

CONVERSATION WITH JACK GIBBONS ON COORDINATING SCIENCE POLICY

In a town marked by bombast and backbiting, John H. Gibbons is a rare commodity. Gibbons, who advised Congress for nearly 14 years as head of the Office of Technology Assessment, sailed unflappably through the Senate confirmation vortex in February 1993 to become science adviser to President Clinton and director of the Office of Science and Technology Policy. Picked for the job mainly on the recommendation of Vice President Gore and influential members of Congress who worked with him at OTA, Gibbons is esteemed as a modest, low profile, science policy wonk, who is both politically savvy and technologically prudent. Despite being a Washington "insider," he has never been taken in by the special interests and the entrenched establishment.

Gibbons came to his new job without great expectations by the science community, which knew little about his views. Like most science advisers, Gibbons was trained in physics. He received his undergraduate degree in 1949 from Randolph-Macon College in Virginia, his home state, and his doctorate in 1954 from Duke University. He spent the next 15 years at Oak Ridge National Laboratory in Tennessee, Gore's home state. At Oak Ridge, Gibbons bombarded heavy elements in reactors to understand nucleosynthesis in stars. In 1962, together with five coworkers, he used this expertise to start a company that made radiation detectors and other scientific instruments. The firm still bears the original name, Ortec, and is now part of EG&G Corp.

In the late 1960s, at the urging of Oak Ridge's director, Alvin M. Weinberg, Gibbons began studying how to conserve energy and minimize the environmental impacts of energy production and consumption. In 1969 Weinberg chose Gibbons to head the lab's environmental program. Then, in 1973, at the start of the nation's first major energy crisis, Gibbons was appointed the first director of the Office of Energy Conservation in Washington. Two years later



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Creators of science policy:
Jack Gibbons
and Al Gore.

he returned to Tennessee to head the Energy, Environment and Resources Center at the University of Tennessee. In 1979 he was back in Washington to direct OTA, and in 1993 he joined Clinton's White House inner circle. A spelunker in his youth, Gibbons tells friends his experiences in dark caves prepared him for Washington.

His 16 months in the Old Executive Office Building, a battleship gray, excessively columned edifice located a stone's throw from the White House, have not been easy. Without any associate directors for the first seven months, Gibbons has kept up with White House demands for background papers and political advice with a staff of 46, about the same number as his predecessor, D. Allan Bromley, though OSTP acquired the Space Council and the Critical Technologies Council, which had their own staffs in previous Administrations. In a period of severe budget restraints, Gibbons has trudged the corridors of Con-

gress to champion larger appropriations for academic research programs, cooperative technology ventures and science and math education. He has shared criticism with Clinton for not campaigning more vigorously for the ill-fated Superconducting Super Collider and for not curtailing NASA's space station and favoring robotic explorations of the solar system. Gibbons has been faulted also for not meeting with the scientific press as frequently as Bromley, who enjoyed sparring with reporters.

When asked for an interview with PHYSICS TODAY, however, Gibbons agreed to an unrestricted session on 7 July. The meeting with Washington editor Irwin Goodwin took place in Gibbons's cluttered office on the fourth floor of the Old Executive Office Building. There, before a handsome, carved granite fireplace, Gibbons discussed what he and the Clinton Administration are doing in science and technology policy.

Q. When President Clinton named you his science adviser, you were described in the press as an "insider." Having worked in Washington for years, you were supposed to know better than many others on the President's first team how the great game of politics is played. Even so, since coming to the White House 18 months ago have you encountered some surprises?

A. Even after 14 years at OTA, which is a bipartisan office of Congress, I'm still overwhelmed with the complexity of governance in our democratic society, where the name of the game is the sharing of power. Sharing power means that decisions can't be made unilaterally. The number of bases you have to touch to gather the kind of support required to move ahead on complex issues is truly staggering. I don't think most people understand this. Nothing like this happens in either academe or in corporations. The White House is a wholly different universe. I've been gratified that I have all those years working in Congress to give me a better-than-average sense of what you have to do in order to try to get things to work. So that's become clear to me.

The second thing is the extent of the knowledge base and commitment to the proposition that science and technology, which are inextricably woven together, provide us almost uniquely with new options to do things, to enable futures to unfold. The proposition was espoused in the election campaign by both Bill Clinton and Al Gore. They not only speak about it, they understand it. They've been very supportive of the concept. They didn't hesitate to form the National Science and Technology Council, which in turn is already, only 18 months into the Administration, showing good evidence of elevating the level of attention to science and technology as fundamental instruments for change. To a degree, the commitment and understanding by both men even surprised me.

