a proposal for how to improve Congressional oversight of science and education programs—an idea whose time has yet to come, not only for these topics but for many others that Congress must consider in its lawmaking function. At other places in the discussion, Bromley makes a case for coming to the aid of scientists in the former Soviet Union and for reinventing science and technology policies in the US to deal with the emerging economic and societal realities of the post-cold-war era.

Q. In your years as science and technology adviser to President Bush have you gotten a sense of what can be done to advance R&D in Washington?

A. I believe I have a new appreciation of the opportunities for what can be achieved as well as a totally new appreciation for how difficult it is to

make anything happen here on any reasonable time scale. I also have to say that I have been impressed since coming here with the generally high quality of people with whom I have had the pleasure of interacting, both in the Administration and in the Congress.

Q. What's been your biggest challenge in the White House?

A. Probably the job of converting this office from what had really been the Office of Science Policy into the Office of Science and Technology Policy. In association with that, the challenge of convincing a number of my colleagues in the White House that it was possible for the Federal government to move substantially forward in the development of technology policy by working with the private sector more closely than in the past, without in any way compromising Republican conservative ideals. I think we achieved that conviction toward the end of the Bush Administration, but I regret that we weren't able to do it earlier.

Q. In this connection, one of your achievements was a paper on technology policy [see *PHYSICS TODAY*, December 1990, page 54]. After what you

just said, how did you manage to get that document through the White House? It was challenged by some people as an opening to what heretofore was anathema in conservative circles.

A. That's very true. But I think first of all that the report has to be recognized as a first step. Its very existence is proof of its importance, because the report was signed off by everyone in the White House from the President on down. As such, it gave us the base on which we could build. What was required in getting the document cleared was a very concerted campaign—discussion and argument—to convince senior people in the White House that I wasn't going off the reservation, that I wasn't advocating industrial policy and that there was a perfectly good, rational reason for what I was doing.

Q. Still, some saw the paper as a precursor to industrial policy.

A. There is no question about that, but I think the fundamental thing we achieved in that document was a clarification of the definitions of what we meant by fundamental research—there was very little question about that; by technology policy—there was considerable question about that; and then by industrial policy—something that ideologically a lot of my colleagues didn't want anything to do with. In fact, I didn't want to have anything to do with industrial policy, because as we defined it I think it was not an appropriate role for the Federal government. We did manage to sharpen the understanding of what is meant by research and technology—from the initial discovery to the point at which a promising technology can be identified and the next stage when the technology can be commercialized so that some company is able to ask,

A. That is certainly the case. I happen to believe that Sematech is a really remarkable success. If you ask how a country like the US can get back the market share it once had in some field, the answer of "catch up" is bound to be a loser. The correct answer is "leapfrog" over the existing technology. This means you don't develop the technology for the next generation but for the next generation but one. That's what Sematech is doing. With the new technologies Sematech is developing, companies can then adopt the advances and move into the marketplace, to have and to hold market share. Sematech is part of technology policy and the companies [in the consortium] are able to decide for themselves what their industrial policy should be.

Q. Isn't this also happening in the field of high-definition television?

A. It's precisely what happened in HDTV. I think we made a fundamental mistake early in the Bush Administration, because instead of presenting the concept as a particular realization of three generic technologies—high-resolution imaging, application-specific integrated circuitry and application-specific software, which are all fields where we are world leaders—we asked the American public, in effect, "Are you prepared to pay \$3000 or \$4000 to see what is available on TV but with much better resolution?" So, when the public answered, "You have got to be kidding," the manufacturers quickly lost interest. Fortunately for us, the Europeans and the Japanese went ahead and developed analog HDTV systems. In the last few months they have come to realize that we are now saying "Gotcha" about HDTV. Our companies have vaulted ahead of theirs by developing digital systems—

we can do to be technologically competitive.

Q. As you look back over the White House years, what mark do you think you've left on the office?

A. The most important thing we've accomplished, something that probably will have the longest impact, could not have been done without help from the President. That is the restructuring of the FCCSET activity, the Federal Coordinating Council for Science, Education and Technology. Because the President was strongly behind what I was trying to do, he helped convince the Cabinet Secretaries that FCCSET was an important activity and that they should get personally involved. There is no question that in the early days of FCCSET the representatives of the various agencies were very skeptical, very wary. But after they sat around the same table, discussing the whole range of science activities, they, first, began to know one another outside the Cabinet room, and second, they even got to trust one another. We soon discovered that FCCSET was providing a forum where there was peer reinforcement. We discovered that Cabinet-level officials were reluctant to bring programs to the table unless the programs were really outstanding. We found that the agencies were paying more attention to improving the quality of their activities and on occasion to redesigning their programs to fit a national goal. Perhaps most important was that having learned to communicate and trust one another, the agency heads developed bilateral and multilateral inter-agency agreements quite apart from FCCSET. So what we now have is a more integrated network of science and technology throughout the Federal government. This is an important change in the way science and technology programs are conceived and carried out in the agencies.

