THE WHITE HOUSE

WASHINGTON

July 3, 1991

MEMORANDUM FOR JOHN H. SUNUNU

FROM: D. ALLAN BROMLEY

SUBJECT: ROBERT WHITE OF NAE

On the basis of everything I have been able to determine the attached **Technology Review** interview with Bob White is an accurate portrayal of his views. You will note that in general he is very supportive of the Bush Administration.

I think that the view that he was negative developed about the time Leon Lederman of Chicago was advocating his immediate doubling of the physical science budgets and Leon Rosenberg of Yale was telling everyone that "biomedical science is burning." In all this flap some of the radio and TV folk appear to have picked up only the last part of Bob's frequent statement that "too many scientists and engineers were chasing too few research dollars" (see page 41 of the attached interview) and included Bob as one of those who was greatly exercised over "too few dollars."

It bears noting that Bob was not responsible for the headline on the enclosed interview!

I have known Bob for many years and was, I remember, very surprised by this since I have always considered him a very solid citizen endowed with wisdom and common sense.

I have also talked with him during the past few days at an NAE breakfast prior to my talking to the Presidents of the assembled engineering societies and was again convinced that there has been a major misunderstanding here.

To the best of my knowledge and belief Bob has been, and remains, a strong supporter of what we are trying to do in the Bush Administration.

You may want to give him a call at your convenience because he is quite upset to think that the White House has him miscalibrated.

Attachment

Technology Review : May/June 1991

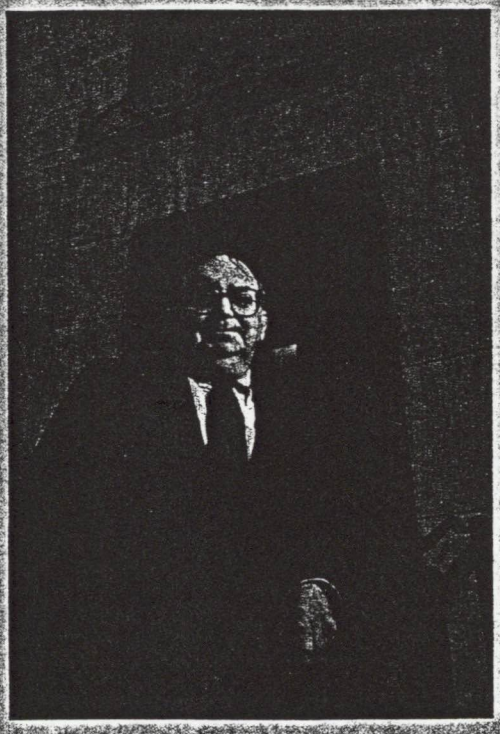
The Crisis in Science Funding

AN INTERVIEW WITH ROBERT M. WHITE

Is this the best of times, the worst of times, or what? An alien visitor trying to make sense of today's scientific funding situation would be excused some Dickensian confusion. President Bush's proposed 1992 budget would devote $76 billion to civilian R&D—an increase of 13 percent (not accounting for inflation). National Science Foundation spending would rise 18 percent, to $2.7 billion. The National Institutes of Health, which funds most of the country's biomedical research, would get a 7 percent increase in its basic science budget. Such growth is conspicuous in a budget that is otherwise mostly flat or shrinking.

But prominent voices from the scientific community are calling for more radical increases to deal with what they describe as a crisis. Nobel laureate physicist Leon Lederman, president of the American Association for the Advancement of Science (AAAS), has pronounced the U.S. scientific enterprise "sick," and has prescribed as a remedy the doubling of federal spending on R&D. Based on an informal survey of academic scientists, Lederman says a malaise has descended upon the research community. He paints a picture of financially struggling researchers who feel that the glory days of U.S. science are past.