Creating the NSTC concept

Q. Why did it take 18 months to get the NSTC started?

A. Well, it took a long time to develop the concept, which was first proposed last year in the Vice President's report on reinventing government. It was the end of November by the time we had checked all the bases and had a basic understanding of how it would fit into the constellation of the National Economic Council, the National Security Council [and] the other White House offices, how it would relate to the Cabinet

agencies and organizations, and how it would work with Congress. It's been only seven months since the NSTC was formed. And while it was only two weeks ago, on the 29th of June, that the Council met in full session, it's actually been working away since late November. The council members and their key staff people have been working together to shape the 1995 budget requests, to move ahead with our public-private partnerships such as the so-called clean car initiative, to resolve the problems of the US Polar Weather Satellite systems, which required lining up several agencies to agree on what to do and to transfer money between agencies so that we could achieve the convergence of military and civilian satellites. Over the past decade or so, there had been eight attempts, I believe, to get the system of satellites to this stage, and all had failed. We reached agreement by virtue of having the NSTC. So there was a lot of activity going on in the committees working for the NSTC even though the Cabinet-level council itself hadn't met.

Q. NSTC committees are carrying on most of the functions of the Federal Coordinating Council for Science, Engineering and Technology—those groups of Cabinet secretaries and agency directors or their staff people from the R&D agencies in previous administrations. FCCSET [as the interagency coordinating council was abbreviated to adapt to Washingtonese] succeeded in formulating a sensible program and a reasonable budget for the big new science and technology initiatives. FCCSET groups reported to the White House through the Office of Science and Technology Policy and the Office of Management and Budget but not directly to the President. If the work of your NSTC committees is going so well and is able to come to grips with problems involving budget allocations and turf wars, what's the purpose of the Cabinet council and why are meetings necessary at all?

A. The meeting on 29 June was simply a time to get all the principals together, for the President to hear the Cabinet Secretaries and the others express their ideas and needs, and for them to hear him and the Vice President reiterate their interest and commitment and to get a catch-up on what is going on—that is, the progress and the problems. The NSTC process is well under way. We finished our work on a review of government science policy, which is now in press.

Q. You're speaking about the so-called white paper on science policy, aren't you?

A. Yes. We utilized a forum at

the National Academy [of Sciences] last February to help pull ideas together, on top of the work we've done among the agencies. Since then the paper has received a long review. But it was only last week at the NSTC meeting that the President and the other members approved the release of the document, which has the title of *Science and the National Interest*. At the meeting the council members also approved the release of a major paper on environmental technology. That paper, called *Technology for a Sustainable Future*, should come out on 15 July when the Vice President speaks on the subject in Golden, Colorado. The environmental paper also started as an interagency activity to get our arms around the whole question of environmental technologies, then moved to the academy for a public dialog to shape and hone the thing. So it now emerges as a paper that integrates the interests and the wisdom of the agencies, and also the private sector and our peers out there. We hope it becomes another instrument to elevate the public dialogue and awareness of the opportunities of environmental technologies, and that we can then proceed to the development and implementation of a new family of "green" technologies, in both the private and the public sectors. We are convinced there is a very large world market for environmental technologies. To underscore our commitment, we intend to set up a cost-sharing program of grants to industrial firms that develop and commercialize technologies to monitor the environment, clean up existing pollution, reduce waste and prevent environmental foul-ups. We're also going to try to engage the state governments as well as the Federal government in this.

Q. How would you characterize the two policy papers?

A. They provide strategic guidance to people in the agencies, and they serve as policy declarations for everyone else. The documents tell people what our science and environmental policies are all about. We also write other papers for internal purposes, such as reviews of the Federal labs. All these are done under the umbrella of the NSTC.

Q. Was there any controversy about the policy documents at the meeting of the President's science council? Was there any dissent from the positions set forth in the papers?

A. There was discussion, but there was no dissension, there were no negatives. What that did, I think, was to indicate to the President that we'd been doing our homework, that all the individuals around the table

were fully informed of what we were doing as a group. It was a sort of endorsement of all the virtual meetings we'd been having as clusters of activities within the NSTC. What the NSTC members basically told the President was that they see this as a very important mechanism for pulling together their several resources into a more coherent whole, so that we can be even more responsive to the Presidential initiatives. I was very pleased by the discussion at that first meeting.

Q. Will the President release the science paper together with a speech or a briefing?

A. We expect the Vice President to issue the report on 3 August.

Q. The issues and goals that you set out in the Gibbons-Panetta memo [a memorandum to all departments and agencies from Gibbons and Leon E. Panetta, then director of the Office of Management and Budget, that contained guidelines for the budget-making process] . . .