Q. How did you manage to avoid turf wars among the agencies?

A. We learned several lessons. First, I think OSTP should never dispense any money. OSTP needs to remain an honest broker, because otherwise it would be seen as simply another agency in competition with other agencies. Second, having the President firmly behind anything gives it clout. And third, we made it very clear that if it ever comes to a head-on collision between what FCCSET wants an agency to do and what the Cabinet Secretary decides to do, the Secretary will always win. He has the last word. But once he agrees to a program, then the Office of Management and Budget freezes the

'We are now saying "Gotcha" about HDTV. US companies have vaulted ahead of manufacturers in Japan and Europe . . . by taking advantage of our science and technology. HDTV is a metaphor for what we can do to be technologically competitive.'

"What's in it for us?" and transform a nascent technology into marketable products.

Q. The distinction seems clear enough, but some fuzziness about definitions exists in some minds in describing an organization like Sematech [the semiconductor research consortium funded by US chip makers and the Pentagon].

all the way from the production of TV material in Hollywood and elsewhere to the transmission of the shows and the home receivers. We will set the rules and the regulations that the world is going to have to follow in that new technology. We moved farther up the information curve by taking advantage of our science and technology. HDTV is a metaphor for what

funds agreed on, so that no one is able to play run-around Washington Monument games and use the imprimatur of a Presidential initiative to get funding and then to subsequently move the money to other programs. This is a key to the success of FCCSET. Another key is the rule that there will be no substitutes for a Cabinet official at FCCSET meetings, so representation

really don't have much hope of changing the closely guarded preserves of Congress. Still, I think that joint hearings could help maintain the coherence of R&D programs through the whole legislative process.

Q. It's obvious that in the time left to you at the White House you are not going to influence Congress to change its committee practices. What else

third leg I would work with George Fisher [president of Motorola Inc] and his private-sector Council on Competitiveness to launch a study on industrial research. There there is a real problem: For 15 years prior to 1985, support for industrial research in this country grew at about 7.5% per year; since 1985 it has dropped to a growth rate of about 0.2%, and maybe it is now even negative. Worse yet, the character of corporate research has changed. The focus of industrial R&D is shifting to the branches, closer to production, to a shorter time horizon, while the long-term research that once was done in the corporate research laboratory is diminishing.

So what I would like to have done is, on the basis of those three studies, to attempt to articulate a new vision for science and technology in the US. The vision would project the rationale, the structure, the support and the effective utilization of research and development in our society. That would have been my first priority if I were to be here another term.

Q. You can propose such studies to the Clinton-Gore Administration.

A. I will recommend it to the transition team and to my successor. And I'll be happy to work with anybody who undertakes such studies because the subject is surely in the national interest. Science and technology are much too important to be caught up in partisan bickering.

Q. Was partisanship among the major disappointments you encountered in Washington?

A. I guess my major disappointment was that we were so unsuccessful in letting the public know just how much George Bush cared, how much he had accomplished and what was his vision for the country in terms of how we could apply science and technology to providing good jobs, invigorating our economic competitiveness and generally improving the quality of life. We had excellent programs, in my view, and we were implementing them, but few people knew anything about them. That is largely our fault.

Q. Still, if you look at the Clinton-Gore priorities, they appear to be extensions of many of the Bush programs for science and technology.

A. I believe that is true, and I am rather pleased with that. From my discussions with members of the transition team and from other people closely associated with the Clinton-Gore Administration, I think they feel that we have built a number of things that they would like to consider as foundations. In fact, I can think of only two areas where there will be really major differences between

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is always at the very highest level.

