32. R. Gessain, *Medd. Grønland* **161**, No. 4 (1960).
33. J. B. Jørgensen and W. S. Laughlin, *Folk* **5**, 199 (1963).
34. W. S. Laughlin and J. B. Jørgensen, *Acta Genet. Statist. Med.* **6**, 3 (1956).
35. F. Boas, *Science* **30**, 535 (1909).
36. C. F. A. Moorrees, R. H. Osborne, E. Wilde, *Am. J. Phys. Anthropol.* **10**, 319 (1952).
37. W. Howells, *Mankind in the Making* (Doubleday, New York, 1959), p. 300.
38. K. Chang, *Science* **136**, 749 (1962).
39. H. Suzuki, in *Actes du 6e Congrès International des Sciences Anthropologiques et Ethnologiques* (Paris, 1960), vol. 1; *Zinruigaku Zassi* **70**, 1 (1962).
40. F. Weidenreich, *Palaeontol. Sinica* **1943**, No. 10, 127, 246, 256 (1943).
41. H. Suzuki, in *Selected Papers of the Fifth International Congress of Anthropology and Ethnological Sciences* (Philadelphia, 1956), pp. 717–724.
42. M. T. Newman, *Am. Anthropologist* **64**, 237 (1963).
43. Professor Penrose adjusted his coefficient of divergence to accommodate discrete traits, made the original three-dimensional model, and provided a photograph from which the figure was drawn.

R&D, and the Relations of Science and Government

A statement before a congressional subcommittee by the retiring president of the AAAS.

Paul M. Gross

Mr. Daddario and members of the Subcommittee, I appreciate the opportunity to meet with you today to discuss some of the persistent problems involved in the relations between government and science. I will touch on only a few major areas, for it seems to me that this Subcommittee has a special opportunity to consider the underlying and more fundamental issues.

When you invited the American Association for the Advancement of Science to take part in these hearings, you asked us to consider two questions: (i) What are some of the most important or difficult problems involved in the relations between government and science? and (ii) How might the Association be of help in enabling the Congress to deal more effectively with issues in which science and government interact?

In taking up the first of these two questions, I should like to try to get behind the specifics of particular fields of research and particular aspects of their administrative management to consider some of the basic, persistent problems of government-science relationships. Because these problems are fundamental and persistent, they deserve the thoughtful consideration of the Subcommittee, of the Congress, and of the scientific community.

I start with the premise that the present character and size of federal research and development expenditures owe their initiation in large measure to ideas and concepts originating in the scientific community. The basic research supported by the National Institutes of Health, the National Science Foundation, and other agencies is almost wholly determined by the scientists themselves, who decide what seems worth working on. The applied research and developmental programs of the Department of Defense, the Atomic Energy Commission, NASA, NIH, and other agencies have become possible as a result of work which, in the main, was initiated by scientists. As some of that work developed, it became clear that it could and should be exploited to serve military, industrial, health, and prestige goals of the nation.

In appropriating funds for research and development, the Congress has certain objectives in mind, as have the executive agencies in submitting their R&D budgets. In submitting proposals for work that is to be funded from these appropriations, scientists and engineers on the staffs of university, industrial, and other research laboratories also have certain objectives in mind. In the long run and in general, there is agreement between the objectives of the government and those of the scientists and engineers, but the match is not always a perfect one, and the amount of agreement may be greater in the long run than in the short run, and greater for some kinds of research activities than for others.

Both scientists and government officials understand, however, that there is a strong interdependence between the government, which depends upon industrial and educational research laboratories to conduct research, and those laboratories, which depend upon the government for a large fraction of the necessary financial support. Because of this interdependence, there is need for mutual understanding, and sometimes for compromise and adjustment. There is also need for the kind of analysis of basic problems that this Subcommittee is undertaking.

