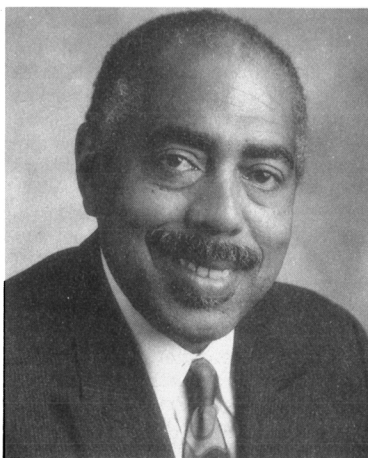


CONVERSATION WITH NSF'S WALTER MASSEY: LEANER TIMES, MEANER TIMES FOR SCIENCE

When Walter Massey entered Morehouse College in Atlanta as a freshman in 1954, after completing the tenth grade in Hattiesburg, Mississippi, he had never heard of physics or taken a course in advanced algebra or chemistry. After two weeks, he asked his mother to take him home. His mother, a schoolteacher in Hattiesburg, insisted that he stay. He graduated from Morehouse in 1958 and went on to earn a PhD in physics in 1966 from Washington University in St. Louis. The rest, as the cliché goes, is history.

"He was the kid who we all pinned our hopes on to do great things," says an old friend. "He knew early that he was expected to do great things." Massey worked in theoretical physics at the University of Illinois and later served as dean of undergraduate studies at Brown University, where he originated the Inner City Teachers of Science program and won the Distinguished Service Citation of the American Association of Physics Teachers in 1975. His rising reputation as an administrator and educator led to a call in 1979 from Hanna Holborn Gray, then in her first year as president of the University of Chicago. She offered Massey the position of director of Argonne National Laboratory, which Chicago was about to take over entirely from a consortium of universities that had run the lab for the Department of Energy. He replied, No thanks, he preferred teaching and research, with the hope of becoming a college president himself some day. But Gray persisted, and Massey soon agreed to take the job. "It was just too big a challenge not to accept," he recalled later in an interview.

In the years since, Massey has taken on other challenges. He was a professor of physics and vice president for research and for Argonne at the University of Chicago when President Bush nominated him in September 1990 to be director of the National Science Foundation. When the proposal to head NSF was first made by



CAROL CLAYTON PHOTOGRAPHY

Massey: Pleasure and pain at NSF.

D. Allan Bromley, the President's science adviser, Massey refused it. For one thing, he was about to take a six-month sabbatical to study how technology is transferred in Western Europe from academic and government labs to the marketplace. For another, he didn't like the idea of yet another career change. In the end, he reconsidered. The opportunity to "make a difference" in the nation's research and education programs was too important to let slip by, he has said (see PHYSICS TODAY, October 1990, page 55). In March 1991 the Senate confirmed Massey, and a month later he arrived at NSF.

Massey is without doubt the right man for the times at the agency. Had he known all that awaited him, he might not ever have accepted Bromley's proposition to run the foundation. Only days after he unpacked his belongings in his spacious fifth-floor office at NSF, Massey told the House Committee on Science, Space and Technology of "a growing perception that the research community considers itself exempt from the pressures of competition and accountability and 'entitled' to public funding. Questions about... indirect costs, merit review and scientific misconduct have be-

come front-page news and debates over... the disconnect between research and teaching tend to fuel the image of a self-serving, socially irresponsible university research community.... These issues are serious and deserve our attention.... However, these problems should not be allowed to detract from the vital contributions made by our colleges and universities to the well-being of the country through the people educated and the new knowledge developed at these institutions."

Massey quickly earned a reputation for being serious, scrupulous and suave. These are characteristics that are absolutely necessary to keep the scientists seeking grants at bay during persistent budget storms, while steering a straight course with those politicians who want to cut any excesses of fat or foolishness from the foundation's programs.

One of his virtues is that he has sought to improve the morale of program staff, who have been frustrated by budget cuts, inundated with excellent proposals they cannot fund and criticized in Congressional hearings for inflating estimates of scientific manpower shortages so that the foundation could justify doubling its budget in five years. What hurt most was the accusation that NSF grants were being misused by universities for parties or office furniture. An audit of NSF grants to three prestigious universities (Chicago, Harvard and Michigan), conducted by Congress's General Accounting Office last year, turned up only \$10 000 spent inappropriately out of a total of \$52.5 million awarded in all of 1989. NSF's inspector general testified that stronger cost-accounting procedures had already been adopted.

For Massey, the directorship of NSF is as much a personal journey as a political challenge. In the following interview with PHYSICS TODAY's Washington editor, Irwin Goodwin, conducted on 1 July, Massey speaks about many of the issues he confronts daily.

Q. Why did you give up a secure position at the University of Chicago and directorships at several of the largest corporations in the Chicago area for a job that probably will leave you with few friends, not because of anything you do, but because NSF is wedged in a painful budget crunch?