Q. Would any Presidential R&D initiatives exist without FCCSET?

A. Not a chance. In all six of the initiatives—high-performance computing and communication, math and science education, global change research, biotechnology, materials science and technology, and advanced manufacturing—the FCCSET approach enables us to assemble up to 20 agency programs into one comprehensive national program. Because OSTP maintains a close collaboration with OMB, we are able to bring together the programs in all the individual agencies at one hearing before OMB. I wish we could do the same thing in the Congress. It's well known that Congress is completely Balkanized. We send our integrated initiatives up Capitol Hill and they get taken apart in the fragmented committee structure. We then need to reassemble the initiatives while taking into consideration the various actions of the committees.

Q. That's like putting Humpty Dumpty together again.

A. Last year I think we broke new ground in the authorization process. We convinced Chairman [William] Ford [of the House Education and Labor Committee] and Chairman [George] Brown [of the House Science, Space and Technology Committee] to let us present the math and science education initiative at a joint hearing. So Lamar Alexander [the Education Secretary], Walter Massey [director of the National Science Foundation], Jim Watkins [the Energy Secretary] and I all testified on behalf of the national education program. What I would like to see happen—and what I certainly would have worked for if I were going to be here—is to do the same thing with the appropriations subcommittees and eventually to merge the hearings by the authorization and appropriations panels. But I

are you leaving undone?

A. Probably the thing that I would have most liked to have done had I been here for additional time is to follow up on the recognition that has been growing in the past year that this country has been living with a vision of science and technology research and development that was enunciated back in 1945 by Vannevar Bush in his marvelous monograph *Science—The Endless Frontier*. But if you stop to think of the changes that have taken place—the end of the cold war, the fragmentation of the Soviet Union, the emergence of the European Community and the Western Pacific as economic superpowers, as well as all the deep-seated changes in our own society—it is not at all obvious that Vannevar Bush's blueprint is as appropriate for the first half of the 21st century as it was for the last half of the 20th century. In particular, until you go back and read *Science—The Endless Frontier*, most people, myself included, forget that Bush didn't speak about industry. Industry, clearly, is a critical player now. So what I would have done is to build on the report that both the President's Council of Advisers on Science and Technology and FCCSET have just completed on the interface between the Federal Government and research universities as one leg of a triad. As another leg I would have mounted immediately a major study of the Federal laboratories by PCAST. There are more than 700 laboratories in the Federal government. We don't need that many, but it is not easy to close even one. Of course, they represent an absolutely unique resource in terms of know-how, technology, equipment and personnel that no other country can match. We spend \$22 billion a year on their support. Quite frankly, taxpayers are not getting an appropriate return on that \$22 billion, in my view. Then as the

what we were doing and what the new Administration will do. The first is that I fully expect the new Administration will want to inject the Federal government much more aggressively into the market than we did. The new Administration intends to have an industrial policy and to pick winners and losers in technology. The second thing that they clearly want to do is to work toward developing what they might call a civilian DARPA [the Defense Advanced Research Projects Agency]. That concerns me, because the reason DARPA has been such a success is that it was clear at all times that the little agency had one clearly defined customer—the Defense Department. DARPA's decisions about what to support and how to support things were always made within that framework. But the idea of creating a new agency, with tens of billions of dollars, strikes me as offering an irresistible temptation to create the Mother of all Pork.

Q. If you hadn't brought up the topic of pork, I would have.

A. Within OSTP we have been studying budget earmarking over the last three years. I begin talking about that by describing three kinds of earmarks—one good and two very bad. Good earmarks occur when Congress decides that the Administration has somehow missed something or has inadequately supported some project or program of potential national benefit. It is entirely appropriate for the Congress to correct that. The other kinds turn up when a constituent makes it known to a representative or a senator that he or she can't get what is needed in competition with the other guys, so he or she asks to get it without any of that nonsense. Even worse is the third kind—when a constituent goes to a lobbyist and pays for the lobbyist to get the project or program by approaching an influential member of the Congress. This type of earmark usually gets put into an appropriations bill at the conference committee stage when it is too late for public debate on the floor of the House or Senate. At that stage in the budget process the pork is passed out quietly, without much notice, and certainly without all that nonsense of merit review. If we continue placing earmarks in our R&D budgets, we will nullify the source of our preeminence in science and technology—those three deceptively simple rules that Manny Piore and Robert Conrad invented back in 1946. The rules are: Pick the best research people by peer review; give those researchers as much money as you can to allow them

to do what they think is most important; and keep the hell out of their hair while they're doing it.