A. Oh, that had to do with the fiscal 1996 budget. It was another activity of the NSTC.

Q. Were the Administration's goals for R&D discussed by the NSTC?

A. What came up at the council meeting was a reference to the way we're going about shaping the 1996 budget. So the Gibbons-Panetta memo was seen as a key initiative, mainly because it gave the agencies, for the first time in the history of our government, some strategic guidance early in the process of the budget development, rather than just a number to plan their budgets around. And the principles set forth in the memo will be followed—we hope by mid-August if not early September—with an integrated set of key priorities for the 1996 budget. With those in hand, the agencies will have the President's priorities as a part and parcel of the consideration of the individual agency budgets when they are delivered to the Office of Management and Budget in the fall. So I'm pleased at the way that's moving. It's kind of reassuring to know that the agencies together worked on these integrated budget plans through the committees of the NSTC. So in a sense, it's their own creation. What the President heard from them at the meeting was: We think it was a good idea to put our heads together and do this on an interagency basis rather than agency by agency. That was the response I was looking for.

Establishing PCAST anew

Q. All this has been done without the President's Council of Advisers on

Clinton and his new science council

The Roosevelt Room of the White House was crowded at 11:30 on the morning of 29 June for the first meeting of the National Science and Technology Council. The council, created by President Clinton's executive order last November, is intended to oversee the government's entire R&D portfolio, which will cost \$72 billion—about one-seventh of the total discretionary spending in the US budget this fiscal year. With Clinton presiding, the meeting had the appearance of a Cabinet session. Around the shiny mahogany table were 24 people—Vice President Gore, Cabinet secretaries, agency directors and senior White House officials.

The President opened the meeting with a statement stressing the importance of the national investment in both fundamental and applied research and in support of technologies such as advanced manufacturing and biotechnology, which will enable US industry, he said, "to compete effectively in world markets." He sometimes seemed to be preaching to his own choir: "We need to lead the world in international science and technology cooperation, such as on the space station. Science and technology programs like this allow us to build bridges between societies and nations as we deal with the challenges facing the post-cold war global community."

During Clinton's half hour at the 75-minute meeting, he went around the room calling on each participant to describe the principal science and technology activities in each domain. Donna Shalala, secretary of health and human services, and Neal Lane, director of the National Science Foundation, spoke about the intrinsic value of basic research. Shalala emphasized the economic and social benefits of biomedical research, while Lane discussed the need to establish closer links between research and teaching in universities. According to some accounts of the session, Transportation Secretary Federico Peña argued for more applied research on immediate problems like inflight safety, nonpolluting engines for cars and trucks, and maglev trains—all of which, he claimed, would reap economic, environmental and social advantages at home and trade profits abroad.

Clinton also directed the NSTC members to actively pursue four goals: His top priority was for each department and agency to "reprioritize science and technology investments to match national goals"—presumably meaning the goals set forth in the recent Gibbons-Panetta memo to R&D agencies (PHYSICS TODAY, July, page 49). Other priorities included "establishing closer and more productive relationships" in science and technology among Federal government labs and industry, state and local governments, and universities; providing "a broad base of support among the American people and the Congress for continued investments" in Federal R&D programs; and promoting the nation's best interests "through international science and technology cooperation."

After Clinton left, Gore took over and observed that the NSTC is able to act as a "virtual agency" to coordinate "the disparate parts of our science and technology enterprise into a whole greater than the sum of its parts."

In theory, NSTC is on a par with the National Security Council and the Domestic Policy Council in the White House political loop. But there's little likelihood that it will be equal in influence. Even so, though the first meeting of NSTC did little to excite new ideas or stir the agencies to action, it attracted four Cabinet secretaries and several stand-ins, including John Deutch, deputy secretary of Defense (to the right of John Gibbons in the photo). —IG



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Science and Technology, which you said at the time you announced NSTC you would establish in a framework not too unlike the PCAST formed by your predecessor in the White House science office, Allan Bromley.

A. It was done without PCAST because PCAST is like the mills of the gods: They grind slowly but exceedingly fine. For a group like PCAST you need to subject its members to a great deal of screening through the personnel process. Then the names all go to the President. Then they come back, and the people on the list are actually asked if they are willing to serve if they are asked. If they say yes, the names go to White House counsel for further background checks. Invariably, you run into a few snags in the process. We had hoped we would have all names ready to announce more than a month ago. We now believe that we'll have the complete list ready for a combined release of the science policy paper and announcement of PCAST at the same event. At least, that's my present aim.

Q. Isn't there the fair chance that naming the PCAST members at the same time the science policy paper is issued will overshadow the paper's message?

A. I don't think so. I think that it will draw more interest to the President's science and technology policies. What you want is an event that has enough in it to engage the President directly.

Q. Can you say anything about the science policy document before it is released?

A. We had a draft of the paper even before the forum at the National Academy [of Sciences] last February. But we felt it was really important to get some thoughtful reviews and critiques. In my days at OTA, whenever we had a two-year study, at least six months was devoted to reviews and comments. And that's about the way this has gone. We went through extensive reviews and comments, and the last set of comments, in this case a couple of things raised from inside the White House after the document had actually been sent to press, led to calling back the document for 24 hours so that we could make some late changes. So the paper hasn't just been sitting idle. We've been trying to work it over and get it into a form that's more readable by a broader audience. And that takes time.