A. I thought about that a great deal, and the reason I finally decided to come to Washington was that I was at a point in my life where I could really do the job well. I was confident that I had enough experience and enough knowledge that I could make a contribution. The job has turned out to be much better, frankly, than I had expected.

Q. In what ways?

A. First, the director actually has more opportunity to get things done than I had realized. Second, the position is way more interesting than I had expected. It's not a bureaucratic job, pushing paper forward and backward. I find that I can stay very close to the substance of issues, both policy and research. But to keep up with the policy and the research, I am on a learning trajectory. So it's exciting. The job has some of the same characteristics I found at Argonne when I was its director. In this sense, I am constantly tested as an administrator, since I need to be at the cutting edge of the scientific and technical programs in our shop or run the risk of losing touch with the work and the people doing it. And I like the people I've met in Washington. I think Allan Bromley is good to work with, and the other research agencies have been very easy to work with so far. So it's turned out to be more pleasant and more interesting than I thought it

pens inside the agency. I don't go out of my way to irritate people. In fact, I prefer not to. But I didn't come to Washington to win a popularity contest. Even physicists who didn't get along with Erich now look back and can see what a good job he did. So these things blow over.

Q. Many of Bloch's difficulties in physics circles had their roots in the agency's fiscal quagmire, don't you think? For its first 35 years, NSF was more or less insulated from the budget cutters, possibly because the cost of basic science was relatively cheap. Then President Reagan issued a decree about doubling NSF's budget. Ironically, just when funding should have been increasing, the troubles began. The mood of physicists seemed to depend on how much NSF had in its bank account. As the gap widens between the high expectations of academic scientists and the research dollars at the granting agencies, the gloom increases. Last October, Roland Schmitt [president of Rensselaer Polytechnic Institute] organized a discussion on the situation, which some call the malaise among university researchers. You took part in Schmitt's meeting, along with Peter Eisenberger [Princeton University], Ralph Gomory [formerly at IBM and now president of the Sloan Foundation], Stuart Rice [Chicago], Homer Neal [University of Michigan], Mark Wrighton [MIT] and several others. After diagnosing the problem, did this group come up with any remedies? Can NSF allay the malaise?

A. You're right in saying this group is engaged in a discussion rather than a study. Yes, it has turned up some things, but it hasn't

would like more time to teach and to participate in the affairs of the university but they can't do either because they have to be so single-minded about getting support for their research. The real driver for hiring at universities these days is finding people who can bring research dollars to the institution. Securing grants—and their amounts—rather than the quality of research often determines the course of a career on many campuses. This results in a paper chase—an escalation of proposal submissions and an imperative to publish within two or three years in order to get a new grant or a renewal.

I don't think that even if we doubled our budget it would relieve all of the anxieties. One of the things that we need to do is to try to get universities to look at factors other than grants that might produce or promote anxiety. I don't think Federal policies, such as indirect costs or research regulations on something like animal research, are the leading causes. We suspect that one cause is that research universities have become, in effect, holding companies for entrepreneurs. And scientists are expected to be entrepreneurial.

Q. Is the anxiety that afflicts university scientists the same syndrome that is causing an epidemic of departures among university presidents?

A. That's the problem. You can't tell if it's contagious or if it's happening for a variety of singular reasons. I think there is concern in the university community about leadership. Among university presidents there are concerns about the ability to manage institutions in these times of rising expectations and diminishing resources. I think this uneasiness is transmitted throughout the institution and it affects the faculty, scientists included.

Q. Isn't this a reflection of the widespread anxiety in our society today? Aren't worries about economic uncertainties, cultural values and so on generally pervasive?

A. It could be, but I think universities are special. I'm not sure the same sources of anxiety exist in the rest of our society. Universities are going through a transitional period, especially in research, because there have been changes—no matter how subtle—in the relationship between the government and the universities. For instance, the issues of indirect costs and scientific misconduct point up something important: Universities are no longer held in a special, exalted, privileged position by the Federal government and, for that matter, by the wider public.

'The real driver for hiring at universities these days is finding people who can bring research dollars to the institution. . . . Scientists are expected to be entrepreneurial.'

might be.

Q. Your predecessor, Erich Bloch, had an uncanny knack for irritating people—research scientists most of all. He won no public opinion polls in the scientific communities. How do you think you're doing?

A. I frankly don't know. Right now I'm probably doing okay, or very well, from what I hear, but I've only been in the job a year or so. I'm sure that my popularity can rise or fall, depending on what happens to the foundation's 1993 budget request and what hap-

produced any definitive answers. It has corroborated one of the findings of several surveys, that there is a lot of anxiety—I'm not sure what the proper word is, though malaise may be too strong, because there's a lot of excitement in almost all of science today—that simply can't be understood by looking at funding problems. Some of the troubles have to do with the quality of life for researchers, especially young faculty members. We identified a variety of reasons for the distress. Many researchers say they

Then there are the financial pressures. Faculties have grown faster than resources. Neither the research infrastructure nor the research grants have kept pace. And resolution of these problems is not in sight.