Q. In your characterization of pork, would you say that the last two types are unkosher?

A. Dishing up pork of that sort is strictly unkosher. It is important to think about the numbers for political earmarks. Two years ago, the total

doubtedly offered some suggestions for the operation of OSTP. What did you say?

A. I can tell you my most important recommendation—that my successor be appointed as quickly as possible. The reasons for this are two: First, because as the Assistant to the President for Science and Technology, my successor is going to be one of the

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amount of pork in R&D budgets amounted to \$600 million plus. A year ago it was just under \$1 billion. This year it reached \$1.7 billion. That is a frightening growth curve.

Q. Those who serve the pork are in Congress, but those who give birth to the porkers are academics.

A. Oh, yes. One reason for this, I have to admit, is that we are dealing with a zero-sum game in the domestic discretionary budget, so we cannot come up with a competitive Federal program to which universities can apply on a competitive basis to modernize, renovate or build anew. In the absence of that, a lot of universities have gone to the trough. Universities have made pork acceptable to members of Congress. If this continues, the three rules will have no meaning and our unique system for funding R&D will disappear.

Q. In 1986 you and David Packard [of Hewlett-Packard] issued a report on behalf of the White House Science Council calling for \$10 billion to rebuild many university campuses and laboratories that were in various states of ruin. What's happened to your recommendation?

A. The fact is, we have not been able to come up with the program we called for in 1986. A recent NSF study shows that the need is no longer \$10 billion, but \$12 billion. To be more specific, \$4 billion is needed for remodernizing and renovating and \$8 billion for new construction. In our current circumstances, given economic conditions today, we should make the purpose of the \$4 billion a high priority. We should leave aside the purpose of the \$8 billion for a while. The \$4 billion is necessary to give our scientists and engineers the facilities they need for their work.

Q. In your meetings with the Clinton-Gore transition team you un-

inner circle of the President's advisers, and therefore it is important that he or she be on board the Administration Express as early as possible. That can make a significant difference in the way science and technology are integrated into the full panoply of White House activities. The second reason is that the person can then be involved in the selection of people to fill the key science and technology posts throughout the government.

Q. Just what was your own relationship with the White House?

A. In my last conversation with President Bush before taking on the job, I asked him to promise me three things: First, that I would have access to him when I needed to. I promised not to abuse that privilege. Second, once we agreed on something worth doing, he would give me full support. And third, that he would appoint the four associate directors that are called for in the 1976 legislation establishing OSTP. For whatever reasons, the associate directors had never been appointed previously. The President came through on all of my requests. As I said before, I am convinced that no President in memory has been more sensitive to the importance of science and technology or more prepared to provide support for it as an investment in the nation's future. His convictions show in each of his budgets.

Q. Why do you think the science community never got that message?

A. In part it reflects the fact that the science community, in a way, is a victim of its own success. At the end of the 1980s and in the early 1990s, the research community in this country should have been celebrating a fantastic few decades of discovery and development that moved the world's quality of life forward by leaps and bounds. Instead, we find our-

selves in a pessimistic mood.

Q. Isn't it natural that scientists expect to be rewarded for their success? Instead they find themselves snarling at each other for scraps. Are expectations too high? Someone once accused scientists of being welfare mothers in white coats.

A. I have tried in all my discussions—particularly with the scientific societies—to convince them that we all understand the situation. If the case is made to Congress that science is ready and able to take advantage of all its discoveries and developments to pay back to society many times over the amounts of grants received, Congress will respond to the satisfaction of the science community. But if, on the other hand, it is an attitude of "As a chemist where is my Federal grant?" the response will not be up to the expectations.

Q. Isn't there a danger in trying to convince Congress that supporting science will have a payoff?

A. Yes. As recently as in some of the rhetoric about the SSC, some scientists have given Congress the impression that the accelerator might eventually cure everything from cancer to dandruff. Such statements are counterproductive and in the end reduce the credibility and confidence in all of science. It is important for us to be realistic in the promises we make, because they often come home to haunt us. Some things we do in science—and the SSC is one of them—are high points in the great adventure of human civilization. This is significant in its own right. Most of the things we do are done for very practical reasons, but the US, as the richest and most powerful nation on the planet, should be able to spend a tiny fraction of its GDP on nothing more than pushing back human frontiers. The SSC, the most dramatic instrument that has ever been conceived, is an example of that. The space station is another example. It is not a scientific project as such. It is a first step in that great adventure that takes man off the home planet. What I found difficult in my job at the White House was to convince the scientific community that we are in difficult times but this is certainly not the time to defend ourselves by pulling the wagons into a circle and shooting at ourselves. That is exactly what has happened in the past few years. I have tried to impress on scientists that money designated for the space station or SSC is not fungible. If it weren't spent on those projects, it would not go to support individual investigators, who provide the heart and backbone of our science. One of

the things we tried to do in the past four years is to shift Federal spending from responding to immediate consumer demands to investments in the future. Space station, the SSC, the Presidential initiatives in science and education and individual investigator research are all investments in the country's future. If we can get our community to support investments of those kinds, we will all benefit.