Such demands have raised a firestorm of controversy. Congressman George Brown (D-Calif.), chair of the House Committee on Science, Space, and Technology, downplayed Lederman's report of malaise. "You could easily document the same level of despair among other groups," he told a recent meeting of the AAAS. Politicians, he warned, "no longer regard unlimited federal funding as a birthright for scientists."



The President of the National Academy of Engineering says that more than money is needed to fix what ails the research enterprise.

Robert White, president of the National Academy of Engineering since 1983, remembers fondly the days when money was plentiful. In 1950, fresh out of MIT with a doctorate in meteorology, he worked at the Air Force Cambridge Research Lab. "I had my own laboratory at a young age," he recalls. "I had as much money as I could possibly want to spend. It's hard to believe that there were actually times like that."

White says that despite the outraged demands of many scientists today, support for R&D remains generous, and has risen faster than inflation over the past two decades. Overall U.S. spending on R&D, says White, "dwarfs the investments in science and engineering research of our major trading partners." Still, he says, today's more constrained budgetary climate should lead the research community to rethink its approach to funding.

White served from 1963 to 1977 as chief of the U.S. Weather Bureau and then as the first administrator of the National Oceanic and Atmospheric Administration. Before his election to the NAE presidency, he headed a 50-university consortium that operates the National Center for Atmospheric Research.

Technology Review senior editor Herb Brody talked with White at his Washington office about the perceived crisis in science funding, and about the proper role of R&D in an industrial economy.

PHOTO: L. BARRY HETHERINGTON

TR: How do you support your contention that research in this country is, overall, pretty well funded?

WHITE: In 1990, both the public and private sectors spent $150 billion for the support of R&D across the board, not just on academic research. That's a 61 percent increase over the preceding decades in constant dollars. And even if you discount the very large fraction of the R&D expenditure by the federal government for defense, the amount is still larger than any of our industrial partners or competitors. The country has over 200 research universities, and 35 of them have research budgets exceeding $100 million. Government laboratories have also grown remarkably. Additional resources of course would help. But I have seen no clear justification for requesting a doubling of the funds for R&D.

TR: If we have a burgeoning research community, and we spend more money than any of the countries we do business with, why do so many people feel so many scientists feel so threatened?

WHITE: The problem is simple: In academia, where the problem is acute, we appear to have too many scientists and engineers chasing too few research dollars. It is evident in statistics that indicate the low success rate that scientists and engineers have in getting their work funded. Almost all fields have suffered significant drops in the proposal success rate. At the National Institutes of Health, less than one in four approved applications actually receives support. The question is, are there too many scientists and engineers, or is there too little money?

TR: Well, which do you think?

WHITE: Some of both. It's quite clear we're going to have to live in a constrained federal budget environment. That means we're going to have to adjust the other side of the equation. And that side of the equation is the production rate of scientists and engineers who follow careers in academic research.

TR: You have compared the production of academic researchers to the fable of the sorcerer's apprentice.

WHITE: Yes. In the Disney movie *Fantasia,* a sorcerer's apprentice sets in motion a multiplying army of brooms carrying buckets of water that become a flood. In a way, the same thing has happened here: the nation has loosed a flood of scientists and engineers who seek careers in academic research. Over the decade from 1977- 1987, the number of doctoral scientists and engineers in academic research and development increased 65%, from approximately 94,000 to 155,000. This is a phenomenal increase.

TR: And this has gotten out of control?

WHITE: At any given time a faculty member may have about five doctoral students under his or her tutelage. Assuming that two complete their work each year, then even if only one-third of the graduates go go into academic research, there is about a 15-fold replication over a teaching career of 20 years. Faculty members train many students in their own images. And many of these students aspire to remain in academia, doing research and teaching. Each seeks funding support and funding is unable to keep pace. That fundamentally constitutes the problem.

TR: What should these PhDs do instead?

