Keyworth: Parting shots from the White House science office

George A. Keyworth II left the White House Office of Science and Technology Policy at the end of 1985 with the nation's scientific enterprise in better shape than he found it, but with some vexing problems still to be solved. In the four years and seven months he had been OSTP director and President Reagan's science adviser (five months less than Donald F. Hornig, the Harvard chemist who served as science adviser during Lyndon B. Johnson's "Great Society") Keyworth was rightly credited with increasing the budgets for basic science. But he had no desire to stick around for the decreases in science appropriations that are sure to result from the Gramm–Rudman–Hollings deficit-balancing act.

Personally a cheerful optimist and politically a Reagan loyalist, Keyworth still believes, as he reveals in the following interview, that the country can have it all—a defense build-up, a Strategic Defense Initiative, major science facilities, even a hypersonic aerospace plane. All this is possible, claims Keyworth, despite the incontrovertible priority of reducing Washington's budget deficits to zero between now and 1991.

Reagan's performance at the Geneva summit conference with Soviet General Secretary Gorbachev effectively "made me obsolete," says Keyworth, in the sense that the President had asked him in December 1984, when he had seriously considered resigning the OSTP job, to stay another year or "until SDI is out of the woods." The President's resolute commitment to "Star Wars" research at Geneva, he asserts in the interview, in effect was like "pouring concrete around the foundation of SDI. This reassured me this was an excellent time to leave. It put me out of business."

Keyworth organized a business of his own in January. With Herbert Meyer, a former editor of *Fortune* and vice chairman of the Central Intelligence Agency's National Intelligence Council, and Bruce Abell, OSTP's spokesman in the Keyworth years, he has formed a consulting service in Washington to help businessmen gather "intelligence" about new technologies to improve their positions in world markets.

Keyworth's tenure as a White House adviser was controversial. From the outset he reversed the traditional role of White House science adviser. Previous occupants of the office have functioned chiefly as conduits into the White House for the scientific community. Keyworth saw himself as a member of the President's team, not as a member of the science community. As such he spent from 50% to 80% of any given week over the past year explaining and promoting Star Wars, which many academic scientists and policy specialists just as vocally opposed. His activities led his critics to characterize him as a "cheerleader" for SDI. Keyworth blithely accepts the appellation, though he bristles at name calling, such as a newspaper cartoonist's label of him as "Dr. Dense Pack."

KEYWORTH

Keyworth was wholly unknown in science-policy circles at the time of his appointment in May 1981, having spent his entire career at Los Alamos, where his last job was physics program leader in charge of military lasers and inertial fusion. His principal backers for the White House position were Harold Agnew, one of the country's chief nuclear-weapons designers and former director of Los Alamos, and Edward Teller, now with the Hoover Institution. When Keyworth arrived, the fate of basic science seemed uncertain in Washington. Right off, Keyworth faced a hostile audience at the National Academy of Sciences, where its new president, Frank Press, fresh from service as President Carter's science adviser, organized a politically embarrassing review of Reagan's hurried efforts to trim nondefense research from agency budgets that were inherited from the departed administration. Less than a year later Press almost canonized Keyworth as a savior of science, observing that Keyworth had urged patience to those in panic and that "in many areas of basic science he did achieve real growth, and I know he had to fight for it."

During the Keyworth era, funding for basic research surged by 56% to a new high of $8 billion in fiscal 1986, with more than half the support going to universities. The total increase is equal to a real rise of 26% after inflation is taken into account. This was exceeded only during the peak years for scientific research just after Sputnik. Keyworth found support in the White House to bankroll the budgets for defense, physics and computer research with increases of 13% to 18% per year, and he got similar backing for minimal increases in the social sciences and biomedical research. This funding scenario is in keeping with the main themes of the Reagan Administration: to strengthen military and industrial technology while at the same time reducing demonstration and development of technologies it argues are better left to commercial ventures, particularly in such fields as energy, medicine and transportation.