The group led by Roland Schmitt is not going to make recommendations. It's going to carry out a process. Whenever the group has engaged young scientists and established researchers or members of the National Science Board in its discussions, one suggestion is that it should meet on various campuses so that the institutions, meaning the administrators—presidents, chancellors, provosts, deans—take part in the dialogue.

This is what I meant when I said we need to get the institutions involved in working with us. Actually, Peter Eisenberger, a member of the Schmitt panel, came up with this concept. His model, he told us, was the procedure used by [the condensed matter division of] The American Physical Society in its examination of the materials research community about two years ago. To collect information about the community, discussions took place at the campus level. The issues were not as broad as the ones we're dealing with, but in both cases they involve university administrators and faculties.

Q. Are these events in the nature of town meetings?

A. They're initiated by the universities. Afterward there might be regional meetings or special forums where recommendations could be agreed on. The whole point of the exercise is to stimulate discussion at the level where people are engaged in the issues. The report on materials science contained a great deal of data and expressions of discontent, along with some recommendations. It was widely supported by the materials community.

I've made it a high priority to visit universities, colleges, community colleges, to meet with faculty and students, to get a firsthand impression of the issues, to learn how NSF programs are perceived and how they work, and also to see the research as it's happening.

Now PCAST [President Bush's Council of Advisers on Science and Technology] and FCCST [the Federal Coordinating Council on Science, Engineering and Technology] are conducting separate studies on the health of the country's research-intensive universities. Those examinations may give us another handle on the problems and allow us to come to grips with them. One conclusion may well be that more money is necessary

to support academic research, but I think there may be ideas for policy changes that do not depend on getting enormous increases in research dollars. Still, even small budget increases for science are going to be difficult to come by.

Q. These are lean times for all the science agencies in Washington.

A. This year we are fighting to keep what we have.

Q. Are there any common themes about remedies for the stress in science?

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A. There are common concerns. There are a number of suggested remedies, some contradictory. No, there is no "silver bullet." People would like to see less pressure on having to write so many grant applications. There are several ways to address that. The easiest is to have more money. Then the science agencies could give grants for longer periods or give grants with larger awards or both. But without more funds for research, both options would result in fewer grants.

Q. The National Institutes of Health have extended the grant period for research projects to five years in some instances.

A. That's right, and we're looking at that.

Q. What about a longer budget cycle for the R&D agencies—say, two or three years rather than the current practice of single-year allocation? Would that help avoid some of the stress and strain on individual research projects as well as on big projects like the Superconducting Super Collider or the optical telescopes? In Europe, most countries provide enough funds to see a scientific program through to the end, once it has been approved. This avoids the peculiarly American research predicament—namely, scrounging for funds year after year.

A. Well, the foundation awards three-year grants. We face a lot of uncertainty because of the year-to-year budget process. Every chance we occasionally get before Congress we recommend that the foundation and most R&D agencies should be placed on a multiyear cycle. The last time we advocated this was a few

months ago, at hearings on setting priorities before the House science committee. On that occasion, Bernadine Healy [NIH's director] and I testified in favor of multiyear appropriations. Just consider our situation: The foundation got an 18% increase last year over the previous year, but we will consider ourselves fortunate to get anything more than a flat budget in fiscal 1993. We have some relatively big projects on a growth path: LIGO [the Laser Interferometer Gravitational Wave Obser-

vatory], two 8-meter telescopes and the National High Magnetic Field Laboratory. We have selected two sites for LIGO. We have international agreements on the telescopes. The High Magnetic Field Lab is under construction at Florida State University. With those obligations and more, we find it very difficult to do long-range planning.

Q. Congress also has other ways of disrupting long-range plans. Take, for instance, the decision by the House of Representatives in June to scuttle the Superconducting Super Collider. Do you think the House action heralds what's to come for the big science projects—at least in this period of Draconian budgets?

A. It's definitely a message that large and costly projects are going to be looked at very carefully.

Q. As you read that message, are LIGO and the 8-meter telescopes now at risk?

A. I don't see the SSC votes as directly tied to those. Our appropriations committees haven't dropped any hints that support will be withdrawn. I think our problem with big projects is internal to the foundation. How do we construct the large projects if we don't get overall funding increases? Unlike the Energy Department and NASA, our projects are not separate line items. Congress could treat our projects that way. I'm glad they don't. LIGO and the telescopes are part of our overall budget, and Congress leaves it to us to allocate the funding. So when Congress doesn't provide an increase large enough to cover the new projects, the foundation is under great pressure to keep the projects going while protect-

ing the traditional basic science programs for individual investigators.