WHITE: One would think that if we're producing scientists and engineers at the PhD level, we have a marvelous opportunity to upgrade the quality of our science and engineering staffs in industry and government laboratories. Government laboratories are having a very difficult time attracting top-level talent. And the economic effectiveness of many industries is large-

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ly dependent on their technological capabilities. So there are outlets for scientists and engineers other than to continue doing research in academia.

TR: Can't PhDs often get more money working for industry than for a university? What further incentives are needed to get them to leave academia?

WHITE: Industry does not actually pay much of a premium for PhDs. In fact, over a working lifetime in industry, a scientist or engineer with a doctorate doesn't make that much more than one with a master's degree. This suggests that the economic incentives are weak. Industry and government might take this opportunity to upgrade its entire technological work force.

TR: You faced that choice personally, didn't you—you got a meteorology PhD, and then left academia. What persuaded you to make the move?

WHITE: Well, my professor, Henry Houghton, sat me down—he was a wonderful human being, head of the Department of Meteorology at MIT—and we had a long talk. He said the department was not going to be hiring many people, but that there was a big world out there with great opportunities for people well-trained in meteorology. He advised me to make a move and set out on a different kind of career. I was a little upset by that, because I had my eyes set on staying in academia. But it was good counsel.

TR: So more professors ought to be nudging their students out of the ivory tower?

WHITE: Yes, but you have to have the receptors out there. There has to be some place where the young PhD can go and get a rewarding and exciting job.

TR: I can see why an excess of PhDs in academia would be bad news if you are one of them. But it would seem to be great for the nation—it becomes a buyer's market for research talent, and the taxpayer is the buyer.

WHITE: That's true—especially if scientists and engineers put their minds toward advancing the economic effectiveness of this nation. Many universities are quite prepared to do that. MIT is a good example, trying to combine its manufacturing program with its management school in its Leaders for Manufacturing program. And you see that happening at universities across the board. Many universities recognize some of the central problems in this country, and they are seeking to help. This great pool of trained people that we've been producing is a marvelous opportunity for us to begin to increase technological capabilities across the board, whether in government agencies or in industry.

TR: Since industry benefits from doing R&D, companies would seem to have an incentive already to hire more scientists and engineers. What further incentives are needed?

WHITE: I think industry has to recognize that they need to build up their R&D capabilities. Obviously, some industries invest substantially in R&D. But you can find many industrial sectors that have invested minimally—the construction industry, for example, and machine tools. As a result, U.S. industry loses market share. The U.S. machine tool business lost much of its market share because of a failure to conduct R&D and to exploit R&D that had been taking place at universities and elsewhere.

TR: You would think that these industries would have a market incentive to preserve themselves. Since that incentive seems not to have worked, what else should be done?

WHITE: There's no silver bullet. It is not solely a matter of R&D. We need economic policies that will encourage industry to make investments in R&D. And we need to improve the management of technology. The recent book by Daniel Roos and others at MIT—*The Machine That Changed the World*—documents beautifully some of these technology management issues. Also, government needs to play a larger role in the support of generic tech-

nologies important to our industry and the economic effectiveness of the country in the global marketplace.

TR: Do you think the government is starting to take on that role?

WHITE: Yes, I'm encouraged. I'm very pleased with what I see as a gradual change of view in the government—for example, the recent issuance by the White House Office of Science and Technology Policy of their first technology policy. I'm also pleased with some of the new directions in the proposed FY 1992 budget.

TR: Particularly —?

WHITE: I'm pleased that the high-performance computing initiative has received an increase of some $150 million, or 30 percent, to help establish American preeminence in this field. Another good sign is the increase in the budget for the Advanced Technology Program in the National Institute of Standards and Technology, which provides grants for development of generic technologies. The NSF's investments in engineering and science and technology research centers have been additional steps in the right direction. We're beginning to see the emergence of efforts by the federal government to focus funding on areas of technology that are important to the long-range industrial health of this country.

TR: So it's an industrial policy?