Though a polished public performer, his manner is often blunt and confrontational. One of his first speeches before The American Physical Society was a lecture on unrealistic expectations for Federally funded accelerators; the next year, at another APS meeting, he admonished physicists for their "strangely dogmatic" militancy against SDI. He admits he has done little to defuse the scientific debate over SDI. For that matter, he says he could have done more about two other problems he is turning over to his successor: the "big science versus small

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science" controversy and the government's confused and often arbitrary approach to restrictions on unclassified research and on access by certain foreign scientists to advanced computers. In retrospect he considers such scientific restrictions to be "nonsense."

Though he recommended to the White House that Erich Bloch, director of the National Science Foundation, be named acting head of OSTP "for continuity" until someone is permanently appointed, Keyworth was rebuffed and John P. McTague, OSTP's deputy director, was made acting director.

In an interview with Irwin Goodwin of PHYSICS TODAY, conducted on 10 December in Keyworth's spacious corner office on the third floor of the Old Executive Office Building, Keyworth spoke of his accomplishments, his disappointments, his relations with the President and the bureaucracy, the Star Wars program and the President's "open labs" idea for sharing research with Soviet scientists working on a space defense against nuclear missiles, and the problems he leaves behind for his successor. Keyworth also describes the unprecedented lunches at which the President discusses scientific and technological developments and policies with the nation's top scientists and engineers. Excerpts from the interview follow:

Q. Why are you leaving OSTP?

A. People in this office normally spend one term here, so it's natural to consider leaving. I also recognize several things. First, my successor should have time to get things done. Second, the President's performance at Geneva was as much a catalyst [to my leaving] as anything.

Q. What do you consider your principal accomplishments at OSTP?

A. The priority for basic research is well established and the concept of trying to better integrate industries and universities by forming centers like the Engineering Research Centers developed by NSF. These are the things I look back on as my most important contributions.

Q. What about your greatest disappointments?

A. I don't feel any disappointment. I mean that quite seriously. Even my concerns, which I think were well known early on, about whether the space station was being represented in a candid fashion are completely withdrawn when I now see the prospects of reducing the cost of launching materials into space by a factor of 100 or so with an aerospace plane. I think such a vehicle suggests a new set of dimensions for space travel.

Q. Do you think there's much chance of funding such a plane?

A. In my years here I haven't seen anything that has received as high a level of support in such a short period as the aerospace plane. I think we'll doubtless proceed with it, flying a prototype in the early 1990s. The Air Force, DARPA, NASA have all been committed to the project for several years. It's not a brand-new program.

Q. Philosophically, though, isn't it the sort of thing this Administration has opposed—a civilian project funded by Federal dollars?

A. It began in DARPA because it was pertinent to defense. But it also has applications for a full spectrum of space capabilities as well as major importance in commercial air transport. The commercial aspects will see large involvement by the private sector. In a classical sense, it is a defense spinoff to the civilian community.

Q. Is this aerospace plane—or hypersonic transport, as some have called it—another life for the Supersonic Transport?

A. It doesn't resemble the SST in many ways. We're talking about an airplane that flies at possibly Mach 15 at altitudes up to 150 000 feet or more. We're talking about a plane with a range [that is] virtually unlimited, because it is capable of reaching space orbit. It would climb at a high rate, so that the significant shock disturbance—noise—would be drastically reduced. Most of all, there is the possibility—still premature in our thinking now—of being cost effective because it could carry large payloads.

Q. Are the Soviets working on something like this?

A. Not to the best of our knowledge. I would say that's fairly unlikely because the range of technologies that have come together—materials, propulsion, design—give us a rare exponential opportunity. There is no single advance or invention involved, like the transistor, say, but an array of new ideas and technologies. Imagine, an hour to Europe from Washington or New York and an hour and a half to Japan. Incredible!