The science white paper

Q. What are the key points of the white paper on science policy?

A. What it does is reaffirm the fundamental value of science and technology in enabling our nation to

achieve the goals of national defense, environmental protection, economic growth, the quality of life. It rejects the old notion of a linear paradigm for the development of things from basic science to applied science to technology commercialization, and rather talks about a feedback system between science and technology, with commercialization being one of the outputs. That approach changes the way you think about the process and therefore how you go about doing your business and engaging people in these actions.

We strongly emphasize the need for peer review in the choice of science programs and facilities. We underscore our conviction that you can have a strategic approach to science and at the same time that it be fundamental and driven by the best ideas. We don't believe this is a contradiction but, rather, that the ability to do this is compatible if you approach it in the proper way. The forum was especially helpful in placing that thought in the right context. The concept is different from the idea many people had about doing research even as recently as a year ago.

Q. The term strategic has been kicked around a lot.

A. That's right.

Q. Many of the scientists who do the most independent fundamental research oppose the idea of strategic research because it is identified somehow with commercial applications or a marketable product. Is it true, as some who have read the paper have said, that the word "strategic" doesn't even appear in the white paper?

A. I'd be surprised if it didn't appear. But I honestly don't remember.

Science, a taxpayer investment

Q. Perhaps it was the word "strategic" paired with "research" that doesn't appear.

A. Again, I don't know. But I do know that our feeling is that what we want to do in science is not only the best science, but we want to constantly remember that insofar as it's government money for research grants or a new scientific instrument, science is being supported by a bunch of investors—the taxpayers.

Our job, as underscored at the academy forum, is not only to pick and choose and then fund the best science, but also to make the best use of science and to report the work and its implications to the investors in a way that connects them to it. We know the way to connect to them is to cast science not only as an activity inherently valued in its own right, but also in a way that reasserts the connection between fundamental discov-

ery and its ultimate outcome as having great utility, on average, for people beyond intellectual enlightenment. You can only determine those values by looking backward. You can't do it by looking forward. The process involves a great hysteresis.

The whole process reaffirms what economists would call the social rate of return of fundamental science. You can't predict it. Therefore you can't say we're going to do science in order to attain a particular purpose or product. You can say we are doing science because it is relevant in the following ways: It's relevant to overarching national goals, such as a more healthful population, a more pleasant environment, a stronger national economy and a stronger military defense.

Making science policy

Q. It's more than the conventional perception of many scientists that President Clinton designated Vice President Gore as his Administration's point man for science and technology. Clinton said as much during his election campaign and on other occasions since then. And so, the perception goes on, your job is not as a policy maker but as a staff director for the Vice President.

A. Policy making has been compared with sausage making: Both require a lot of ingredients and you don't want to watch it being made if you want to enjoy eating it. For my part, my plate has been more than filled with helpings of policy decisions. I am very pleased that the President picked a Vice President who really does know a lot about science and technology and is keenly interested in it. And the President himself is not disengaged in this process. The President led off the meeting of the NSTC and basically spent the first half hour talking about what he hoped to have happen. The Vice President is his point man, as you stated before, especially for environmental matters but also more broadly on all issues pertaining to science and technology. Their relationship—I hadn't thought about this before—is similar to the relationship between science and technology. One doesn't follow the other. They are intertwined in a way that you just can't pull apart. There is a symbiosis there. I therefore see myself as having two champions rather than just one. They both have been extremely helpful in this regard.

In terms of frequency, I see the Vice President a lot more than I see the President. But anyone would expect that, especially with these kinds of assignments and divisions of labor. But it's my joy, rather than my regret,

that we have two people in the White House who are keenly interested and engaged in this process.

Q. It's been said that both the President and the Vice President have some blind spots in science, particularly in basic science, and perhaps some hot spots, with environmental issues and the telecommunications superhighway being the turn-ons for Vice President Gore, for instance. Does this affect your relationship or cause you some difficulties?

A. An essential part of my job is to help inform them and give them suggestions or recommendations in the areas where I think their own internal wisdom needs to be bolstered by my presence here. Part of my job is to do what I can to make sure that their decisions related to science and technology are the most informed decisions that they can make.

Congress and science policy

Q. For all their concern about supporting the best science and technology for the country, there is another perception among some in the science community that the President and Vice President have abdicated leadership in science policy to Senator Barbara Mikulski [Democrat of Maryland] and a few other members of Congress. This is an impression received by listening to some vocal scientists at conferences and by reading the scientific press. Is this impression generated by the news media and a few disgruntled scientists, or is there some truth to it?

A. I think Senator Mikulski and Congressman [George E.] Brown [the California Democrat who heads the House Committee on Science, Space and Technology], among several others in Congress, are doing a wonderful job of paying a lot of attention to science—for different reasons. Mikulski, because she has the responsibility of chairing a Senate Appropriations subcommittee that sets the budgets for NSF, NASA and EPA, among the agencies in her jurisdiction. Those responsibilities are nerve-racking insofar as she has to balance the interests of veterans, public housing, science and other things. So she has a Gordian knot every year in terms of the appropriations process. And thank goodness she's a champion of the science and technology enterprise. So she ought to be a leader. And so should George Brown.