Q. From time to time, someone will argue in the halls of Congress or in a newspaper editorial that this country may be investing too much in basic science and that other countries spending much less on research often turn our research into their technologies. Is there any pressure on NSF to reduce its support of basic science so that it can devote a larger portion of its budget to applied science and to engineering and technology?

A. No. No to the first part of your question. The idea that we can have too much basic science I find ludicrous. I just don't understand the argument that we should cut back on our basic research because other nations make use of it. That won't make us any better off and it will only do us harm. The truth is we have not put enough emphasis on translating our research into applications for the marketplace. But the foundation isn't under any serious pressure to reallocate resources. I think people are suggesting that we ought to have additional resources, and that's also the way I feel.

Q. Under Bloch the foundation introduced some new approaches to academic research, such as Science and Technology Centers and Engineering Centers. Bloch also redirected materials research into more practical paths, so that the program more nearly met the needs of industry. Will you continue those concepts?

A. I definitely intend to continue them. Knowing that the S&T centers were somewhat controversial, I have spent a great deal of time in understanding them. I have visited a number of them and I am very impressed by what these centers have done in so many areas—not just in research, but in education. They are very involved in outreach programs. They are interdisciplinary. They are very exciting places. So I think they are a very dynamic concept. While we aren't going to cut back on the centers, I'm also not going to be putting more emphasis in that direction.

My highest priority is to accelerate support for the basic disciplines and to make sure we get as much support as we can for individual investigators and small groups. I think the balance that I inherited between the centers and individual researchers is about right. We are going to add some more centers in particular areas. What I have in mind is not a major new program. We also are looking at other ways to support research. We have talked about these with the Science Board.

Q. Can you give us some inkling of what these new ways might be?

A. The discussion runs like this: Should we have larger grants that are more institutionally focused? I'm trying to come to grips with something we just talked about: How do you support research in a way that involves the best people and relieves them of the pressure of constantly writing grant proposals? How can we package the support so that we are assured we attract the best people and the most worthwhile research? How

foundation. On this subject, I hark back to my earlier comment about looking at different ways to support research, because interdisciplinary research will probably involve a different style and culture from the older sciences in terms of grant size, award duration, peer reviews and so forth.

Q. Science subfields rise and fall. There are, to be sure, some research programs no longer worthy of support for various reasons or no longer deserving of government backing. In-

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can we remove the bureaucratic paperwork burdens from the academic institutions and the foundation? I hesitate to use the words "block grants," because that carries a connotation that upsets almost everyone, but we are exploring ways to package research grants in larger units with less administrative hassle. We need to develop some understanding and coordination among our program managers and the institutions that eliminates much of the writing and reviewing of proposals.

Q. Isn't there another aspect of your problem—the surge toward multidisciplinary research, which doesn't always fit neatly into the foundation's structure?

A. Exactly. You've just put your finger on the crux of a major issue we're dealing with as we develop our strategic plan, the new long-range plan for the foundation.

Q. An example of multidisciplinary research is biophysics. NSF has no directorate for this field and yet it's one of today's most vital fields.

A. You must have walked in on our conversations. We are saying what you just said—that the dominant trend in research is multidisciplinary. We are not abandoning the traditional disciplines, but we need to respond quickly to the new directions in research and to stimulate these directions. We are probably not as organized as we ought to be for the care and keeping of emerging fields of science, but neither are universities.

What we are seeking to do in our planning process is figure out how we can best be responsive to new fields and subfields, as well as how to improve our housekeeping within the

deed, when Erich Bloch proposed, in a particularly chilling budget climate a few years ago, that the foundation might stop funding high-energy physics and allow the Energy Department to support all research in that field, the outcries could be heard from Boston College to the University of Washington. He said later that he made the suggestion to prod people into a debate on research priorities under conditions of budgetary restraint. He was bitterly attacked for even suggesting such a thing. Now, as the foundation reviews its program plans, are there some fields that the foundation ought to realign or simply drop as no longer relevant?

A. We are asking the same question. I have asked the directorates—and through them the various divisions—to find out from the science and engineering communities which fields and subfields are flourishing and which ones are withering. The purpose is not to get the foundation out of certain fields but to determine the important trends and the new directions. We are asking, What is exciting now in science and engineering? With limited resources, NSF's job, it seems to me, is to make sure we are continually able to support science at the forefront. If we don't do that, then we're really not fulfilling the mission that Vannevar Bush set us on back in the 1940s.

We are not a maintenance organization. We don't have enough money to support all the ongoing research in the country. So some fields will get less support, others will get more. I don't know now which ones will wax and which will wane, but there's no doubt that NSF must make some

critical funding decisions. Having said that, I go back to your first question, because such decisions will affect the rise or fall of my popularity.

Q. Let's turn to the subject of science education. You and your predecessor have been placing great emphasis and heaping large sums on science and math education in pre-college programs, and that's certainly the right thing to do. Still, questions abound: Is there any indication that the foundation's programs are succeeding in improving the teaching of science and math? Is there any evidence that we are no longer "A Nation at Risk"—recalling the title of a government report that was so unsettling in 1983?