Q. What sort of support do you seek from industry?

A. Defense and NASA will need to spend $3 billion to $4 billion to build and fly a prototype in 1991 or so. By doing that, we will gain a lot of experience with ultrahigh speeds and the companies in this new domain can then proceed to build commercial aircraft. Virtually every aerospace firm in this country, including engine manufacturers, has been involved in the project for the last three years. They are all very excited about it. Everyone in defense and space sees applications and opportunities with the aerospace plane. The only hitch is there may be a tug of war over who pays for what.

Q. Except maybe the airline companies that looked at the Concorde and found it wanting.

A. Let me remind you that the Concorde, from its beginning, along with the SST proposed by the US, had severe problems of noise, range and capacity. On top of that, it only flew at Mach 2. So the ratio of total flight time introduced by the Concorde was not so dramatic.

Q. The cost of an HST prototype is about the same as that of building the Superconducting Super Collider. Which do you consider more important?

A. No more than I would compare a B-1 to a university contract would I compare those two. I think an SSC is absolutely essential if we're going to maintain our national commitment to being number one in fundamental research. The aerospace plane, or, as some call it, the TAV, our transatmospheric vehicle, is critical if we're going to maintain preeminence in technology, broadly, and aerospace in particular.

Q. Can you discuss the President's feelings about SSC and HST?

A. A President's job is to make policy. This President has supported basic research and that's why SSC has been carried along. As for the TAV, the President has not been briefed on it yet. What I'm saying is that Ronald Reagan does not spend a lot of time poring over each item in the Federal budget. We're now spending $20 million a year on the SSC, and the TAV is only a small part of DARPA, which in turn is a very small part of Defense. Neither item is a Presidential priority.

Q. Would you talk about some of the broader issues of science and technology policy? What will Gramm-Rudman-Hollings, for instance, do to the overall Federal-support situation in the next few years?

A. Gramm-Rudman-Hollings attempts to contain the budget deficit and places some limitations on our ability to support our priorities. In that context I think science can thrive because of its present high priority. But it will be increasingly difficult for us to see the kinds of increases we saw in this Administration's first term. I

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look at it positively, but I think that under Gramm–Rudman it will be more difficult to have dramatic thrusts. Gramm–Rudman does not mean we will look to more "privatization" of science. Basic research is a Federal trust in large measure. Still, we need to make some changes, albeit modest, in how we build science and technology base links with our universities. Having industries involved in multidisciplinary research centers on campuses is, in my opinion, the best way of narrowing the existing gap between science and technology, as well as of catalyzing the intellectual base in newly emerging technologies. It's an opportunity to help narrow the industry–university chasm for a lot of smart people in both sectors.

Q. What's the likelihood of centers being formed at, say, 50 campuses?

A. One thing I can say with great certainty is it's 100%. The pace at which we get that number, I have less confidence about. But it's happening. We had $10 million in NSF's 1983 budget for the centers, and we had proposals [submitted] totaling $2.2 billion. That kind of response with new proposals in a matter of months does not occur unless those universities had ideas for it on their own, so that when the Federal program was in place they were ready to jump. The centers are an example of a program born in many minds simultaneously. It's not just NSF. It's the Agriculture Department. It's Defense. It's the National Institutes of Health. There's support in the agencies, in the White House, in OMB, on both sides of Congress.

Q. Will you speak about your contribution to SDI?

A. The President's accomplishments at Geneva represent pouring concrete around the foundations of SDI. I think General [James] Abrahamson has done a remarkable job in building the foundation of a strong program. I feel thoroughly confident that the directions of the program and its emphasis on high technologies for ballistic-missile defense are on a solid footing. I think the nature of the public debate on SDI was fueled heavily in the months before Geneva. I think the public is much more enlightened now. I think the same thing is true for Europe. This is reflected in the strong support SDI is getting in recent opinion polls. The program is here to stay. We now have a tremendous amount of work to do, and I think you'll see some strengthening of the SDI office and structure over the next few months.

Q. What was your precise role in SDI, beyond your own speeches?

A. The process of preparing the President's first speech [March 1983], the formation of the technical basis for supporting it in the first place, up through the development of the program, the policy and the articulation of it. My primary role was as science adviser to the President, obviously, on the feasibility of it and the various approaches.

