

## Scientific Freedom and Responsibility

### Report of the AAAS Committee on Scientific Freedom and Responsibility.

John T. Edsall

Problems of scientific freedom and responsibility are not new; one need only consider, as examples, the passionate controversies that were stirred by the work of Galileo and Darwin. In our time, however, such problems have changed in character, and have become far more numerous, more urgent, and more complex. Science and its applications have become entwined with the whole fabric of our lives and thoughts. On the one hand, basic science has enlarged our intellectual horizons—one need only mention as examples the vistas opened up by the formulation of quantum mechanics and the discovery of the genetic code. Applied science has largely freed mankind from the terrors of infectious disease; but these terrors have been replaced by new terrors, also the fruits of science. These include not only nuclear weapons with their incomparable powers of devastation but also such organic chemicals as the dioxins, accidentally discovered as contaminants of certain herbicides, which can kill guinea pigs at dosages as low as 600 parts per trillion (*1*) and are perhaps comparably poisonous for human beings. The unprecedented rate of popu-

lation growth in our time, largely a consequence of advances in medical science, sanitary technology, and transportation, threatens the ecological balance of the earth and raises the specter of catastrophic famines.

These and other problems have led to intense and often bitter disputes among members of the scientific community, and between scientists and policy-makers. As examples we may recall the controversies over the biological hazards of nuclear weapons testing, over the use of defoliants and herbicides in the Vietnam War, over the effects of DDT and other chlorinated hydrocarbon pesticides, over the antiballistic missile program, over the supersonic transport, and over the extent of the hazards from nuclear power plants. In these conflicts the contestants are often unevenly matched, with powerful industrial and governmental forces on one side and a small group of critics on the other. There have been attempts to suppress important scientific data that appeared unfavorable to the policies of some powerful organizations. If wise policy decisions are to be made amid such pressures, there is a compelling need

for fair hearings, due process, and public access to all relevant information.

The American Association for the Advancement of Science (AAAS) is deeply concerned that such issues should be dealt with, and resolved, in a responsible fashion. It would of course be far beyond the capacity of the Association to act as a court of appeal in such disputes, except in very rare and special cases. However, because of its concern with the policy issues involved, the Board of Directors of the AAAS charged this Committee to consider the following matters:

1) To study and report on the general conditions required for scientific freedom and responsibility.

2) To develop suitable criteria and procedures for the objective and impartial study of these problems.

3) To recommend mechanisms to enable the Association to review specific instances in which scientific freedom is alleged to have been abridged or otherwise endangered, or responsible scientific conduct is alleged to have been violated.

The full text of our report in response to this charge is being issued as a special publication of the AAAS. Here we set forth the major features of that report more briefly.

#### The Scientific Community:

##### Its Rights and Responsibilities

The American scientific community, as we define it, includes a wide range of very diverse individuals—basic scientists in universities, research institutes, and government laboratories; engineers; workers in medicine and public health; graduate students and technicians working on scientific problems; and teachers of science in colleges and secondary schools. The discussion that follows applies primarily to scientists involved in basic or applied research, but in large measure it is relevant to the whole scientific community.

The Committee concluded, early in its deliberations, that issues of scientific freedom and responsibility are basically inseparable. Scientific freedom, like academic freedom (2), is an acquired right, generally accepted by society as necessary for the advancement of knowledge from

This article is an abbreviated version of the report of the AAAS Committee on Scientific Freedom and Responsibility, prepared on behalf of the Committee by John T. Edsall. The members of the Committee, which was established in 1970, are: Allen V. Astin, Director Emeritus of the National Bureau of Standards and Home Secretary of the National Academy of Sciences, Chairman; John T. Edsall, Professor of Biochemistry Emeritus, Harvard University; Walter J. Hickel, former Governor of Alaska and former U.S. Secretary of the Interior; John H. Knowles, President of the Rockefeller Foundation; Earl Warren, former Chief Justice of the U.S. Supreme Court (who died in July 1974); and Dorothy Zinberg, Lecturer in Sociology, Harvard University. Mary Catherine Bateson, Associate Professor in the Department of Sociology and Anthropology, Northeastern University, served on the Committee until early 1972.

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The full report of the Committee, *Scientific Freedom and Responsibility*, can be obtained from the Association at a cost of \$2.95 for members and \$3.45 for nonmembers. Checks should be made payable to the American Association for the Advancement of Science and orders sent to the Association at 1515 Massachusetts Avenue, NW, Washington, D.C. 20005.

which society may benefit. Scientists possess no rights beyond those of other citizens except those necessary to fulfill the responsibilities arising from their special knowledge, and from the insight arising from that knowledge.