I don't see their role in Congress as competition to the Administration.

I see that as complementary to the leadership that we have to exercise in the Executive Branch. The President proposes, Congress disposes. And if we don't have some centers of strength on the Hill, then we can't get our job done. And vice versa.

Q. In the case of Senator Mikulski, with all due respect, she has captured a position of leadership by directing NSF to make certain changes in the way it organizes itself to sup-

port research and by forcing NASA to make choices between the space station and certain research projects.

A. You could go to every committee in Congress and make similar observations—that they are directing the Executive departments and agencies. To be sure, a lot of program decisions are made on the Hill. In fact, the Hill is ultimately where all legislative decisions are made. We are the Executive operating arm of government. People need to keep it clearly in mind that the Congress doesn't lie down in front of the Administration. If it does, then Congress isn't doing what Madison and Jefferson wanted and expected Congress to do.

So there is a persistent and, hopefully, productive tension between the responsibilities of the Executive and the Legislative. We talk and argue about this all the time, back and forth, as we review and comment on legislation. We say, Look, on a given bill, you've got some great ideas in here, but you're being overly proscriptive, and if you can pull back and let us go after it, we'll report to you annually and tell you just what's going on, and then you can make corrections. But please give us the operating freedom needed to be able to manage it day after day. That's the kind of tension that's bound to occur.

What I've seen come out of Senator Mikulski's shop is an honest effort to make ends meet in a time in which we are bound and determined to cut our deficit. We've talked about that deficit business for 12 years, but now we're doing something about it. You know it's a lot easier to talk about doing it than to actually do it. No department or agency can escape the pressure of deficit reduction, including the science agencies. When I arrived at this job, I often joked that the deficit problem reminded me of

the theory of holes. The first thing you want to do if you're in one is stop digging. That's easier said than done.

Now I would say this: If there's any investment justified on a deficit basis, it ought to be an investment that's going to pay off in the future, because that is when the people who must pay the debt will enjoy the benefits of the investment. In these years of zero-sum budget changes, everyone, including the R&D agencies, are under pressure. So any gains in science are coming at the expense of something else. That's the problem shared by the White House, Senator Mikulski, Congressman [Louis] Stokes

[the Ohio Democrat who is chairman of the House Appropriations subcommittee that rules on the budgets of NSF, NASA and EPA as well as Veterans Affairs and the Department of Housing and Urban Development] as well as many others in Congress: How can we maintain the vigorous support of science and at the same time cut that deficit down? And it's going to get tougher. It's tough enough in '95 and it's going to be tougher in '96, '97 and '98.

Message for scientists

Q. Is there an e-mail message to the science community in Senator Mikulski's statements?

A. What Senator Mikulski says—and we as scientists need to keep remembering—is that we are competing for funds not only within the science community but with other places where the American taxpayers' money is being spent. Benefits for veterans and housing for the nation's poor both rightfully occupy much of our attention and both are in the same subcommittee of the Appropriations Committee of the House and Senate. There are a lot of people in those interest groups lobbying hard and effectively for appropriations.

The science community must not sit back and think that we enjoy a permanent state of grace. We've got to earn our keep, and we've got to let the rest of society know why we think it's important to do certain things and why we think our work is a sound investment. Another result of the forums was the sense of responsibility that the science and environmental communities felt incumbent on them to speak out on their work and their purpose in ways that connect to the interests of the investors out there—meaning the taxpayers, of course.

Q. Senator Mikulski's directives,

PCAST is like the mills of the gods: They grind slowly but exceedingly fine.

contained in her appropriations reports last year and again this year, smack of micromanaging NSF. She is telling NSF exactly where to put its investments and how to organize itself. In doing this, she also has sent a forceful message to the science community. That message is receiving attention by the science agencies and by the professional societies. At least two societies are rethinking their mission statements and proposing to add language about performing research that is more relevant to society's needs and demands. That suggests a major change in direction, doesn't it?

A. I think you're right. I think it's a period of transformation that we're in. We do need to be responsive. Important signals are being flashed out there, and we need to be responsive. But knee-jerk reactions are wrong. We've got to really listen carefully and understand, to come to a deep understanding of why the general populace, for instance, was not at all unhappy about the cancellation of the Superconducting Super Collider. Why did that happen? What does it mean in terms of the way we should be moving in some areas of esoteric or fundamental research? I think the scientific societies are taking a very important lead in working with the members to try to make sure we understand the current social context in which we are soliciting continued support from the Federal government. It's a disquieting time for research scientists. Most of them haven't faced this dilemma before, but the pressure of serious deficit reductions in the last 18 months is causing considerable pain.