Q. Did you run into obstacles in the White House in promoting the idea or did you have to shoot down any exaggerated high hopes for it?

A. Never the latter. I've certainly run into obstacles, but these could be characterized as resistance to change. That's very human. Bureaucracies are traditionally resistant to change in all forms. Change threatens the bureaucracy. The bureaucracy most certainly reaches into the White House, and if you think that there was no opposition to the SDI speech there, either before it was given or after, then you are greatly mistaken.

Q. Were people on your own staff opposed to SDI?

A. Certainly.

Q. Is your statement about the bureaucracy more generic than just SDI?

A. The response to SDI is a classic example of resistance to change, of preservation of the *status quo*. When we see hordes of people who have been vocal antinuclear advocates suddenly come around to being arch advocates of mutual assured destruction, solely to keep the *status quo*, I think it's a classic case.

Q. What is it going to take to make SDI not only popular in Congress, with the bureaucracy and the wider public, but to make it feasible? Another Manhattan Project?

A. The Manhattan Project was done in wartime, when society was mobilized. To me, it's very simple. You have a Presidential priority associated with SDI that is clearly number one. And you have an issue that is almost unique in the sense that it has dominated the world press for more than a year. The structure and scope of the SDI program have got to reflect this.

Q. What form should the program take?

A. I don't think I'm qualified to say. We've been involved. We [OSTP] continue to be involved. But the best structure to maximize the military support, to bring in the scientific community, the industrial sector and our allies—there are so many different ways it can be done. A fourth star for General Abrahamson would be a good start.

Q. Do you think there ought to be another Los Alamos to bring top scientific and technical talent together for SDI?

A. No. I think we do things much better when we draw upon talent and resources across this country. Some people have talked about a Federal research corporation that would support SDI outside the government structure. But a centralized research facility for SDI? It requires much more.

Q. Right now, SDI is fragmented—a handful of top people at the Pentagon and a few offices in downtown Washington, each of the Defense research offices reviewing proposals and so forth. What's to be done?

A. The program is growing. It clearly needs a larger program office, more people. We're trying to attract top talent, from the military and from outside. There's no question that SDI will be bigger every day for a while.

Q. President Reagan on several occasions has spoken about sharing SDI information with the Soviets, working toward a common goal of defense against nuclear weapons. What is your view of this? Did you have anything to do with the idea?

A. It's a very interesting point you raise and much more important than widely realized. You ask if I had anything to do with it. Look, someday people will realize—as few now do—SDI is the President's program. The only time I've seen the President jump up, [he said:] "Look, why do people keep searching for the origins of SDI. This was my idea." The President is the classic promoter of the argument that a man can do anything if he doesn't care who gets the credit. You know, he struggled two years with this idea. The reason it was born in his head is that only a President thinks about the problems other Presidents after him are going to deal with. Yes, he asked us whether it could be done.

Prior to the President's speech, it was clear what the President wanted, and it was clear to me that the word "sharing" goes back to those formative days. The President believes neither superpower should perceive the other as a first-strike preemptive threat. Putting it in more common sense language, if either side should perceive the other as having an advantage by striking first, then it is an unstable situation. Before Geneva, on numerous occasions, the President raised the question of sharing. It took different forms: sharing SDI, sharing technology, sharing infor-

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mation. If it's necessary to ensure that neither we nor the Soviet Union sees the other as possessing a first-strike threat, and if [it's] necessary to share something to achieve that, he proposes we do it. As a first step, he says, let's try "open labs." Let's get our foot in the door by opening the centers of concentration in SDI research—Los Alamos, the place I come from, being one. We would invite Soviet scientists to see what we're doing and ask them to do the same. In this scenario, there would be no surprises.