A. Yes, there is some indication, but they are of a particular nature. For example, if you go to some areas where we supported curriculum development, you can see the difference it makes in classrooms where the new materials and techniques are used. Teacher enhancement programs have made some telling differences. But if you're asking, Do we really know about definitive improvements and can we see broad-based changes in the structure of how things are done in the classrooms of the country, then I can't answer those questions.

Q. The National Assessment tests certainly don't show that there've been massive improvements in science or math or even in general literacy.

A. That's right. That's right. I think there are two issues, and in our planning process we are looking at both: One is that it is too soon for some of the newer programs to have

but to understand the ongoing process of these activities to see if learning can be improved.

We are moving toward more cooperative agreements rather than outright grants. A significant feature of these agreements is their scale. Consider our program of Statewide Systemic Initiatives. This should make a difference in pre-college schooling throughout an entire state, and the difference should be visible. Then, too, since these are cooperative agreements, we maintain an ongoing involvement with the performer, the individual or group getting the money. And the agreements can be modified during the activity, unlike our operations in the past, when we treated many education programs just as we did our research programs. When we give money to a university—to develop a curriculum, let's say—we follow up as we would any research grant. We don't go to an academic lab and ask, "How did you do it?" We simply say, "If you publish, then we know you did it." We now know that we shouldn't treat our education programs in the same way.

Q. Do you seek tangible results?

A. We all know there must be some tangible results and there must be objective indicators—ones we can all agree on and decide to use to determine whether or not we have attained those results. Now, this will be different in different programs, though some are pretty obvious. We have programs to increase the number of minorities in science. Those programs obviously can yield measurable results. They answer the question of how many people did you attract.

much direction from Washington. But it's too early to know whether this program really works, isn't it?

A. We're just in our second year. We are going to start a new program—we haven't announced it yet but we will soon—focusing on cities. In some states there are such great disparities between a major urban area and the rest of the state that completely different programs are needed. So we will have cities initiatives. I don't know if these will work, though the idea is being greeted with a great deal of enthusiasm.

Three years from now we should be able to say what has happened if you ask your question again, because we have built in a way of tracking what is going on, and we'll be working with the states and cities.

Q. Will you require matching funds for the cities initiatives?

A. It won't be matching. We won't use the word "matching" because the resources that the cities will bring are much greater than what NSF puts in. NSF puts in a small amount of money relative to the resources that are being spent on education. What our program is intended to do is to say: Look, you spend \$100 million or \$200 million or \$1 billion on public schooling in your city. Are you sure you're spending it in the way you want to? Working with us, if you will come up with a comprehensive plan to reform the teaching of science education and show us where the holes are, we'll work with you and then we will put some resources into those key places or subjects that can make a difference. We will work with you by bringing the expertise we have accumulated to help you design the program to meet your needs.

Q. Leon Lederman has a program in the Chicago area that seems to have achieved useful results.

A. We are supporting Leon's program. That's not part of the new cities initiatives yet, but we'll see.

Q. How would the cities program differ from what Leon is doing?

A. Leon is dealing with one aspect, by retraining some 17 000 science and math teachers. In our major education initiatives we try to look at the whole spectrum of activities. We want to retrain the teachers, but we also want to introduce new curriculum materials, and you can't do that if the teachers are not ready. We want to invigorate students, perhaps through a summer program for youngsters who need that kind of outreach activity. We want parental involvement. We try to get industry involved, sometimes by providing summer opportunities for students

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had an effect. But, having said that, we all agree on the second issue—that up until now we have not put enough emphasis on assessing whether or not the programs are making a difference and how they're making a difference. We need to know what works and what doesn't, what we should continue to support and what should be written off as a possibly noble experiment that has failed. So in all of the new efforts we have put a great deal more emphasis on evaluation—not just to answer the question at the end,

Q. Of course, a measure of quantity doesn't begin to give you a measure of quality.

A. We won't be able to put objective indicators on every aspect of the programs. Where we can, we want to. And where we can't, we still want to make sure we have the qualitative assessments we consider essential.

Q. The pre-college Statewide Initiatives program has caught on with the governors, who seem to like the idea that school people in their states can help design the program without

and teachers. So it's a much larger package the foundation offers. One could easily see Leon's effort as being a major component of the initiatives we're speaking about.

Q. On another topic, the government and several scientific societies are very concerned about helping Eastern European scientists in this post-cold-war era. Should NSF be playing a collaborative role in assisting scientists in Eastern Europe? I know you have a small program, mainly structured to involve scientists who have American collaborators. Do you have any plans to enlarge the foundation's role?