Later we shall have much to say of the activities often referred to as "whistle blowing" in which issues of freedom and responsibility are inextricably intermingled. Whistle blowing involves situations in which a scientist, engineer, physician, or other expert becomes aware of hazards arising from some process, material, or product, or becomes aware of possible improvements in technology or procedure that deserve to be adopted but are being neglected. Issues of public safety are frequently involved, and often the whistle blower works for the marketer of the process or product. Some may argue that persons with expert knowledge have a "right" to release information in their possession, if such release is in the public interest. Others would say that it is the responsibility of such experts to release the information, even though they might prefer to remain silent. Both rights and responsibilities are clearly involved here, but it seems clear to us that the responsibilities are primary.

Presumably the potential whistle blower will begin by reporting his concern to his employer and urging that corrective measures be taken; if the matter can be settled without appeal to outside authority, so much the better. If this step fails, however, and the concerned employee decides that he has the responsibility to make the matter public, he faces obvious risks that may include the loss of his job. If whistle blowers are to be encouraged to take such risks—and we believe that they should be encouraged, when serious issues are involved—they must be assured of some form of due process in passing judgment on the issues that they raise. This would call for the presence of outside independent members on any board that passes judgment on the issues, and should also include some right of appeal. We return to these matters later.

### **Should There Be Forbidden Areas in Basic Research?**

Those for whom the advancement of knowledge is a supreme value might believe that, in basic research as distinct from applied science and technology, no subject should be declared off limits. Yet there are clear inhibitions on some kinds of research involving human beings, and indeed animals. Today we are increasingly conscious of the need for informed consent in studies

of human physiology and behavior that may involve risk to the experimental subject. With young children, informed consent is impossible to obtain; parents or guardians must take the heavy responsibility of giving consent for the child. Some experiments may endanger the health, or even the lives, of the participants; some psychological experiments could be regarded as morally degrading or psychologically damaging. In such cases, review of the proposed experiments by a qualified panel of experts may provide more effective protection to the subjects than the attempt to obtain their informed consent, although we would insist on the importance of the latter.

Some experiments are justified, even if they involve great risks. The experiments that conclusively demonstrated the transmission of yellow fever by mosquitoes involved the death of one subject, Dr. Jesse Lazear. Those who took part knew they were risking their lives. Such heroic experiments are fortunately seldom called for, but they may well be needed from time to time in the future.

Recently, in a statement probably unprecedented in the history of science, a group of eminent molecular biologists, headed by Paul Berg of Stanford University, have deliberately renounced, for the time being, certain experiments on the transplantation of foreign genes into bacteria because of potential though as yet unproven hazards to human health (3). This group has spoken with authority as the Committee on Recombinant DNA Molecules of the Assembly of Life Sciences of the National Academy of Sciences. Their views have received wide public attention; of course, this committee has no police powers to enforce its recommendations, but its influence is great and as yet appears not to have been seriously challenged. The members of the committee are well aware of the dilemma; the experiments that are, for the present, being renounced are not only of great scientific interest but also might make positive contributions to human health and well-being. The decision involves an expert balanced judgment of probabilities and risks (3a).

The grounds cited for refraining from these experiments—to protect human beings from possible new and dangerous infections—are quite different from the ethical problems of present or future "genetic engineering," as with the possible production of multiple copies of people with identical genotypes by cloning. The suggested threats here are not so much to health as to human integrity, dignity, and individuality. It seems to us proper to be on the alert for such possible threats, but

we see no justification as yet for attempts to impose restrictions on the freedom of genetic research. We hold that the dangers today are remote, and that they are decisively outweighed by the great benefits that such research can bring.

### **Restrictions on Needed Research:**

#### **Fetal Research as an Example**

As we have said above, the advancement of knowledge by research must often be balanced against risks to experimental subjects that may be involved in gaining that knowledge. The complexity of the issues involved emerges from the diverse points of view that have been collected and set forth in much recent discussion, notably in a comprehensive book (4) and in a symposium (5).

In some important instances we believe that current restrictions on research have gone too far. Thus the National Research Act of 1974 has, at least temporarily, banned research on any "living" human fetus, either before or after induced abortion, except in the very unlikely event that the experiment is intended to save the life of that particular fetus (6).

We strongly oppose such restrictions. Research on the human fetus, over the past two decades, has yielded major benefits for human health. Behrman (7) has pointed out how many diseases that we can now diagnose or treat, or both, would have been unmanageable if a ban on fetal research had been in effect. Especially notable is Rh disease, which is now totally preventable, thanks in considerable part to fetal research. The human fetus is extremely susceptible to many drugs, as the thalidomide disaster dramatically demonstrated. Likewise, the fetus is far more susceptible to radiation damage than the adult. Research on fetuses that do not survive abortions can help us to discover how to give protection from such harmful agents to thousands of other fetuses that are destined to reach full term and to grow into healthy adults. We would urge that fetal research not only be permitted but intensified, subject to careful peer review of the research projects involved.