Q. Isn't it precisely the use of hyperbole that leads Congress to believe that basic research can be transferred virtually immediately into new technologies and new industries? This apparently is the reason the Senate Appropriations Committee recently directed NSF to fund more applied research, presumably to benefit the country's economy. The committee's report makes that case.

A. I'm only too aware of that. It is our chickens coming home to roost. By trying to sell fundamental research in terms of its almost immediate payoff, we do science an injustice. We need to remember what Ed Mansfield [a University of Pennsylvania economist] found out in his 1991 study: Using a 15-year time period for Federal spending on basic research at universities, he figured there were paybacks in the range of 28% to 40%, which is much greater than the returns corporate executives expect from their investment on capital and plant. But if one expects returns on basic research in three or four years, it's not going to happen. Now, the time from initial discovery to commercialization and market success is becoming remarkably shorter in some fields. In industries that are dominated by biology, for instance, the period is far shorter than in industries dominated by physics and chemistry. We do ourselves great harm when we promise spinoffs and payoffs to people who don't understand the details.

Q. The impression persists that,

first session was a bit rocky. After John had laid down the law for a while, I suggested that maybe he should listen while I talked. We very rapidly realized that we both understood science and technology and that we could operate well together. I couldn't have asked for a much better colleague.

Q. Were your initial difficulties the result of the traditional animosity between an engineer and a physicist?

A. I am an engineer too, so that helps. It's fundamental to understand that John is extraordinarily bright and he asks the right questions. A lot of people don't like being asked the right questions, because sometimes they are embarrassed. I was fortunate in having John here for the first part of my tour.

Q. Sununu took a lot of heat over environmental issues.

A. He did, and much of what was reported in the news media was exaggeration. A lot of it was that John was acting as a lightning rod. There are a lot of environmentalists who didn't like the fact that we did not immediately rally to the call that a crisis was upon us and that we needed visible multibillion-dollar programs to address the crisis. John was a convenient and from their point of view a very attractive lightning rod because he made outrageous statements from time to time that really got under the skin of those folks. Part of the problem, to be honest, is that John did his PhD at MIT on thermal transfer in the atmosphere. In those days, he used a simple one-dimensional model. Like almost all the rest of us in science and engineering, when you leave a field after working in it, you find it hard to believe that very much of importance has happened. So John had a certain feeling that in the field of climate change he could ask probing questions because he knew so much. He asked some

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like Congress, the White House tangles with the scientific community at times. John Sununu, who was President Bush's first chief of staff, earned a reputation of opposing environmental scientists. What was your relationship with Sununu?

A. A lot of people felt before I arrived that John and I were going to tangle terribly. I must admit that our

damned good questions. But in some cases, he hadn't the time to really be aware of just how sophisticated some of the models had become since his research. Sometimes that led to misunderstanding. John has taken a lot of bad press for his alleged role in blocking all sorts of activities that the government otherwise would have supported.

In retrospect, I think history will be rather kind to us in [regard to] our stewardship of the environment. We clearly were world leaders in responding to the reduction of ozone in the stratosphere. After all, we introduced the forestry protocol [which calls for reducing the cutting or burning of heavily forested regions]. I think we exerted real world leadership by not signing the biodiversity convention at the United Nations conference in Rio de Janeiro because the protocol was flawed. It would have had a serious impact on the biotechnology activities of our pharmaceutical industry, and it would have had American taxpayers contributing large sums of money to projects over which we had no control.

We organized the 1990 White House conference on science and economics related to global climate change and by doing this we injected economics into discussions of the subject forever after. We came up with a comprehensive approach instead of dealing with the research results, for example, of ozone levels in the stratosphere as separate from the economic implications of reducing chlorofluorocarbon emissions by specific dates.