Q. Is it any wonder that scientists are jittery? Along with tighter budgets comes Senator Mikulski's warning to NSF and NASA that these agencies need to change the way they operate. Her appropriations report last year called for virtually reinventing NSF along the lines of the National Institutes of Health. Her directives were greeted with hostility.

A. I would hope that what ensues from that is this: First of all, it's a signal that there is an uneasiness among the supporters of science on Capitol Hill about the way the agencies are functioning—in this case, the NSF. One way that Congress signals its uneasiness is to propose something different. The proposed change isn't necessarily the way it's all going to work out, but at least it starts the process. In

NSF's case, Neal Lane has been doing an excellent job of working with Senator Mikulski in understanding her concerns and interests and those of her colleagues. It's not just Mikulski who wants to see some changes. She's reflecting the thoughts of many other members, and that's evident in the floor votes on appropriations bills and other legislation. How the changes can be accommodated in ways that makes NSF stronger, more effective and more resilient in terms of future appropriations and support by the American people hasn't been worked out yet. Maybe I'm a born optimist, but I think these dialogs—if we engage in them seriously and listen to each other carefully—are bound to result in an outcome that gets us ahead of where we were.

Congress and particle physics

Q. Congressman Rick Boucher [a Democrat of Virginia], who heads a House science subcommittee, has introduced a bill that supports the conclusions of the High Energy Physics Advisory Panel, the Drell report [prepared by a subpanel headed by Sidney Drell, deputy director of SLAC]. The report calls for the US to participate with the European nations that are members of CERN by contributing to the proposed Large Hadron Collider.

Policy making has been compared with sausage making: Both require a lot of ingredients and you don't want to watch it being made if you want to enjoy eating it.

Boucher's bill is another example of micromanaging the negotiations that would take place between the Energy Department and CERN. If CERN is unable to maintain the construction schedule that all the parties have agreed to or encounters cost overruns, the bill would allow the US to pull out of the agreement—at least that's the implication.

A. I haven't seen the bill so I can't comment on the matter. We all know there are times when an overzealous Congressional staffer seeks to exercise more management controls than are justified for the situation. There also have been times when Congress has had to write legislation in order to get anything to happen. I don't think they need to do such things with this Administration. For instance, I sent a key person to Paris for the OECD [Organization for Economic Cooperation and Development]

megascience forum. OSTP and the Energy Department are wrestling hard with how we can use the demise of the SSC as a signal that we need to get really serious about becoming part of an international consortium in particle physics, rather than to go it alone, which is where we were headed a year ago. While SSC is gone, and the money's gone too, as we were afraid would happen, we are still spending a similar amount of money—\$600 million per year—on supporting particle physics in the US. With the Fermilab upgrade and the B Factory construction at Stanford, we have accelerator capability to carry us for about another decade, which will give us time to work out some arrangements for an international consortium in which the US can be right in the center.

Internationalizing big science

Q. US science has been slow in recognizing that expensive projects should be international.

A. It's sometimes seen as a bother.

Q. American corporations have recognized globalization big time for a long time. And the trend is increasing for US and foreign companies to operate on a world scale.

A. They have done so to survive and prosper.

Q. Consider the examples of IBM or Ford Motor or Motorola—all world class companies with research teams and manufacturing plants worldwide—and Sony or NEC or Glaxo or Philips doing the same thing from abroad.

A. And we're finally getting some market signals from Congress that tell us it's time for certain areas of science and technology to do the same thing. In some areas we will only be able to maintain our leadership as partners and collaborators. But we've been leaders for so long a period, going it alone, that we don't know all that much about partnerships. We believe we can make a good start with CERN. The space station consortium is making headway in a bold and surprising way. When NASA first took up the project, it was without question the world's leading space organization. Yet it sought out participation from Japan, Canada and the European Space Agency. With the cold war over, it was natural to invite Russia, once our political and military rival in the space race, to join the venture. And it's working.

I think we need to spend more time thinking about how we can organize within the science community more effective and sustainable ways to mount these projects that give us the maximum benefit of internationalization, with a minimum of the headaches that inevitably accompany them.

Survival of research universities

Q. In recent years the academic community has expressed a fear that research universities as we know them are in peril. A committee of PCAST in the Bush Administration studied the issue. The study [headed by Harold Shapiro, president of Princeton University] concluded that research universities would need to come to grips with the prospect of abandoning some fields of study in which they were no longer world class or no longer had the faculty or finances to be world class. More recently, some leading universities have restricted the intake of graduate students in some fields of science. And universities are complaining loudly about the limits imposed by the last Administration and your own on overhead costs of scientific research. Do these things bother you?