Q. Have you started any preliminary discussions along this line?

A. It's trivial for us to do this. We've had Russians at Los Alamos for years.

Q. There is some difference of opinion about the sharing concept. Richard Perle [assistant secretary of Defense] told the House Foreign Affairs Committee yesterday that there would be no sharing until we could get an agreement with the Soviet Union about arms reduction.

A. Richard Perle is a member of the Department of Defense. I am a staff person in the President's house. I'm telling you what I think the President means with his word "sharing." I say it from having heard him from the outset. The particular way it would be codified, which is what Richard is addressing, may well be linked some day to progress in arms limitation. But I think the President is focusing on crisis instability, where, in an age of counterforce, a preemptive strike is a real problem.

Q. I'm sure you've heard some of your critics say you have traded in your hat as an adviser for science policy for a hat as a policy promoter.

A. The criticism is just. I serve as an adviser and articulator of science and technology for the President's entire program. If I felt the science and technology parts of the program were wrong, I'd simply have left. I would have—and could have—at any time. So I think it's fairly obvious: Not only do I believe firmly in every single one of the President's objectives in SDI, I am also telling you candidly that it is by far the most important thing I've every been associated with. When I look back on the things that mean something to me personally—not to my image—I assure you that there is nothing I feel prouder of than having worked on SDI. When I have sounded in harmony with the President on SDI, it wasn't because I'm a parrot. It's because I deeply believe in what he's doing.

Q. If you feel so strongly about SDI, why don't you join the program?

A. That's a perfectly legitimate question. If I felt the program needed me, I might just do so. I think the program is, albeit a fledgling, a healthy fledgling.

Q. There were physicists who were pleased when you were named to head OSTP because they hoped you would push magnetic fusion research or new particle accelerators. They hoped for an in-house advocate. They were disappointed.

A. Lots of people wanted or perhaps expected me to advocate something they were connected with. How about national labs? I came from a national lab. I was the first science adviser from a national lab. I worked in fusion research. But what happened is that I emphasized basic research in universities far and away more than at national laboratories. And I've been critical of the amount of leverage held by our national laboratories. The fusion community has pushed aggressively to build the next-generation machine, which seems to me to be based more upon habit than upon sound judgment. Instead, we have turned our attention to a better understanding of the underlying science of plasma to give us a better intellectual base to take the next step. I'm sure there are other scientists who are disappointed. I think we have done exactly the right things.

Q. Are you disappointed that the recommendations in the Packard report [on the national laboratories] have not been fulfilled?

A. No. Actually, I feel very positive. There are some who would like to check off each recommendation as it is achieved. I would say the climate in the national laboratories has dramatically changed. A few years ago the laboratories held the attitude that "we measure our relationship with industrial firms as proportional to their distance—the farther away the better." That insular attitude is now different. The labs have sought opportunities for interaction with industry. That's good. And in Congress there is discussion about a [civil-service] personnel bill for better compensation and better recognition of merit for the corps of scientists and engineers in government. The aim is to keep them in our laboratories. I think there's a good chance of some bill being passed.

Q. Are you disappointed that the idea of a Department of Science and Technology hasn't advanced at all?

A. Quite the opposite, and I'll tell you why. As anyone who has worked in this office knows, my real concern has been more fundamental. That's why this country's science and technology are models for the rest of the world. This nation has risen to its present level of preeminence on the backs of our science and technology. Yet I know of very few countries where science and technology are given such low priority in government as here. This has little to do with whether we have a Department of Science and Technology—that is, it's marginally related to a department. It has much to do with the way Congress is organized—with the way the whole government is organized. But most of all, it has to do with what our elected leaders and representatives see as the major political priorities. When there are parents that want their kids to be computer programmers, scientists, engineers and technical specialists of all sorts and this is a tenth-order priority in our government, you've got a serious mismatch.