### **The Conflict between Science and Secrecy**

Many scientists, especially those employed in industrial firms and in some government laboratories, spend much or most of their time in work classified as secret. Often the grounds for secrecy appear compelling. Nevertheless, science inevitably suffers from the imposition of secrecy on a

research project. The reasons were well stated in the report of the AAAS Committee on Science in the Promotion of Human Welfare (8, p. 177):

Free dissemination of information and open discussion is an essential part of the scientific process. Each separate study of nature yields an approximate result and inevitably contains some errors and omissions. Science gets at the truth by a continuous process of self-examination which remedies omissions and corrects errors. This process requires free disclosure of results, general dissemination of findings, interpretations, conclusions, and widespread verification and criticism of results and conclusions.

That report provided specific examples to illustrate these general conclusions and showed that secrecy almost always impedes scientific progress; in applied science and technology it frequently permits hazards to develop that could be eliminated if information were publicly available. We believe that, with rare exceptions, data that provide a significant advance in fundamental science should not be kept secret, except in a major war situation, as with the atomic bomb in World War II. Even in such cases information should remain classified only for a limited and specified time; it should then be released automatically, unless a strong specific case can be made for withholding a particular piece of information for a further limited time. We should look at claims of "national security" with a very critical eye; such claims, as we have good reason to know from recent experience, often serve to cover up governmental ineptitude or corruption.

### Technology and Innovation:

#### Their Multiple and Complex Effects

When we turn from the problems of basic science to those of applied science and technology, the problems of freedom and responsibility become even more formidable. Whatever the intentions of technological innovators, the results of innovation are always more complex than the innovators intended, and usually more complex than they could even imagine. These facts, in our time, have created a compelling need for the assessment of major technological innovations, and for their critical evaluation and control. The so-called "side effects" of innovation are often deleterious and not infrequently are so pronounced that they dominate the primary effect that was intended.

The history of the use of DDT provides an example of such complexity (9). Its use brought a dramatic halt to a cholera epidemic in Naples in World War II; its initial success in destroying agricultural pests

was spectacular. Only a few biological experts warned of trouble at that time. Gradually problems appeared, as insect pests developed resistance to DDT; as, in many cases, the pesticide destroyed the natural enemies of the pests; as the long persistence of DDT in soil was discovered, and its progressive concentration in food chains led to the killing of great numbers of certain birds and fishes. All this has led, in the United States, to the banning of DDT for nearly all uses. Yet in countries where malaria is widespread, the spraying of house interiors with DDT has proved the most effective antimalarial technique available. In Sri Lanka (Ceylon) malaria had almost disappeared by 1963, when the DDT program was stopped. Then, in 1968 and 1969, there was an explosive increase in the number of infections. In 1967 only 3,465 cases had been reported; in 1968 the number rose to 425,937, and in early 1969 the rate of infection was even higher (10). Other factors were at work, of course; the World Health Organization attributed the rise in the incidence of malaria in large part to conditions that were unusually favorable to the breeding of the *Anopheles* mosquito and to unusual human population movements that helped to spread the infection (11). Nevertheless, until we have something better, DDT appears to be an essential component of any major program of malaria control.

Other complexities have arisen in connection with programs for international development. Dams and irrigation schemes have vastly increased the incidence of bilharziasis (schistosomiasis), a debilitating disease for which there is as yet no effective cure (12). The disastrous effects of the recent catastrophic droughts in the Sahel region, south of the Sahara, have been accentuated by some technological innovations, notably, for example, by the drilling of thousands of deep boreholes which have tapped the abundant water far below the surface. The resultant wells encouraged a great increase in the size of the cattle herds; pasture instead of water became the limiting factor in numbers of cattle. As pasture dried up in the drought, countless thousands of dead and dying cattle were clustered around the boreholes, while the surrounding land, for miles around, was ravaged by trampling and overgrazing. These wells, drilled by men of good will and technical skill in order to bring more water to the people and cattle of the Sahel, became a major factor in intensifying a great human and natural disaster (13).

These illustrations could be multiplied a hundredfold. Let us add at once that we are not among those who consider that

there is something inherently evil about technology. Technology has been indispensable for the rise of all civilizations, and new technology is essential for the survival of our own civilization. As an example we need only mention the need for the development of new energy sources—solar and geothermal energy and nuclear fusion, for instance—that may be less polluting than fossil fuels and less hazardous than nuclear fission.