A Four-Part Subject

Some of the problems could be clarified if we think of the whole subject as having four main parts:

1) *Applied research.* I place this first because much the largest fraction of the total R&D budget is spent for the development, the testing, and the associated applied research involved in perfecting or bringing into use new equipment, new methods, and new products. A great deal of money is required to develop—for example—a new weapon system, but the objective can be foreseen with reasonable clarity, and it is thus reasonably easy to make some of the necessary decisions. Nevertheless, it is rare that such a system can be perfected without our first finding gaps in our fundamental scientific knowledge. Thus we do not go very far in a broad consideration of applied research before we find ourselves thinking about the second

On 22 October 1963 Dr. Gross appeared, at its request, before the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics of the House of Representatives. His statement is here slightly edited.

of the four main parts of our subject, namely, basic research.

As an example of how our applied-research objectives press upon our achievements in basic research, let me consider in general terms the development of a weapon system. It began to appear feasible to develop an effective anti-missile when three essential components became available: radar adequate to track a missile, very fast computers that could quickly plot the required interception course for an anti-missile, and a small nuclear war head. These were the principal necessary components, but as work on an anti-missile progressed, it soon became apparent that they were not sufficient and that without substantial additions to basic knowledge the work could not be successfully completed.

In my experience, the same kind of situation arises frequently in industry: a new development is delayed by the necessity for further research. Industry frequently solves such problems by a cut-and-try process involving the use of a large number of scientists. With a more adequate store of basic knowledge available, the objective could frequently be attained more quickly and with a more economical and efficient use of scientific manpower.

2) *Basic research.* In the abstract, people would agree that the purpose of supporting basic research is to strengthen the nation's scientific competence, to gain a better understanding of the processes of nature and to acquire new knowledge, some of which will prove to be of practical usefulness. But it is in basic research that the scientist finds it most difficult to explain to Congress, to the general public, and sometimes even to scientists in disciplines other than his own, just what he is doing and why he thinks it worth while. It is also usually basic research that is involved when journalists and others poke fun at whole research enterprises by selecting from a list of studies a title which they do not understand and which may appear trivial or even ludicrous out of the context of technical language of the particular field concerned.

3) *Advanced scientific education.* At the advanced level, science education is closely allied to research, for it consists largely of a kind of research apprenticeship and is supported primarily by graduate fellowships and by research assistantships.

4) *Science education at the primary and secondary levels.* At these levels, and even to a substantial degree at the collegiate level, science education is of course much less intimately connected with research. Its improvement consequently poses somewhat different problems from those of graduate and professional training, and the appropriate methods of support also differ. A major reason for differentiating between research training at the advanced level and science education at earlier levels is the fact that the problems of segregation, of religious versus secular control, and of the fear of federal government control, which cannot be avoided at the levels of general education, are comparatively irrelevant in considering support for research and research training at the advanced level.

Some of the executive agencies—the National Institutes of Health, the National Science Foundation, the National Aeronautics and Space Administration are examples—are involved in more than one—even in all—of these four kinds of activities. Because of the way in which responsibilities are assigned to committees of the Congress, several of the committees have responsibility for all or several of them. I would not suggest that the four be separated by agencies—with some agencies responsible, for example, only for applied research and development and forbidden to interest themselves in basic research or science education—nor is it realistic to suggest that congressional committees have their responsibilities similarly differentiated. I would suggest, however, that in the formation of policies, and at some stages in the consideration of appropriations, we can think more clearly about government-science relations if we think separately about each of these four categories. If we do that, we will have clearer opportunities for reaching decisions concerning both policy and operational management.

Allotment of Funds

Let me suggest several advantages of such a separation. First, we could establish more firmly our policies concerning support for fundamental research. In the current budget of approximately $15 billion for research and development, 10 percent or less is devoted to basic research. A wealth of experience tells us that when money gets tight, it is this category that is most likely to suffer. If we differentiated more clearly between basic research, on the one hand, and applied research, development, and testing, on the other, it would, I think, be easier to agree upon the appropriate level of support that the nation can afford. We are now spending a billion and a half dollars or less a year on basic research. I would contend that the nation is getting its money's worth for this amount, for this is the money that we spend to renew and extend our fundamental stock of scientific knowledge.