On a Department of Science and Technology: Yes, I think that's a very good idea. I think it should be done. But most of all, what's really important is to get it on the table, get people talking about the pros and cons of it. I think that has happened. I hear people constantly saying things like: "OSTP should be changed." "It should be reduced." "It should be elevated." Many of the proposals show very little comprehension of how this building works. This is a small place, with few people, and one's ability to function depends upon one's personal relations entirely. Rank has little to do with it. My rank is technically the same as Ed Meese's was when he was at the White House. My position and importance have to do with whether the person elected to serve in the White House wants to use his science adviser as a counselor. That's all there is to it. So when people have called for the science adviser to have cabinet rank, with a department, what does it mean? Is [CIA Director] Bill Casey a cabinet officer? No. What he is is a close, trusted confidant of the President. That's what matters. The number of people who sit in a cabinet meeting is large. In my first two years, I spent a tremendous amount of time and effort supporting the Cabinet Council process [at sub-Cabinet-level policy discussions], and I would say that I've probably gotten a lot more done in the last couple of years when I have been forced to spend an awful lot more time on other issues, like SDI.

Q. Have you learned any lessons in the years you've been in the job that you

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might pass on to your successor?

A. Let me say, humbly, not only have I never learned as much, I never even knew it was possible to learn as much in four and a half years. Bruce [Abell] and I are going to try to write a book. To me, most of all, it is that scientists and engineers are called upon by their country in times of change. Change can be caused by crisis—war, social transition, economic competition and so forth. Today it's created largely by a world transformed by international competition. Who would have predicted only ten years ago that China was going to be the nation with possibly the highest economic growth in the world? Today's change is dramatic and, as I say, we scientists and engineers are depended upon more than ever. Yet, when the pace of change is multidimensional—political, economic, technological—we scientists tend to be one-dimensional. I think that people who come to Washington with technical backgrounds need to immediately begin to acquire information about the other dimensions. You know, the day of statesmen in science—the 1940s and 1950s, with Vannevar Bush, John von Neumann, Alan Waterman—those days seem to be gone. Much of the scientific community's efforts in dealing with the major national issues in the last few years have been very one-dimensional. A notable exception is the responsible job the scientific community has done in dealing with AIDS.

I would say with SDI—and I say this with no bitterness, regardless of personal confrontations and rotten eggs and so on—the frustrating thing has been the narrowness and shallowness of the debate within the scientific community. I would say, as I often have, that it far more resembles maintaining the *status quo* than exploring an extremely complex problem. I'm not talking about whether lasers can penetrate the atmosphere. I'm talking about political, economic, social and technological stability.

Q. How can your successor deal with the situation you portray?

A. I hope he comes from a broad experience base.

Q. Few people come to Washington with as little touch of political experience as you.

A. If you try to pick a model, it's hard. I came from a national laboratory, so some might say, "He was terrible, so don't pick another guy from a national laboratory." Yet I had one advantage at the laboratory I came from. It was multidisciplinary—defense work, medical research, the frontiers of physics, chemistry, biology, as well as links with universities and industry. It gave me exposure with quite a bit of breadth. That was an asset for this job. I had another asset. I had a superb teacher, Ed Meese [formerly counselor to the President and now US Attorney General], who patiently explained to me a lot of areas of complete unfamiliarity. I am very much indebted to him.

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Q. On political matters?

A. It wasn't just political. Watch Ed on tv some time. He has a lot more dimensions than political astuteness. In being a member of a policy team that Meese gathered in his office every day, I had a chance to look through the eyes of a lot of other people at a single problem, and, lo and behold, from each view, the problem looks somewhat different.

Q. When you came to Washington, you urged the scientific and engineering communities to pay more attention to national priorities than to parochial interests. You said money was going to be limited, that quality was important. Have the scientific and engineering communities made any progress in identifying priorities?