So in retrospect, I have no regrets about the way we handled the global climate change activity. Just last week we released our national action plan in Geneva. We are the only country that has actually produced one at this stage. I have talked subsequently to people from France, Germany and the United Kingdom, and they have all been very impressed by what we have produced. In addition, a number of representatives of countries around the world have told me on the quiet that for various political reasons they weren't able to

meetings. Shortly after I came here the President asked me if I would chair the Domestic Policy Council working group on global climate change. That was before I realized what a hot potato it really was. Notwithstanding, I did head the council's panel. We held literally dozens of meetings before Rio to work through what the US position was going to be. We talked with the President. As I said, I am not at all unhappy with what happened. I am unhappy about our apparent inability to explain to the public why we did what we did. Each time that we did anything, other groups managed to get to the press first and painted what we were doing in very negative colorations. Senator Gore and I have had some wonderful dinners off line and we have had some terrible sessions on line during hearings. What it fundamentally comes down to is that the senator is much more convinced than I am that we have an immediate crisis on our hands. He wants an activist response to what he sees as a dreadful situation. I take the view that we need better scientific understanding and that to take amelioratory actions without understanding what is really happening we stand the risk of making the situation worse. I think we have time and opportunity to do the necessary research. I share with the Vice President-elect a deep respect for the environment. That is why we have spent so much time at OSTP developing the global-change research program. We want to understand how best to spend taxpayer dollars to address the problem.

Q. You have some remarkably good relations with the Environmental Protection Agency, the Energy Department and NSF. What about

care of those matters. I chose to put my emphasis on industrial technology rather than national security. Still, we were involved in trying to open up classified data for public use. I also got agreement from Dick Cheney [the Defense Secretary] to increase the amount of research for protection against technological surprise and to improve Defense Department interactions with universities. We must rebuild the bridges that were burned during the Vietnam War.

Q. How were your interactions with the State Department?

A. Disastrous. Just like my predecessors, we have failed miserably in trying to convince our State Department that science and technology should be an integral part of external relations. Every other developed nation has integrated science and technology into their foreign relations. We simply and absolutely have not done it. We have foreign service officers occupying the science and technology attaché posts worldwide. They have no contact with the scientific community worth mentioning, with rare exceptions. They are unable to report back to us in real time what is going on. We're missing a tremendous opportunity to gather information about what is going on in other countries and to offer information to other countries about what great things we have to sell.

Q. What are other nations doing that we are not doing?

A. Let me give you the example of Sweden, which astonished me when I first learned about their activities a year or so ago. I found out that Sweden had just installed its 17th technology attaché in our country, based in Detroit. He is one of 147 technology attachés Sweden has worldwide. They are highly trained engineers and scientists. They are selected and paid by Swedish industry, but they function under the aegis of the Foreign Ministry. And they report in real time, on a daily basis, what they learn. I made some token progress while Bob Mosbacher was Secretary of Commerce in trying to get one of our commercial attachés to tell us something about technology, but that didn't work. Had we remained in office, we were going to clone the Office of Naval Research in many capitals around the world and use our people as windows on foreign science and technology. We recognized from the start that the way to do this properly is to bring in distinguished senior engineers and scientists to whom the doors of labs anywhere would be opened with enthusiasm, and these people would then

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support us in Rio, but they were really behind us.

Q. You were criticized by Al Gore on this subject at a Senate hearing. He asked why, as the President's science adviser, you had not urged him to take the lead at the Rio meeting in limiting greenhouse-gas emissions.

A. Well, first of all, I did advise the President. We had a great many

your relations with the Defense Department?

A. When I first came here I quite consciously cut back on the fraction of time this office devoted to defense activities because my immediate predecessors had been very largely occupied with defense issues to the exclusion of most others. I also had great confidence that Brent Scowcroft [the national security adviser] could take

report what they found. It is strange for a country with the expertise and prowess we have in science and technology to be so insensitive to the need to know what's going on elsewhere. It defies understanding.

Q. Have you made any headway in getting your idea across at State?

A. None at all. During the Reagan years we managed to get an executive order signed by the President ordering the State Department to hire scientists and engineers for posts in our embassies abroad. To the best of my knowledge, the executive order was never carried out. So it is a battle we continue to wage.

Q. The State Department has also been dragging its feet in helping the former Soviet Union, particularly the scientists who are among the most valuable asset of the FSU. As the last science adviser of the cold war, have you been able to make any progress in providing aid to the FSU?