The issue is not whether x dollars is too little or too much for science, but whether the nation's investment in research is producing results that are desirable for the American people. With our investment in basic research we have built a reputation as a great scientific leader among nations—witness the number of Nobel Prizes that have been awarded to Americans. We have made the United States the mecca for scientists throughout the world. We have learned much about the nature and history of the universe and of our planet, about the mechanisms of cellular growth and reproduction. And basic research has been leading with increasing rapidity to applied research that has been of widespread benefit to the American people. A few examples may be quickly cited.

1) Great advances in the health of the American people have coincided with the expansion of federal investment in medical research and public health measures.

2) The nation's military might is a direct outgrowth of the scientific community's responsiveness to the needs of national security.

3) Civil aviation's high degree of safety stems from research that is fundamental to traffic control and navigation devices.

4) The productivity of the nation's farms is directly related to seed and fertilizer developments that originated in the laboratory.

Finally, let me cite a single concrete example as evidence of the value of basic research. This is in part from fundamental research in radiation biology, a field with which I have some acquaintance because of my association with the Oak Ridge Institute of Nuclear Studies.

First let me give the title of an early paper published in the *Journal of Economic Entomology* in 1951. This was "Experiments with screw-worm flies sterilized by x-rays." If one did not live in Florida or Texas and knew nothing about screw-worm flies, this might at first glance indeed seem a subject of doubtful merit on which to spend federal research funds; it is easy to imagine what a journalistic wit might make of it. A little inquiry, however, would reveal the following facts:

1) Fatal wounds in cattle in Florida and Texas caused by maggots from eggs of the screw-worm fly led to losses estimated by cattlemen to aggregate at least $100 million a year.

2) Basic research on the ecology of of this insect, its flight, mating, feeding, and other habits has led to a method for eliminating its occurrence, at least in Florida.

3) Stated simply, the method consists of breeding large numbers of the fly and sterilizing them. After wholesale release, the sterilized males mate with naturally occurring females, but only sterile eggs result.

4) After systematic application of this quite new and novel technique of insect control in Florida for about two years, the insect was practically eradicated and its serious menace to the Florida livestock industry eliminated.

5) From my general knowledge of research costs, I would estimate that the cost for the basic research involved did not exceed $1 million in all. The annual savings to the livestock industry of Florida alone would pay many times over not only for this but for much other basic research.

One of the advantages of treating separately the costs of basic research and the much greater costs of development is that it becomes easier to see what we are paying for. For $1.5 billion a year we get our whole basic research program, including many examples such as the one I have cited on the mating habits of the screw-worm fly. The more frequently cited figure of $15 billion a year includes the developmental costs of military, atomic energy, space, and other large programs. Scientists, the executive agencies, and Congress can defend a billion and a half dollars a year for basic research, and can point to such examples as one kind of justification. It is not so easy to justify such work or the level of expenditure if the budget is thought of as $15 billion a year, a budget that includes a great deal of work that the country has decided is necessary but that does not belong in the basic research category.

The second advantage of a clearer separation of basic research from applied research, development, and testing would be in the clarification of our worries about duplication. Congress has very rightly been worried about the duplication of effort in the R&D sphere. Scientists equally correctly deny that there is any intentional duplication in basic research. Congress wishes to save money, and can very properly raise questions about duplication of developmental efforts in the programs of agencies that have overlapping responsibilities. But duplication of effort in basic research is a quite different matter. The scientist's own motivation, his concern for his reputation among fellow scientists, and the elaborate procedures that prevail for exchanging information about the research being undertaken in different laboratories constitute much better guarantees against unnecessary duplication than could be provided by any set of governmental regulations or congressional hearings.

Third, questions of overhead, of the kinds of reporting required, of the relative merits of grants versus contracts, and other problems of management would, I believe, be easier to agree upon if we took them up separately for basic research and for applied research and development than they have been when these have all been lumped together into an undifferentiated category.