A. First of all, I would say the engineering community has done the best job of that. I've gained a lot of respect for engineers. The way in which the Engineering Research Centers have evolved in the National Science Foundation, I think, is a testimony to that. I think the scientific community also has done a good job. There are traditional areas where it has worked—the space sciences, for example. Look at a tough one we have wrestled with for three years—in elementary-particle physics, encouraging the community to focus not on regional distribution of machines, but on what it would take to ensure that we were number one in particle physics. It was painful, but it was done well. Even so, there is something that I'm very disturbed about. That is the "big science versus little science" debate. This is a legitimate concern—that concentrating on big facilities is not the only way to ensure that we train the best possible people. The issue challenges us. We simply have got to have a broad research base. When we have SSC, for instance, how are we going to structure teams so that we train world-class elementary-particle physicists? The SSC is the epitome of big science. It is going to create more difficulties and place more burdens on individual investigators who are training students. No question about it. But that's not what the argument is all about. An awful lot of the argument is really between the "haves" and "have-nots," and a lofty objective [SSC] is being used to cover up an awful lot of just plain squabbling. When we present that kind of image to the wider community—I mean to the Congress, rather—it erodes what is inherently a strong support base.

Q. Math is one of those traditional have-nots. How has this small science done in setting priorities?

A. The mathematics community has done a good job, because the problem is not the community or what form of mathematics should receive emphasis. The problem is much more fundamental and reflects how we don't react to change very well. As the demand for people trained in computer sciences grew quickly, emphasis was placed on computer-science research and computer-science support at universities. Unfortunately, this defocused attention from the foundation— basic mathematics. Essentially, emphasis on computer sciences overwhelmed the support mechanisms. We're just not paying enough attention to mathematics, not to individual aspects but to mathematics as a whole. If I had a money tree, mathematics would get a lot of its fruit. But I'm conscious that this will happen. Erich Bloch is this year, as last year, setting clear priorities [at NSF], and mathematics will be high on his list.

Q. Mathematicians and individual scientists have fewer constituents to lobby for their fields.

A. Actually, there are far more people in small science than there are in big science. Mathematics is a particular case. There are far fewer people in pure mathematics than in computer science. You know, we have a computer vogue, which overshadows pure mathematics. That's not a big science–small science problem. That's simply a matter of not feeding the roots of the tree when the tree is growing so fast. You know, mathematicians are not noted for their great powers of expression.

Q. Do some scientists feel neglected by this Administration?

A. Oh, sure. Everybody feels neglected, including those who have had 20% increases year by year. They feel neglected, too.

Q. Are you encouraged or discouraged

by the government's attitude toward matters like restrictions on unclassified science papers and access to university supercomputers?

A. You know, some years ago, a prominent weekly newsmagazine sent a woman reporter to interview President Reagan, one on one, and one of her questions dealt with technology transfer at our universities. The President said: "Universities are one of our great strengths. We have none greater. And I assure you that we are not going to do anything that changes the vital environment of our universities." It took us about three years after that to get the National Security Decision Directive on scientific communication signed by the President. It wasn't held off by the President. It was the bureaucracy. The order was very simple. It said that open communication in science is traditional and that the government is not going to change that. We want openness in universities. The directive took a long time coming, and I'm glad it happened. But I think it's frustrating that the President's objective took that long—how shall I say it—to get the message accepted by everyone in his Administration. I do not think that we deal with technology-transfer issues in a thoroughly rational fashion, even now, and the reason is because I think there's so little technical depth in the government to understand whether a particular area of technology represents a potential threat abroad. So I certainly do have concern.

On the supercomputing issue, there is one frustrating thing. Supercomputers are seen, I think, as some kind of data bank for nuclear-weapons design. And having come from this field, I can say that only the most advanced nuclear power would benefit significantly from possession of a supercomputer. It takes a wealth of data to support the codes that are on supercomputers. They're especially effective when they're linked to an active testing program, which a new nuclear power would not be likely to have. So the connection between nuclear proliferation and supercomputers is vastly overstated. The focus on supercomputers has made it rather difficult in some ways to deal rationally with the whole tech-transfer problem.

Q. Looking back on the issues of secrecy and supercomputers, is there anything you could have done that might have defused an angry scientific community? There was great agitation over those issues and still is.