WHITE: Hardly. We need to define our terms. Former Secretary of Defense Harold Brown, when asked how he would distinguish between an industrial policy and a technology policy, suggested using as an example the development of U.S. agriculture. In the early days, the government supported agricultural research and extension services—a technology policy. Government expenditures supported generic technologies that could be used by farmers to increase their productivity. Today, the federal government provides large subsidies for agriculture for a variety of reasons—to protect some growers against foreign competition, to ensure adequate income for farmers, and to achieve other national objectives. That's industrial policy.

TR: Focusing on specific areas of generic technology means either adding significantly to the overall budget, which you admit is unlikely, or taking money away from other areas.

WHITE: If we are to live with a constrained budget, some criteria for funding priorities need to be established. I'm suggesting that one important criterion has to be the contribution of R&D investments to the economic growth of this country. Accepting this criterion puts you in a position to rank investments, and would suggest focusing money on key technology areas.

TR: If you're going to focus on near-term economic effectiveness, that would seem to leave basic research out in the cold.

WHITE: I am not suggesting that economic effectiveness be the only criterion. We also need to ensure the education and training of talent, and we need to invest funds in the continuing search for new knowledge. Also, I am not drawing a distinction between basic and applied research. Let's take a generic technology field—say, optoelectronics. There are many basic optoelectronic phenomena that need to be better understood. So investments in basic science that can illuminate some of the fundamental processes would be enormously helpful. And historically, developments in practical technologies have often opened up whole areas of basic research. The invention of the steam engine helped the discovery of the laws of thermodynamics, not the other way around.

TR: Still, you would seem to have little use for fields of research with only weak connections to generally useful technology—astronomy, say.

WHITE. I don't say that at all. Every society has an obligation to make substantial investments in understanding the world

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about it—whether it's understanding the processes that govern the universe or fundamental human biology.

TR: But it seems inescapable that there will be winners and losers.

WHITE: There always are, even in today's allocation of resources. It is not a question of "either-or." Given the magnitude of the investment in R&D in this country, we should find it possible to focus more of our resources on areas that contribute more directly in the long run to our economic effectiveness.

TR: You've suggested creating a pool of funds by skimming 1 percent off the research budget of every federal research project.

WHITE: I was trying to illustrate what could be done by focusing even a modest amount of resources.

TR: One obvious area of enormous expenditure is defense. Sixty percent of the proposed R&D budget would be for defense. Is that too much?

WHITE: You have to realize that a lot of what the DOD classifies as "research" is not what most people would call research. A large fraction of it goes into procurement and prototyping. In fact, the Academies of Sciences and Engineering have told Congress that our public policy is being skewed because a large amount of R&D resources in the Defense Department is not what one would normally call research.

TR: Still, a large fraction of the country's R&D budget is funded by the military.

WHITE: True. Much Defense Department R&D is on "dual-use" technologies, which have civilian as well as military uses. If you look at this year's budget, there's DOD money for the high-performance computing initiative and for R&D in manufacturing, both of which are obviously dual-use. The Defense Department pumps $1 billion a year into basic science. That's 50 percent of the amount the NSF pumps in. A good chunk of this money goes to the universities. The Defense Department is now a big supporter of university research that is not tied to immediate defense needs.

TR: So the military is doing its share to keep research healthy?

WHITE: My view is that the Defense Department has a larger obligation than it is at present discharging to ensure the vitality of the academic research enterprise. It is one of the nation's biggest users of the output of R&D and of trained personnel, and so should be spending more money on academic basic research.

TR: You have expressed some concerns about the state of the competitive grants system for deciding where R&D money gets spent. Why?

WHITE: Our competitive grants system serves us very well. But there are some problems. For example, the peer-review system for giving out research grants is becoming overloaded.