A. We have been heavily involved. I was fortunate because Yuri Ossipyan, who was Gorbachev's science adviser, is an old personal friend of mine. So we could pick up the phone and have back-channel conversations. Since 1972 I have been one of the American members of the Nixon-Brezhnev agreement committee, so I travel frequently to the Soviet Union. I have good relationships with many Russian and Soviet scientists. Early on, I asked Frank Press [president of the National Academy of Sciences] to put together a national meeting of senior scientists and engineers to advise me on how we would move forward to help civilian scientists in the FSU. The outcome was admirable. In the process of doing this we got many professional societies involved. The American Physical Society deserves special credit for developing a procedure that avoids one of the critical problems—that of Russian officialdom peeling off large fractions of the money that has been collected and using it for maintaining infrastructure or for bureaucratic purposes. The APS has concentrated on aiding individual scientists in a bottoms-up approach. Although I'm dissatisfied with the speed at which we have been able to proceed, I think we are about to succeed in liberating \$25 million, which we will pump into the joint programs that are already in place involving the NSF and the National Institutes of Health.

Q. Do you think all this can be achieved before President Bush leaves the White House?

A. Yes, I do. It is essentially done now. As slow as our effort is moving, it is still faster than the European

proposal. I was in Europe recently, talking to the Group of Seven ministers. It is clear that the Mitterrand money is hung up in the banking system. I am convinced that we're not really going to help our friends in the FSU in a continuing way until the private sector is more involved. There are three things that stand in the way: There is no legal structure

nize that science and technology are international. Scientific instruments should be available to the best scientists worldwide. In such a world, every nation capable of paying its share should help fund big projects. It has reached the point now where frontier science equipment is too complex and expensive for nations to be competing to be first. The real issue is

'Some scientists have given Congress the impression that the SSC might eventually cure everything from cancer to dandruff. Such statements . . . reduce the credibility and confidence in all science.'

in the FSU that defines ownership, so we have people representing laboratory X and claiming that they own everything in it. There is no legal structure to protect intellectual property rights. And there is no structure to resolve disagreements and disputes. Until those three things are put into place, I am afraid nothing much is going to happen. Last May Boris Saltykov [Russia's Minister of Science] told me he was optimistic that in a few weeks he would have a legislative resolution to the problems. But the fact is that the activists and conservatives in Russian society are so well balanced that the situation is at stalemate.

Q. Scientists throughout Europe seem to be in a funding crunch these days. Does this dilemma raise doubts about your efforts to attain some partnerships in supporting big science projects? Or will the European Community prefer to go it alone on some projects?

A. I think that for no other reason than as a matter of pride and reaction to the SSC the Large Hadron Collider [at CERN] will probably go ahead. In a way, that is a shame. It doesn't make much sense. We could have worked out a better way had we had the truly international approach that the Organization of Economic Cooperation and Development is now mounting. There are bound to be a lot of other joint programs that make the Europeans and us think about cooperating in an effective way. I think we're beginning to see the end of this period of rivalry and incoherence.

Q. You have been in the forefront of trying to get partnerships between the US, Canada and Japan in science.

A. I believe it is absolutely imperative that as we move ahead we recog-

to get there and to get there together.

Q. Do you have a message for your successor in the White House?

A. I have a very clear message. First and foremost, the science adviser should not have an agenda of his own. The primary function of the adviser is to move the President's agenda forward. If the adviser is found to be a lobbyist for the scientific community, or even suspected of being one, then his effectiveness will go to zero almost immediately.

Q. What do you plan to do now?

A. Return to Yale. Although both Yale and Harvard have a rigorous rule that says a faculty member must resign if he or she is away from the campus more than two years, I can go back. Yale, you see, has modified the rule. It came about during Lyndon Johnson's Presidency when Walt Rostow was attorney general. Kingman Brewster [then the university's president] called Rostow one afternoon and said: "Walt, you have been gone just about two years. It's time you got back to teaching law here." That was about 4:30 in the afternoon. At 9:30 the following morning Brewster got a phone call. The voice on the line said, "Brewster?" "Yes." "I need that boy." That's all that was said. Brewster knew from the Texas drawl who was on the other end of the line and what he wanted. So Yale decided to insert an exception to the rule: If you report directly to the President of the United States, and if once a year the President of the United States calls the president of Yale and says, in effect, "I need that boy," a leave of absence can be extended for another year. Fortunately for me, President Bush has graciously agreed to personally call the president of Yale each year while I have been here. ■