A. It's a matter of great concern, because higher education and specifically the research universities are an extremely valuable asset to this nation and to the world. We educate many people who are future world leaders in politics, business, science, medicine, engineering. We believe, however—and this came out at the forums we have spoken about—that the old paradigm is not useful. It used to be that you got a PhD and could do what you did for your thesis for the rest of your life with a university appointment, and you would get six graduate students a year so that you could show you were productive, and [then in turn] expect your students to have a job the day they left the university. That's not the right paradigm. In future, PhDs and most other mortals will probably have three or four different kinds of careers in a lifetime. So graduate curriculums and the graduate paradigm are undergoing serious review. We don't exactly know where we're going, but we need to be thinking in terms of graduate students preparing for careers in which their graduate experience gives them not only specific skills but great versatility. They need to know how to learn and to apply their skills to move in different directions. That's number one.

Number two is to try to understand the comparative advantage of carrying out research and development in various institutions, what are the specific

skills in the post-cold war environment that need to be recognized and supported, and where it is that we can be doing a better job with the money that is available. Colleges and universities need to look hard at this matter. We're trying to do a careful review of the Federal laboratory system, which is where half our [Federal R&D] money goes. We are in the process now of determining the commonalities and overlaps at the various labs.

Number three is that we have a very strong commitment, as expressed in our paper, *Science and the National Interest*, on the intimate connection between research and education. If the research universities became weaker, then graduate education would weaken. As a nation, we can't abide that.

So the thrust is to try to be as supportive as we can in terms of the research universities. We all have to take our knocks in order to reduce the deficit. We're all getting squeezed. Universities are squeezed along with the rest of society. But we are trying very hard to maintain, if not reemphasize, the role of the research universities in our total research portfolio.

Defense research dilemma

Q. In this connection, the [Department of] Defense appropriations bill in the House calls for reducing the Pentagon's research budget by half—from about \$1.8 billion in fiscal 1995 to \$900 million. Such a Draconian cut would severely limit the amount of 6.1 funding for basic research at universities and cause some universities great pain.

A. The action would be devastating. Unless that money were to show up somewhere else or be restored in the Defense budget, it would be an awful blow.

Q. What can be done about this?

A. We hope that the Senate will be reminded in part by the university community itself about the benefits of university-based DOD research to the nation and that in conference this problem will be resolved. I, for one, think that Congressman [John] Murtha [the Pennsylvania Democrat who heads the House Appropriations subcommittee on DOD] understands the importance of this perhaps as much as the rest of us. What he's done is bring sharply to our attention that Defense research is an extremely important part of the overall Federal investment. He's had some concerns about how the money is allocated. There's this argument about earmarking.

Q. The issue is whether members of Congress should use Defense appropriations as a private pork barrel.

A. The matter is complex and convoluted. The best you can say about what's happened is that the action has focused attention on the fundamental importance of DOD research in our overall research portfolio. It has made us think we weren't paying close enough attention to DOD research and its significance for educating computer scientists, condensed matter physicists and so on.

Q. That surely wasn't Congressman Murtha's intent, was it?

A. I haven't talked with him directly about his action, but it has had a volatile reaction. It may well have been part of his strategy. I would hope that the various science and university communities respond to this. We're about to send a letter to him that expresses the President's reaction—namely, that this Administration is committed to sustained support of fundamental research. Fundamental research does not come solely from NSF programs; it is generated by places like DOD.

Q. At a hearing of the Galvin committee examining the future of DOE labs [and headed by Robert Galvin, former chairman of Motorola], John Deutch, the deputy secretary of Defense [and a former dean of science and provost at MIT], was asked about cuts in DOD's basic research. He said the Administration strongly supported 6.1 and 6.2 research and did not intend to lose one penny of it.

A. The President's budget for 1995 went in with heavy support there. Now there are other areas that we feel need trimming back at the Department of Defense, but the research is the *sine qua non* to keep our defense capabilities up high. We need to know what's going on. And we need to be at the forefront of research that in a broad strategic way is relevant to national defense. So there's no question about where the Administration stands on this. It's a matter of how we can work it out with Congress.

Labs competing with industry

Q. Another subject brought up at the Galvin meeting on DOE labs came in a question by Ben Rosen, CEO of Compaq Computers. Rosen asked whether the nuclear weapons labs, in their search for a new mission, not only would enter into research collaborations with commercial companies but might actually want to compete with industry by developing products for the marketplace. There seem to be some worries about this in some industry circles.

A. Not about competing with better bombs, though. This Administra-

tion certainly wouldn't support any notion for the labs to compete with private industry. We do support the notion that the laboratories are, first of all, primarily there to help fulfill the supporting agency's missions. We also feel that information and technology gained in work on mission needs, using very special and expensive resources and facilities at the labs, could and should be more broadly shared in the American economy. So we encouraged cooperative research agreements in which industry interests and laboratory resources can be brought together to cooperate more extensively, through the so-called CRADAs [Cooperative Research and Development Agreements]. In many ways that is working very well in a number of the labs—from supercomputing to high-temperature materials, in automobile technologies and many other technologies. It involves sharing national resources with our national industrial base. But we want to make sure that what is done is done collaboratively, rather than competitively, with industry. And that such collaborations be cost-shared and that it have specific milestones and outcomes.