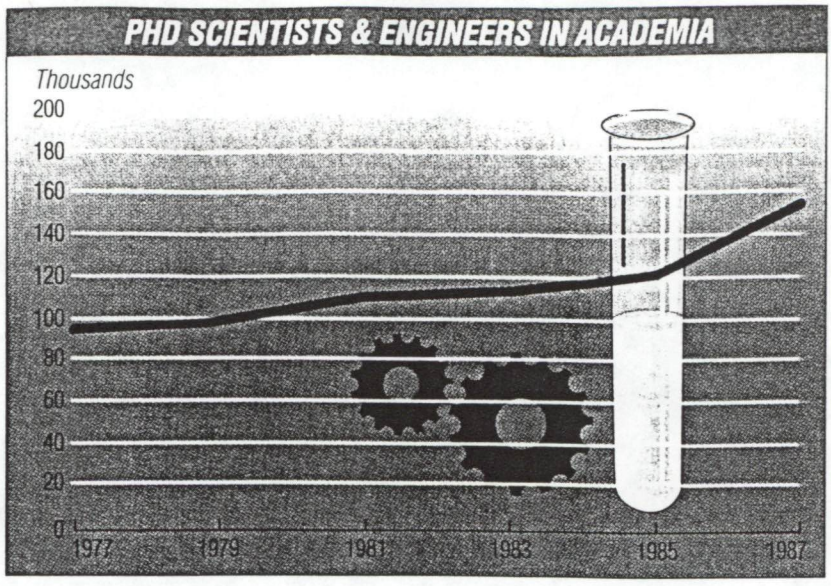
TR: Why?

WHITE: There is an increasing number of proposals being submitted that need to be evaluated and peer reviewed. The probability of any individual proposal's success goes down. The logical thing for a grant seeker to do is to submit more than one proposal. That's what's happening, and a National Science Foundation report says the system is under stress.

TR: If the peer-review system is overloaded, is it still serving its function of making sure that funding goes to the most deserving people?

WHITE: Generally it is. One concern I have is that young investigators too often are unable to get funds for their work. The peer-review system disadvantages the young investigator who doesn't have a track record.

TR: How might we attack that problem?



The growing number of academic researchers is straining the federal funding system. A shift into industry, says White, would both relieve stress on the federal R&D budget and help focus research on economically important areas.

WHITE: The government should set aside federal money specifically for young investigators. Some of that is happening already; for example, the National Science Foundation gives out about 100 Presidential Young Investigator awards each year.

TR: But that's not enough?

WHITE: I'd like to see more. And that program requires matching funds. NSF provides some money, then the awardee has to obtain matching funds from industry or other private sources. Another remedy would be to provide institutional grants directly to universities, which could then allocate them to young researchers.

TR: Why would that help?

WHITE: The knowledge of who the promising young scientists and engineers are is much better at the local institutional level than at the federal level. Institutions could make sure that their bright young researchers get some initial resources—some seed money—which would give them the track record they need to compete for federal funding. On the other hand, some faculty members think institutional grants are not the way to go.

TR: What are they worried about?

WHITE: They're concerned that universities might divert the money to other research purposes—that the funds might go to inferior proposals unsuccessful in the federal grant process.

TR: What other suggestions do you have for revising the research funding system?

WHITE: The defense industry offers a useful model. Each year, defense contractors negotiate with the government a certain fraction of their overhead funds that can be used for independent research and development—IR&D. We don't do it for university contracts and grants. We ought to look into it.

TR: You have said that the R&D enterprise is heading for a "shakeout," something like what industries go through. An industry shakeout usually means that weaker companies drop out of the market. What do you see happening in R&D?