A. It's going to be difficult for us to commit much larger resources than we are already obligating to Eastern European scientists unless our government establishes a national program. There has been a great deal of discussion about committing large resources to the former Soviet Union and to Eastern Europe. If there were to be a larger foreign aid package in which science and technology make up a significant component, then I think what we are doing are the kinds of things that would work. What we are doing is building on scientist-to-scientist relationships. We are supplementing some existing grants for joint research by US scientists and FSU scientists so that researchers in the FSU can use the additional money for various scientific purposes—mainly for instruments and journals and some travel to conferences. We discourage paying salaries, not because we are against that, but because we have been told by the Russians and others that they see such a small

traditions to accept charity.

A. If the money went generally for research support, that would be legitimate. But you're right. We have been told that they don't want to think of scientific support as foreign aid. Nonetheless we are working with scientists in the former Soviet Union and other countries in other ways. And that's going very well. It's a modest amount of money in the scheme of things—a total of \$1 million this year.

One reads a great deal about some large programs that are under consideration. But as far as I know, we have one of the few actually in place. So if there could be more money available, we have a way to use it.

Another thing we will be doing has me very excited. We want to help FSU scientists put a system in place whereby they can support research on a merit basis. We have had a number of visitors ask us how to set up a Russian and Ukrainian science foundation. I have just sent a letter off to the Russian Academy, inviting some interns to come as rotating program officers at NSF, working alongside our scientists, to learn firsthand how our process works. The reason I say I like this is because I thought I understood this place until I got here as director. So I say, If you want to set up a similar agency in another country, in another culture, you need to see how our foundation functions, from the inside. I'm hoping that the Russians accept our offer to learn at our elbow about grant applications, peer review, conflict of interest and about the responsibility and accountability that are necessary for a nonpo-

litical science foundation.

an order that had as its first item the authorization to create a self-governing science foundation, but it seems he hadn't figured on opposition by the Russian Academy of Sciences. So, while the scheme has some roots, it hasn't blossomed. Have you been told how such a foundation would work? Would it operate through the research institutes or through the universities?

A. They seem to be moving in the direction of university-oriented research. I should say, they want to move in that direction. And there are opportunities to set up the kind of foundation that would encourage that. I think that might be a very good way for Western nations and charitable foundations to really make a difference and to be able to put infusions of money into this system in a way that will give us some assurance that the best scientific research is supported. We have no interest in maintaining research mediocrity or in maintaining a science bureaucracy in the former Soviet Union.

We have had discussions with my counterparts in Germany and France, and they are supportive of this kind of foundation. So I think if the Russians can decide on the mechanism, then I see us encouraging our governments to support such an activity. It would be something that NSF could work with very closely.

Q. If the Russians accept the idea of the internships, how many would you bring to NSF?

A. The number would be small, at least at first.

Q. Would they function in the style of NSF's independent program officers or would they be just observers?

A. I'm not sure what they would do. I think we would look at their background, their experience, and bring them in under a new category of rotating interns. We would certainly want them to get hands-on experience. I don't think we could give them sign-off authority on grants. No, we couldn't do that. But they would gain understanding of our review process, learning how to choose reviewers, reading proposals, setting up panels, examining the guts of the operation. They would not just be observers.

Q. This discussion of NSF's operations leads me to ask if you are giving more authority to the program officers. There has been some gossip about increasing the authority of program officers to sign off on some types of proposals without the need for the traditional peer review.

A. I don't think that's true. Some directorates—not all directorates—

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proportion of the money. The funds are taxed by the republic first and again at the institutional level. In the end, the scientist may get only 10% of the original grant or allocation. We don't want our resources to go into big tax bites. We would be willing to give direct support to FSU scientists if we could figure out a way to do it and to make sure it gets to the individual.

Q. You would have to be careful that the funds are not seen as charity. Russian scientists have said they have too much pride in their scientific

litical science foundation.

Q. The idea of a science foundation for the Soviet Union was mentioned by Yuri Ossipyan more than two years ago, when he joined Gorbachev's inner circle of advisers (PHYSICS TODAY, May 1990, page 67). The concept seemed to be advancing under the State Committee on Science and Higher Education when the failed putsch occurred a year ago. Then, after Gorbachev resigned in December, the idea was put on hold. Last April, President Yeltsin signed

are able to do this for proposals up to \$50 000 when the idea is especially exciting and if it gets the Science Board's approval as a special program. This enables us to take chances and to support high-risk research. These are one-time grants and cannot be renewed as such. Directors also have some discretion under another program for young investigators, people just starting out.

Q. Are these new programs?

A. No, they were in place when I came. They are small. But other than those programs, I think all proposals are still reviewed, either by panels or external reviewers.

Q. Would the high-risk category include work on, say, cold fusion?

A. I suppose it could.

Q. Cold fusion was supported by the Department of Energy under its advanced projects branches in the Office of Energy Research. Those units can support high-risk ideas in basic energy sciences, fusion, and nuclear and particle physics.