Fourth, the government supports science education in a variety of ways in order to have a continuing supply of people qualified in pure science and its applied fields, but there is a considerable amount of confusion in the process. For example, much of the money that is allotted for research purposes is, in fact, used for the advanced training of graduate students. I said earlier that education at this level consists largely of a research apprenticeship. A great number of the grants for basic research and many of those for applied research that are carried out in university laboratories include funds for graduate assistants. The money is usefully spent, and the training received by graduate students contributes to our future supply of scientists and engineers. But some of the issues are clouded, because money that appears in the budget for one purpose is expended for a related but nevertheless different purpose.

There are, as I have said, some major differences between the proper methods of support for science education at the graduate level and for science education for younger students. The budgets upon which Congress has to act include funds for both these levels. But at no point in their consideration is there a clean separation between the two, and consequently there is never an opportunity for a clear decision as to how much money can appropriately go to each and the differences in arrangements that will most effectively foster each set of objectives.

Division of Responsibility

Fifth, a clearer separation of the four main categories would make it easier to define the kinds of responsibility that can most appropriately be carried out by Congress, by the executive agencies, and by the scientists who are ultimately responsible for the research and educational activities that are being supported. The lines are not completely sharp, but I would suggest that Congress and the Office of the President have primary responsibility for deciding what the total budget shall be and how it should be divided among these four broad areas. Within the area of development, testing, and associated applied research, Congress and the Office of the President also have primary responsibility for subdividing funds, for here are involved specific national goals —for defense, for public health, for our activities in space, for industry, agriculture, and for national prestige. On the other hand, the cognizant agencies, such as the National Science Foundation or the National Institutes of Health, and their grantees have a better basis for deciding how money for basic research should be spent and how money for the advanced and graduate education of prospective scientists should be spent. Confusion, mistrust, and a considerable amount of wasted effort result when either group tries to make decisions that might better be made by the other. In his testimony a few days ago, Dr. Wiesner spoke of the great speed with which a new finding in science may alter a variety of research activities. When this happens, a great deal of time can be wasted by going through a lot of bureaucratic red tape in order to secure permission to alter the direction of a study or to obtain a piece of equipment the need for which was not foreseen when the proposal was originally submitted. Congress and the Office of the President have great and overriding responsibilities for the health of the nation's research and development effort. They need not and should not dilute that responsibility by attempting to exercise a kind of control in one area that is only appropriate in some other area, or by attempting to make detailed research decisions which they are not truly qualified to make. Who is responsible for what would be easier to decide if we were thinking separately about the four parts of the total R&D effort rather than trying to establish rules and procedures for R&D as a whole.

To summarize: It seems to me altogether desirable that the Subcommittee study seriously and thoroughly the general question of the relationships between government and science, and I believe that you can do so most constructively if the four categories that I have discussed are taken up one at a time.

Geographic Distribution of Research Funds

The second general problem that I would like to discuss is closely related to the first. The problem is that of the geographic distribution of federal research funds.

The facts are perfectly clear and are a matter of record for each agency. A few states get a great deal more money than do all the rest. In general, the states that get the most money for research are such populous states as California, Massachusetts, and New York, but even on a per-capita basis the disparities among the states are tremendous. Whether the distribution is what it ought to be has been and no doubt will continue to be subject to a good deal of argument. A considerable part of the argument has been confused and confusing because we have been trying to use the same money for objectives that in the short run are mutually contradictory. In the abstract, most people would, I believe, agree that it is desirable that research be done on a variety of problems and that the research be of as high quality as we can procure. In the abstract, I believe also, most people would agree that it would be desirable to have a larger number of research and educational institutions of high quality than we now have, and that such institutions should be located in various parts of the country instead of being concentrated in a few.