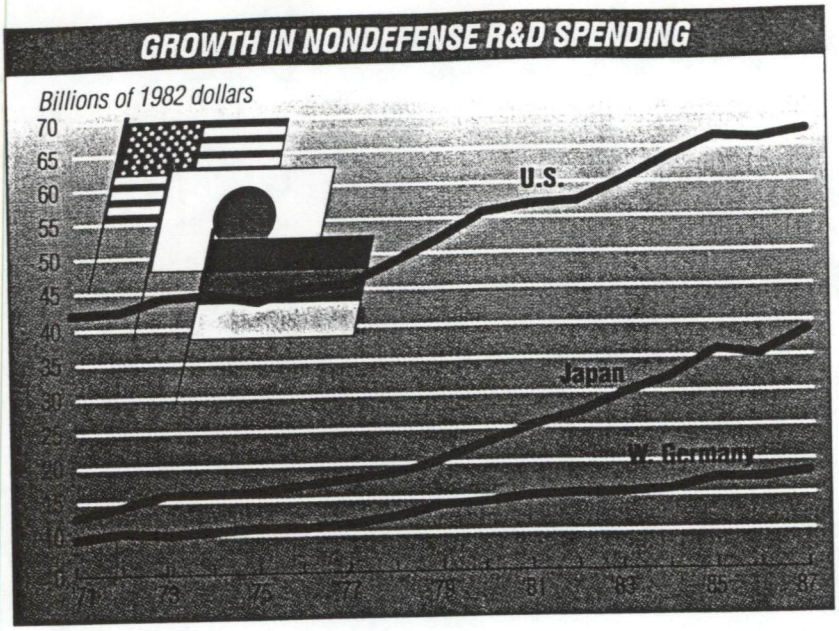
WHITE: If the federal competitive grant process is indeed merit based, and if funds are tight, then a shakeout is inevitable. Weaker proposals aren't going to get funded. And the universities will have to decide what they're going to do with those people in the academic community who aren't competitive in acquiring funding—universities don't have enough resources to carry them for long.

TR: Will only the best and richest universities be able to keep doing research?

WHITE: Certainly the best, but not necessarily the richest. We have a very large number of universities that maintain a broad spectrum of R&D programs. The quality of the R&D varies from field to field. It may well be that a university recognizes that one of its departments is not competitive and decides to focus its resources on areas of strength. When you have a shakeout in industry, you take a look at what your strong and weak lines of business are. You preserve the good—in fact you may build up and strengthen those areas with comparative advantages. I hope we will manage the shakeout wisely so that what we preserve are the strong elements of our R&D enterprise, wherever they may exist.

TR: How will this shakeout come about?

DIAGRAMS: DEBORAH PERUGI DESIGN



Despite complaints from the scientific community, federal support for R&D has been growing steadily and far exceeds that of our economic competitors.

WHITE: It's going to be up to individual universities, deans, department heads and boards of trustees. I've been at universities where they have closed down departments and opened new departments—all as a function of estimates of what was important, what they could do well, and what they couldn't do well.

TR: One of the options a university has is to turn directly to industry to get funding.

WHITE: Yes, that's happening more and more.

TR: Isn't there a threat to academic independence if universities become key elements in economic development?

WHITE: As far as I can see, and from what our studies at the academies indicate, there have been few distortions of the R&D enterprise in universities as a result of industry support. I think industry has approached support of university R&D in a statesmanlike and open way. Universities have been jealous of their independence and academic freedom and are careful not to allow the availability of funds to torque their R&D programs. But the danger exists. If there is a serious shakeout, there will be a temptation to torque research programs to acquire funds. Then you have a problem.

TR: And what do you do about it?

WHITE: That's a matter that each university administration must cope with in its own way. Some universities see themselves as important elements in economic development, others are much more concerned that they remain independent places for education and training of students, and for the conduct of basic research.

TR: An international issue also arises: If the university is an element of a program to make the country more economically competitive, then it hardly makes sense to share its research with, say, the Japanese. Doesn't that subvert the principle of open communication among researchers?

WHITE: I understand that there are concerns in some parts of Congress about access of industrial competitors, like Japanese corporations, to R&D that has been supported largely by taxpayer money. That issue has especially been joined at MIT. My view is that as long as the principles of academic freedom are observed, and as long as the research program is not torqued, and as long as there is no favored access for foreign corporations, the country benefits from support of our universities by foreign corporations. It's more important for the country to have an intellectually vibrant university system than it is to try to build walls around the university. That doesn't make any sense for a university. The information it produces is available to anyone through the world pool of knowledge.