A. We wouldn't support such projects continually. As I said, it would be a one-time grant to individuals or to groups that have a hot idea, and clearly it's a risk. If, in the judgment of the program officer, there is reason to believe it's worth trying out, the foundation will support the research.

Q. Are there many such projects?

A. No. Total funding can't be more than \$2 million or \$3 million.

Q. What fields in particular have an abundance of high-risk projects?

A. I wouldn't characterize any field as abounding in such projects. Engineering has a program, and there is one in the mathematics and physical sciences directorate.

Q. There's another high-risk program I would like to ask you about: It concerns advanced technology, a subject that raises hackles in the Bush Administration, which abhors any program that would enable a government agency to attach a winners or losers label on a technology. I have heard you say that the foundation has no intention of restoring a program that it abandoned in the 1970s—namely the RANN program, Research Applied to National Needs, which sought for a while to support research that might have practical applications. Do you think a son-of-RANN program would help strengthen the nation's economy?

A. I have read the history of RANN. In retrospect, the criticism of RANN was not that it was a bad idea conceptually. The idea was that we ought to look for ways that Federally supported research can advance the nation's goals. But the program evi-

dently wasn't constructed in such a way that it supported the highest quality of research. That's the reading I got from its final reviews that went to the Science Board. But the reviews didn't invalidate the idea of seeking ways to emphasize and encourage research to be applied to areas of national urgency and national concern. We certainly want to do that. We are trying to do that through education programs and some others, like high-performance computing and advanced materials

will deal with technology, science and organizational issues that lead to improvements in engineering.

Q. What's happened to the Critical Technologies Institute, which is supposed to operate within NSF? You'll recall that the institute was the brainchild of Senator [Jeff] Bingaman [Democrat of New Mexico]. It was opposed by the Administration at first, but it was embraced after Congress handed it some \$5 million in the Defense Appropriations Act of 1992.

A. The Defense Department hasn't

'We are encouraged by Congress to get international funds for big science projects, but we also need to assure our foreign partners that we are going to keep our part of the bargain.'

science. But we wouldn't go back to a RANN, because it simply didn't work.

Q. Allan Bromley announced a few months ago that manufacturing would be one of President Bush's new initiatives next year. That means manufacturing research would acquire the same high standing that is now reserved for programs such as global climate change, high-performance computing and pre-college education. Bromley said manufacturing had been anointed by the Federal Coordinating Council on Science, Engineering and Technology as a program that NSF, Commerce, NASA and other agencies would elevate in their fiscal 1994 budget requests.

A. We've been very active in helping to formulate this initiative. There is a major role in it for NSF.

Q. Isn't the subject of manufacturing somewhat strange in NSF's portfolio? I realize that when the NSF organic act was amended several years ago the word "engineering" was added wherever the word "science" appears. But manufacturing?

A. We support technology in several directorates, not only in the engineering directorate. We do technology research to make engineering legitimate. The manufacturing initiative will appear in engineering, in social and behavioral sciences, and there also is quite a bit in the basic physical sciences. It came as a surprise to me that manufacturing has to do with composite materials, with surface physics, with polymer chemistry, with optical sensors, to mention just a few. The word "manufacturing" doesn't really describe the research that will be included. The initiative

passed along any money. Bromley is the institute's chairman, and a council of agency heads has been named, but the institute has not been instituted.

Q. Would American science benefit from international collaboration on some of the big science projects, such as LIGO or the SSC, before these are presented to Congress? The big projects remind us that basic science is essentially global in scope. Perhaps all projects of \$1 billion or more should require international partnerships. In fact, Bromley once suggested that those science projects requiring international partnerships should be the subject of treaties so that Congress, by approving the treaty, would be obligated to fund the venture to its completion. Is that an idea whose time has come?

A. There may be ways other than a treaty. I think Allan was citing treaties as one possible way to get the commitment of Congress. I think we should look at every big project involving a facility that has multiple users. We ought to ask ourselves, Does it lend itself to international cooperation? That should be one of the questions. We have done that with the 8-meter telescopes, but we still haven't got enough money to completely match our half before we begin construction. We have agreements with Britain and Canada, but we are about 10% short of the matching 50%, I believe. I see this as a model for the future.

We didn't start that way with LIGO. It began as a national project, and at this late date it's difficult to ask foreign governments to join us,

because the design has been determined. I wish we had approached other governments when it was first proposed. Our problem—which is what Allan alludes to with his suggestion—is that other countries have doubts about our commitments when we show signs of pulling back. We are viewed as somewhat unreliable partners in international science projects.

What I would like to see is a process whereby, when a project is approved

by the Congress, the money might be placed in escrow to complete the whole facility. The funds wouldn't go to us in one lump sum but would be given over a period of years. The money would be there over the course of the project. Perhaps Congress could have an international account so that our foreign partners would know we have obligated our funds.