In practice, there has been conflict between these two objectives. The need for defense, the fear of possible attack, the desire to ameliorate or eradicate crippling and disabling diseases, and the desire to achieve other national goals as rapidly as possible have all argued in the direction of placing research grants and contracts with those institutions that are best qualified to conduct the desired research. There are not many such institutions. Consequently, there has been a pile-up of federal research funds in a relatively small number of universities. In order to fulfill their obligations, these universities have recruited competent scientists from other universities and colleges, and so there has been further concentration of research talent in the best institutions. From time to time, this system has been criticized and the claim advanced that research funds should be more broadly allocated among the 50 states. The concentrated distribution has often seemed necessary in the past. The urgency of attaining some of the goals we have had in mind would have made anything like an equal distribution among the states a serious mistake.

But this situation has posed a dilemma for Congress, one that was illustrated—to take a single example—by the hearings of a subcommittee of the Committee on Appropriations of the House of Representatives earlier this year. In the review of the 1964 budget of the National Science Foundation, officers of the National Science Foundation were criticized several times for what members of the subcommittee considered undue concentration of NSF funds in a few states. The same hearings, however, resulted in striking out of the NSF budget the funds that had been requested for developmental grants that would have enabled NSF to assist a number of universities to attain greater research competence, and thus on merit to secure a larger proportion of funds handled through the regular grant procedures of the National Science Foundation and other agencies.

We cannot let down our guard, but I suggest that we have reached a stage where we can do some longer-range planning, and that it would now be appropriate to allot funds specifically to each of the two purposes. That is, some funds should be allotted for research support, with selection of recipients to be made strictly on grounds of quality, as has been the policy of the agencies in the past; and some funds should be allotted specifically for the purpose of building up a broader base of high-quality institutions scattered throughout the land.

Here, clearly, is a matter of high policy for the Congress and the President's Office. The change of policy would recognize that there is now an overemphasis on research at the expense of teaching and an overemphasis on short-term research goals at the expense of a broadened research competence.

When the establishment of the National Science Foundation was first being debated in Congress, consideration was given to the possibility of allotting some portion of its funds—perhaps 25 percent—among the several states on a formula basis and of allotting the rest strictly on the basis of merit. This proposal was killed, partly because the pork-barrel label got attached to it, but the objective is still desirable. I propose, therefore, that the government's total objective in supporting science would be better served if immediate research competence were not the only criterion for the distribution of funds and if some grants for research and for the improvement of science education were to be made either on a formula basis or by selection of especially promising institutions, with the intent to develop first-class institutions in parts of the country in which they do not now exist.

To the extent that federal funds can be used to accomplish this purpose, it will be necessary to use a larger fraction of that money than we have been using in past years in the form of institutional grants rather than individual project grants, and it will be necessary frankly to recognize the desirability of placing a larger amount of the total budget into universities that have the potential of reaching top rank but that have not yet done so.

All in all, I would list as one of the most fundamental problems in government-science relations the need to arrive at a better adjustment between the immediate, short-term research goals and the long-term goal of attaining for the nation a broadened educational and research competence.

Nature of the AAAS

I shall turn now to the second topic that I was asked to discuss, the nature of the American Association for the Advancement of Science and the ways in which it might help the Congress to fulfill its obligation to study and review legislative matters that are influenced by or that have an influence upon science and science education.

Just as the American Bar Association is the large, national, voluntary society of lawyers in the United States, so the American Association for the Advancement of Science is the large, national, voluntary society of scientists. The association was established 115 years ago. It now has 90,000 members. It covers all fields of science: astronomy, mathematics, physics and chemistry, the various fields of biology, agriculture, medicine, psychology, and the social sciences. While we have sections in all of these fields, provide for meetings covering all fields, and publish papers and technical symposia in all, most of our attention is devoted to matters that concern science as a whole, that involve several different fields of science, or that deal with questions of science education. In the last 8 or 9 years, we have been devoting a good deal of time and energy to problems of science education.

We hold national and regional meetings each year. Occasionally we are responsible for international scientific congresses. And we have a number of publications dealing with science, science education, and the public understanding of science.