TR: Many research scientists and engineers believe that too much money is going into "megaprojects" like the superconducting supercollider (SSC) and the Human Genome Project. Do you think the balance ought to shift back in favor of individual researchers?

WHITE: I think the big-science, little-science issue has been blown out of proportion. Many of the big-science activities have been proposed by individual scientists because they needed to do frontier research. The SSC, the astronomical observatories

and the planetary space probes are good examples. Where did the proposals for these big-science activities originate? They came from individual scientists who said, we want to work at the cutting edge of science, and we need the following facilities to do that research. Who do you think uses the telescopes? It's the individual investigators. I happen to be very familiar with the National Center for Atmospheric Research in Boulder, Colorado. That's a big center. It serves hundreds of individual university scientists who couldn't do their work otherwise, whether it's the use of an aircraft, or a very large scale computer, or a field observing system.

TR: But it is, as you've said, a zero-sum game: if you're putting money one place, it follows that you're not putting it somewhere else.

WHITE: Not in the past. The budget for individual investigators has been going up and the budget for big-science projects has been going up, too. Scientists and engineers out there would probably like to see a higher rate of growth for individual scientists than they have.

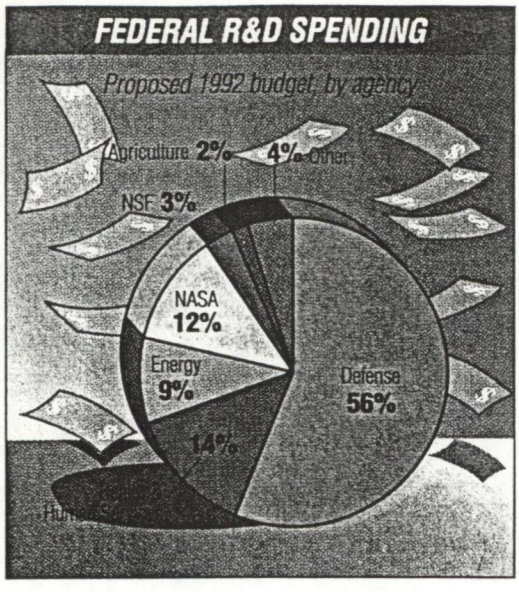
TR: Do you think the growth of "pork-barrel science" is changing the image of science in this country?

WHITE: I worry about that. With the growth of lobbying groups, and with one discipline taking on another discipline, the scientific community is in danger of looking like just another special pleader for funding.

TR: Isn't that what it is?

WHITE: But science and engineering are held in special regard because of the recognition that investments in research and development have paid off handsomely for the nation in improved health care, higher standards of living, jobs, and economic growth generally.

TR: You think research is losing that special stature?



The nation would spend $76 billion for R&D in fiscal 1992 under the administration's proposed budget, an increase of 13% over 1991. Defense research would continue to dominate the funding picture, but NASA, NSF, and the National Institutes of Health would see big gains.

WHITE: Yes, there is that danger. We have an obligation to justify our requests for funds more specifically. It is not sufficient to claim entitlement to as much money as is necessary to support every good scientist in the country because we contribute so much to the understanding of the world and to long-term economic development.

TR: When you say justification, you mean economic payback?

WHITE: Yes, in the long run, investments in research and development have to have an economic, social, or defense payback. Science and engineering research, like any other activity in this country, has a social purpose, and it must justify expenditures in ways that can be understood and lead to the social and economic betterment of the country. In using the term "social payback," I also mean that all societies have an obligation to make an investment in the search for understanding of the natural processes of our universe—the search for knowledge for knowledge's sake. ■

With the growth of lobbying groups, the scientific community is in danger of looking like just another pleader for special funding.