I have brought this up before the House science committee. I hope that

Congress will consider it seriously. We are encouraged by Congress to get international funds for big science projects, but we also need to assure our foreign partners that we are going to keep our part of the bargain.

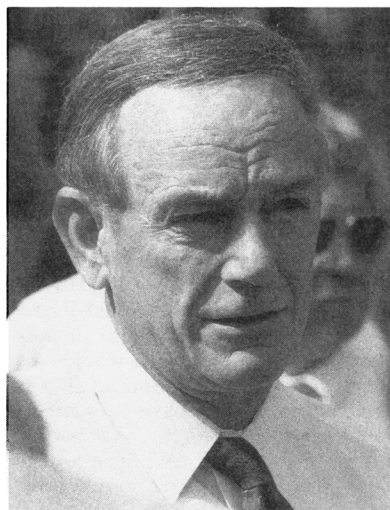
Q. Congress often wants to be sure that the project is built on US soil with US products and by US labor.

A. You can't have it all, unless you have very dumb and rich partners. I haven't found any of those.

WHAT'S GONE WRONG WITH THE SSC? IT'S POLITICAL, NOT TECHNOLOGICAL

This is a critical testing time for the Superconducting Super Collider. The proposed proton-proton accelerator failed an important political test on 17 June, when the House of Representatives voted to cancel its construction (*PHYSICS TODAY*, July, page 53). But the gargantuan \$8.25 billion machine passed another test of strength in the Senate Committee on Appropriations a month later, on 23 July, when senators agreed with a subcommittee markup of the energy and water development bill and allocated \$550 million to the SSC—\$100 million less, to be sure, than the Bush Administration had requested for fiscal 1993, which begins on 1 October. While this action improves the prospects for the SSC, its opponents consider the reduction from what was asked for a sign that the super collider is vulnerable.

An equally important test for the SSC is technological. It involves a string of superconducting magnets—five full-scale dipole magnets, each 15 meters long and with 50-mm apertures, and one quadrupole, all cooled to 4.35 kelvin. The test is scheduled to take place this month in a steel-frame shed that has been erected on the first parcel of land purchased by the State of Texas near Waxahachie, where the accelerator and its laboratory complex are to be built. The building for the test is 14 feet wide and two football fields long—slightly bent to simulate precisely the width and curvature of the proposed tunnel. If the six prototype magnets perform without quenching and without encountering some circuitry problem and reach a stable critical current of 6.6 tesla, two industrial consortiums—one led by General Dynamics and including Westinghouse Electric, the other led by Babcock & Wilcox—will begin mass-producing a total of 8600 dipoles and 1600 quadrupoles, respectively. The magnets are neces-



Johnston: Leading the faithful.

sary to hold and bend the two counter-circulating beams of 20-TeV protons around the 54-mile oval tunnel.

The fate of the SSC is something of a cliff-hanger. The Senate's energy and water bill is in the midst of a political fracas. In an effort to ease the SSC through the Senate and to secure the passage of a complicated 400-page national energy policy, Senator J. Bennett Johnston, the Louisiana Democrat who is chairman of the energy and water appropriations committee, had employed an artful device: He attached the comprehensive energy policy measure to the \$22 billion energy and water development bill. As a veteran Senate floor manager of energy legislation, Johnston was convinced he could attract support for both bills by hooking them together. "Appropriations bills have got to pass," he told a reporter.

The sticking point is not that senators don't want to pass both bills but that each has controversial parts. The energy policy bill would stimulate the nuclear power and natural gas industries, promote renewable

energy sources and impose tougher efficiency standards on buildings, motors and light bulbs, among its many features, but it also would avoid the issue of how retired union coal miners and their dependents could continue to receive health care benefits from a fund established in 1946 that is now insolvent. Senator John D. ("Jay") Rockefeller IV, a Democrat who represents thousands of coal miners in West Virginia, attached an amendment to the bill that calls for a tax on coal companies to replenish the health care fund. Rockefeller threatens to delay or scuttle the bill if attempts are made to remove his amendment. He has the help of his West Virginia colleague, Robert C. Byrd, chairman of the Senate Appropriations Committee. Byrd, once the majority leader and characterized as the most powerful figure in the Senate, set the bill aside, even as it had attained full committee approval.

If the Senate approves the energy and water bill, with or without the massive energy policy section, the SSC will undergo another test in a floor vote. Upon passage, the bill will go to a conference committee of both chambers, which, of necessity, will negotiate a compromise. To be sure, the House could decide to reconsider its decision in light of the Senate vote, and in that event it could instruct its conference members to restore funds for the project. The more likely outcome is a fight within the conference.

In the four-year history of SSC funding, the Senate has championed the machine more enthusiastically than the House, but the House decision to close down the project seems to have enabled more senators to join the opposition. "In a period of severe budgetary constraints, like this one, the SSC competes for funds with programs that more directly affect