In my experience at Oak Ridge, where I helped form one of the first private-sector companies that drew upon technology that had been developed in the laboratory, that was the way it worked, and several people at the lab ultimately left and went into private business. There are now about a hundred of those kinds of start-up companies in eastern Tennessee, largely because of the presence of the university there and the national lab. So we would hope that the entrepreneur types in these labs might well want to leave research and start a business, but not start a business in the laboratory.

Dual-purpose technologies

Q. Defense Secretary William Perry and his deputy, John Deutch, have stated several times that the Pentagon will be buying commercial products more often than it orders some special military technology. They have made it clear that Defense is interested in dual-purpose items, of use in civilian life as well as for military purposes.

A. That's absolutely part and parcel of the so-called reinventing government concept. It was part of our technology outlook symposium at San Jose in February 1993. It's the notion that the way technology is moving, more and more dominated by commercial markets rather than by defense markets. It's the reverse of the old idea of spin-

out technologies—that defense is going to be able to get more for its buck by buying from the commercial sector rather than inventing it. So the whole notion of procurement reform has flipped. But it takes a long time to get that into the system. And dual use is another facet of that same thing. It's to procure, when you can, from the commercial market, and get away, when you can, from milspecs [military specifications], because they're a lot more expensive. And sometimes Defense doesn't get the best. The front edge of a lot of sectors, such as advanced electronics, comes out of the commercial sector. It doesn't come out in the military sector any more. So Defense would be impeded by adhering rigidly to milspecs. That's why Perry and others want to move it to where acquisition is basically reformed. I think they're right. They also want their R&D programs to keep in mind that dual use is to the department's advantage.

Q. Does this new way of doing Defense business have implications for the future of the Advanced Research Projects Agency? This Administration hasn't put as much money into ARPA as it has NIST—that is, the National Institute of Standards and Technology.

A. In my book, ARPA is extremely important in that they're helping take the lead in moving toward dual use and facilitating defense conversion, which is a big issue. In fact, one of my people is in Siberia right now sharing with some of the Russians what we're trying to do in defense conversion technology. Because if we think we have problems getting converted, just think about poor Russia.

Q. Why are you investing so much in NIST?

A. NIST is growing, we hope rapidly, toward being about the same size as one of the smaller Federal laboratories.

Q. Is the Administration's vision of NIST that of a civilian ARPA?

A. Our vision of NIST is a place where R&D in the civil side of our economy gains more attention as we shift from defense-dominated to civilian-dominated R&D. NIST is the place where we hope to embody a capability to elicit really interesting new partnerships between private-sector ventures, maybe consortia of universities and local industry and the Federal government, to push research in the direction that enables new kinds of commerce to appear, new kinds of ways of doing things that either improve our environment or our health or our manufacturing productivity or some other aspect of our economy. The mandate for NIST includes providing new ways to make

the best technologies more accessible to small business. In other words, NIST is intended to facilitate and underscore the diversity and resilience of our civil sector. And we do it along the lines, again, of partnerships, cost-sharing, tough milestones, outcomes-based analysis and sunset timetables.

Q. Do you see NIST as a broker rather than an actual laboratory or research organization?

A. Yes. It's more of a catalyst than a lab in and of itself. It's a place not only with its traditional functions and emphasis on standards, but it's an important part of the development of the civil sector. So its old functions remain, but the major expansions have to do with fostering, catalyzing, managing and evaluating those kinds of public-private sector ventures.

Q. And will NIST be able to cross the spectrum of Federal agencies? Even though it is now a part of the Commerce Department, can it function through another department or agency—say, in Energy or DOD?

A. Sure. Or in NASA, let's say. NIST can do that with the cooperation of those other agencies. It's part of the partnership we envision, not only between the public and private sectors but across our Federal agencies. To facilitate that is where NSTC comes in. That's the apparatus that enables this to happen easily because all the principals are involved.

Q. That answer brings us back to where we began this conversation—with our discussion of the NSTC. I want to ask one last question: Why did the NSTC exclude biotechnology and advanced materials as two of the Presidential initiatives, since those are so important to our economy?

A. We didn't. These two R&D fields are included in the portfolios of the NSTC committees on industrial technology and on health, safety and food. Biotechnology in and of itself is not so important, and neither is energy. It's how they each relate to some of these overarching national goals. Our work on and support of biotechnology continues to be very important. But we don't think it was necessarily that productive in terms of just doing the budgetary crosscuts. Attention to biotechnology and advanced materials has not disappeared. The topics are incorporated into the NSTC structure. I think that makes a lot more sense, because the structure is organized around a better match between R&D and national goals than it was under the FCCSET arrangement. Those who think we've dropped those two fields ought to look a little harder. ■