A. I didn't speak much on those issues. They have been bureaucratic issues the whole time that I've been here, and with bureaucratic issues it's better to keep your words inside. I think there were a few shrill screams from within the scientific community that were uncalled for—that were unjustified, I mean—but, basically, I think the concerns of the scientific community were respected in large measure and carried forth. I'll give you an example: The Corson panel [which issued a National Research Council report in 1982 on restrictions on scientific communications] did a responsible piece of work in my opinion.

Q. But in the end, it was neglected.

A. No, it was not. It was a very powerful basis for getting the President's directive on scientific communication accepted by all parties. The "gray area" proposed in the Corson report was a problem because it lacked a clear definition and could be a gigantic impediment to open communication. Once I was shown a professor's notes on the most rudimentary aspects of electronics that someone wanted to withhold and classify.

Q. Could you talk about the new organization you are starting?

A. You know, most of the issues here that I've been wrapped up in—whether they be basic science at universities, the engineering centers, international cooperation in science, even trying to gain greater leverage into national security through advanced technology such as the Stealth plane or the aerospace plane or SDI—have to do with our competitiveness. I was the only member of the Administration to serve on the President's Commission on Industrial Competitiveness and helped establish it in the first place. So I've gotten interested in the whole question of how American industries can become more competitive. Our strongest competitors, Japanese firms in particular, have access to a coordinated information base to help their corporate leaders plan. Ours tend to operate intuitively from information obtained in an era when the domestic market dominated their thinking. American companies simply lack organized information about how to be more competitive abroad—"intelligence" about the political, economic, cultural, technological environments in foreign countries. What we're going to do is not sell information, but help our businessmen develop strategies and structures in their organizations to become more competitive.

Q. Did the idea for this come from your work on the Young commission on industrial competitiveness?

A. It came from many things. Let me share with you several observations. One of the reasons I'm so high on industrial-university centers on our campuses, why I advocated 50 such centers in a speech I gave, is that when I was on Capitol Hill talking to people about protectionism, I was aware of their frustration. Many of them said they voted against protectionist legislation, but they wanted something positive to counter the arguments for protectionism. I began examining a few advances—computer vision being one. The Japanese are aggressively pursuing this field, and we're sort of randomly pursuing it. We graduated nine PhDs last year in research that you might identify as on the edges of computer vision. I asked myself, what would I do if I wanted to ensure that we were number one in this field? Our first reaction is to put a $2-billion DOD grant into US industries. We could do that, but even if we did, I'm not sure we would win. Then I thought, I do know how to do it. I'd build five centers on academic campuses—no, I won't define them, because I'd wait for the proposals—and fund them at maybe $5 million to $10 million apiece. In this way, I would multiply the nation's intellectual base and improve the research climate, by factors of 10 or 20 or 30. I think we do this better than any other country. In my gut, I am confident that if we were to do this there is no question who would be number one in computer vision. I decided I was too young [at 46] not to get out there and help do it better. The thought of being a college president does not inspire me.

Q. I understand you've been thinking about leaving for more than a year.

A. Yes and no. I thought seriously about it at the end of the first term. Everybody does. But last year—at almost exactly this time—the President asked me if I would stay until SDI is out of the woods. Now you know why I went to see [White House Chief of Staff] Don Regan on one of the first days after the Geneva summit meeting.

From the beginning [with Regan] I started talking to him about SDI. The result of that is we've started an interesting innovation at the White House: technology luncheons with the President. We don't talk about them much. It began by bringing our Nobel Prize winners to lunch to talk with the President. We had a luncheon a few months ago and brought in some key technologists—Sol Buchsbaum [Bell Laboratories], Ralph Gomory [IBM], experts in neurobiology. It was one of the most exciting hours I've spent in my life.

Q. Were you all seated around one table?

A. Yes, having a private lunch with the President.

Q. What went on?

A. The purpose of these luncheons is to give the President a sense of how scientists and technologists see technological change coming about. I ask the participants not to lobby for anything, just give him your sense of what lies ahead in your field of research. It's incredibly exciting. The President absolutely enjoys these sessions. □