As a matter of general policy, we rarely take formal positions on public issues. This is not because of lack of interest, but rather because we think we can be of greater service by providing an open forum for their analysis and discussion than we could by trying to decide upon the right answer in each case. Once in a while there is an exception. For example, from 1946 to 1950 we tried very hard to persuade the Congress and the country that it would be a good thing to establish the National Science Foundation. But in general we do not try to influence legislation or national policy by taking a position on one side of an issue.

A forum for debate and discussion of such issues is provided at our annual meetings. It is provided also, on a continuing basis, by the weekly magazine *Science* which we publish. Editorials, news, and news analyses concerning pending legislation, programs and decisions of the executive agencies, and other political, economic, and social actions and forces that have a bearing on science or upon which scientific activities have a bearing are published regularly in *Science*. These are very widely read in the scientific community and have a fair readership among governmental policy makers. A fast printing schedule enables *Science* to reach the scientific community very rapidly; the editorial staff finished writing last night or even today the News and Comment material that will be printed and mailed tomorrow in this week's issue of *Science*.

A second way in which we have attempted to serve a useful role is through the publication of analyses of problems that arise in the interaction between science and public affairs. As an example, several years ago there was considerable interest in the possibility of establishing a cabinet-level Department of Science or of Science and Technology. We collected half a dozen knowledgeable people who held different ideas about this possibility, kept them together for three days of intensive discussion, and as a result published in *Science* an analysis that did not try to give a simple yes or no answer to the question of whether there should be such a department of government, but instead laid out the issues, discussed the pros and cons, and tried to analyze the probable effects of the several proposals that were then current.

As another example, in 1952 we published a book reviewing the status of work in the various fields of science in Soviet Russia. This was before there was any general concern over a race with the Russians, and it has since become much easier to get information about what the Russians have been doing. But at the time, it served as a widely useful source book of information about Russian scientific work. More recently we have done the same thing with regard to Communist China. In 1960 we set a group of American and Chinese-American scholars the task of reviewing all the Chinese journals and scientific reports that were available in the United States. (The amount of material for the decade of the 1950's was extensive; since then the flow of information from Communist China has been substantially curtailed.) We published the result in 1961, and it is still the best available source of information about what the Communist Chinese are doing in geophysics, medicine, and a variety of other fields.

The magazine *Science* and analyses such as those I have described are primarily intended for scientists. They are read by others, but in the main they reach a scientific audience. I want, therefore, to mention three ways in which we might be of more direct help to the Congress. Whether the suggestions I am going to make would be helpful is something I hope you will discuss. The extent to which we could do these or other things that you might propose is something that I would want to discuss with the Association's Board of Directors, for there are limits on what an organization that has a limited staff and that is primarily supported by the annual dues of its members can promise to do.

Possible Aids to Congress

Several recent bills have advocated the establishment of a group of scientific staff members or science consultants to work with Congress and its committees. If such a congressional office is established, the staff will certainly not be large enough to handle all questions by itself. Help from outside will be needed, just as you have indicated that the existing committees need help.

One possibility for us would be to serve as a source of information about advisers. It is always difficult and sometimes impossible to get advisers who are well informed about a matter and who are not also either recipients of government grants or advisers to executive agencies. But we know the scientists of the country and, perhaps as well as anyone else, could arrange to get well-qualified advisers on a variety of scientific matters of concern to congressional committees.

A second possibility is through the seminar mechanism. The Committee on Science and Astronautics has its own panel of advisers that meets periodically. In a quite different fashion, we have held, jointly with the Brookings Institution, several series of seminars for an invited group of members of the House of Representatives. Mr. Daddario and Mr. Mosher, I am told, have been regular participants in those seminars. Each seminar has dealt with a specific area of research. The purpose in all cases has been educational and deliberately has not dealt with pending legislation. But if a committee wished, we could arrange for a speaker or a panel to discuss the scientific background or the probable implications of a problem with which the committee was concerned. The discussions might be held here and constitute part of the record, or they might be held in a more informal atmosphere at our building and be off the record. The British have had considerable success, and also some problems, with a standing committee consisting in part of members of Parliament and in part of scientists. That committee meets periodically to discuss matters that are to come before Parliament. I do not think that a standing committee would be the best arrangement here, but perhaps it would be useful to arrange some *ad hoc* joint meetings that would serve a similar purpose.

As a third possibility, the AAAS may at times be able to carry out analyses or studies that would be of use. As an example: for the past two years the Association has had a group of physicists, chemists, economists, urban planners, and public health specialists, with the help of a small staff, conducting a study of the problems of air pollution that are beginning to be of general concern and have long been of concern to some local areas, notably Los Angeles. We will have the report ready for publication next year. Last month we published in Spanish and later this fall will publish in English a review of American experience in the handling of arid-land problems. We published the Spanish version first because it constituted the United States' contribution to the Latin-American Congress on Arid Lands that was held with UNESCO assistance in Argentina last month.

Both these studies were planned and written not with any particular legislative or congressional problem in mind, but rather as efforts to bring together the available information on an important matter of public concern. I hope that they will be widely useful. They might have been of more direct use to you had we discussed with you your interest in such matters before we started the two studies.

As an example of how such discussions in advance might be useful, I refer again to the problem of geographic distribution of federal support for scientific research and for science education. These are questions of obvious concern to Congress. They are matters that affect the operating policies of a number of government agencies. And they are of great importance to the educational institutions of the country.

Obviously the suggestions I have made would by no means wholly solve the problem of giving Congress the competence its seeks in handling scientific and technical problems. But if, after you and the staff have had an opportunity to consider these and other ideas, it appears that the Association can be of worthwhile assistance, we shall be glad to continue this discussion.

News and Comment

The Big Picture: House Committee Hears Views on Basic Problems of Science-Government Relations

One of the problems afflicting congressional treatment of science is that, because of the committee system, the congressional diagnosticians rarely look at the whole patient.

The quality of the legislative end product is by no means overwhelmingly affected by the dispersal of major scientific jurisdictions among some dozen committees, but this appears to be an important factor, one that contributes to the production of conflicting decisions. For example, the congress will endorse massive technical commitments, such as space, oceanography, and atomic energy, but will fail to recognize that much of the manpower that these programs will require in a decade is now being intellectually shortchanged in financially strapped secondary schools.

A quick way out of this situation is difficult to achieve, for the committee system is here to stay, and, furthermore, it would merely be a jump from the frying pan to the fire if, by some legislative magic, the whole of science were to be entrusted to one or even a few committees. If this were to come to pass, an intoxicating concentration of power and authoritarianism, rather than fragmentation and diversity, would probably be the problem, and who is to say that these would be preferable?

A sizable part of the solution would therefore seem to lie along the lines of slowly educating the congress in what is known about how science thrives. Happily, such an effort has been going on during the past few weeks, before a subcommittee of the House Science and Astronautics Committee, the witnesses being Frederick Seitz, president of the National Academy of Sciences; Jerome B. Wiesner, the president's science adviser and wearer of multiple hats in the executive branch's science advisory apparatus; Edward Teller, the nuclear physicist, who is professor at large at the University of California; Paul Gross, president, AAAS; and Leland J. Haworth, the recently installed director of the National Science Foundation.

In the past, scientists aplenty, including the aforementioned, have appeared on Capitol Hill to discuss this or that aspect of science; in the case of these latest hearings, however, the difference is that the witnesses were asked to paint very wide and broad pictures, and not to address themselves to the problems of a particular segment of the scientific community.

They responded by painting broad and wide, and while each addressed the committee in his own fashion, many of them made the same points:

1) The Cold War is losing force as an impetus for scientific spending, and the nation will therefore have to begin to accept public well-being, rather than national defense, as the principal motive for large-scale support of research and development.

2) In allocating research funds to educational institutions the government will have to break away from the practice of making the rich richer. The development of new geographical areas of scientific excellence should be given weight, along with the need for meet-