Likewise we reject the notion of the so-called "technological imperative"—the idea that we must pursue new technological possibilities, wherever they may lead. Thousands of projects may be technically feasible, including the destruction of all human life on Earth. Even among those projects that appear attractive at first sight, careful appraisal may lead to the conclusion that they will do more harm than good. The U.S. Congress drew such a conclusion in 1971, when it voted to cut off funds for the supersonic transport program, which it had been generously funding a few years earlier.

In summary, the development of new technologies is indispensable; the training and encouragement of gifted and imaginative technologists deserves a high priority among our national needs, but the multiple repercussions of new technology need to be critically evaluated before they are introduced and constantly monitored after their first introduction. Many schemes that are technically brilliant must be rejected because their wider impact would, on the whole, be more damaging than beneficial. In some cases it would be preferable, in the eyes of some thoughtful scientific policy advisers, not to carry a project from the stage of research even into preliminary development, lest pressures would then arise that would lead to its full development.

### Conflicts Involving Scientific Freedom and Responsibility

We turn now to the second item in the charge to this Committee, which calls for us "to develop suitable criteria and procedures for the objective and impartial study of these problems." The conflicts that call for such study generally lie in the realm of applied science and technology, including medicine and public health. In most instances they involve the right, and the responsibility, of an employee to warn concerning the dangers inherent in some product or process with which he has become familiar in the course of his work; that is, the "whistle blowing" activity of which we have spoken earlier. The employer may

put intense pressure on the employee to keep quiet; the employee may be fired, or life may be made so uncomfortable that he decides to resign. Interested parties may seek to suppress scientific data that are vital for the proper resolution of a controversy. On the other hand, the employee may be acting not in the public interest but out of prejudice or spite against the employer. To be an "objective and impartial" judge in such circumstances is not easy; one person's "objectivity" looks like bias to another. In all these cases scientific evidence is an essential part of the whole situation, but wise decisions involve complex human factors, ethical judgments, and standards of value that go far beyond purely scientific argument. We consider briefly a few specific cases, before discussing criteria and procedures.

*The problem of standards for exposure to radiation.* A few years ago, Drs. J. W. Gofman and A. R. Tamplin, who worked at the laboratories of the Atomic Energy Commission (AEC) in Livermore, California, claimed that existing standards for exposure to ionizing radiation were far too tolerant, and would permit a large increase in the number of deaths from cancer if exposures rose to the allowed levels. They publicized their views widely. The chief authorities in the AEC sharply opposed these views and held them to be invalid. Gofman and Tamplin eventually left the AEC, after what they believed to be considerable harassment, and eventually the AEC did impose considerably stricter radiation standards for the protection of workers within its jurisdiction. A committee appointed by the National Academy of Sciences, after intensive study, produced a report, commonly known as the BEIR (Biological Effects of Ionizing Radiation) Report (14), which stands at present as the most authoritative statement on the hazards of ionizing radiation. In our full report we consider this controversy at somewhat greater length.

*The case of the BART engineers.* A major feature of the Bay Area Rapid Transit (BART) system in the San Francisco Bay area was to be the Automated Train Control (ATC) system, for which a contract was awarded to the Westinghouse Electric Corporation in 1967. Beginning in April 1969, three of the engineers on the project became increasingly concerned about what they saw as serious defects in the system. They expressed their concerns to the management but drew no significant response except vague warnings not to be "troublemakers." Late in 1971 the three engineers decided to take their case to the Board of Directors; this led to a public hearing in February 1972, after which the Board voted 10 to 2 in favor of the management

and against the engineers. The managers then told the three engineers that they could choose between resigning and being fired; they refused to resign and were summarily dismissed. Subsequent events vindicated their concern. The ATC system failed on several occasions; the failures were so dangerous that the system could not be used, and it became necessary to control the trains in the traditional manner.

The California Society of Professional Engineers (CSPE) initiated an inquiry. However, BART's top management refused to meet with them, or to offer explanations to anyone. Then CSPE undertook a full investigation of the firings, which brought out much disturbing information, and the California State Legislature set in motion a study, resulting in a report (the "Post Report") which essentially confirmed the warnings of the three engineers. Although CSPE took tentative steps toward a court action on behalf of the engineers, the society did not follow through on this. The engineers themselves launched a suit against BART for \$885,000, the outcome of which we have not yet learned (15).

*The case of data suppression concerning the carcinogenicity of vinyl chloride.* In May 1970 an Italian investigator, Dr. P. L. Viola, reported at a cancer congress that high concentrations of vinyl chloride caused cancer in rats. Up to that time there had apparently been no research in the plastics industry concerning the possible hazards of vinyl chloride, although tens of thousands of workers were exposed to it. More than a year later, the Manufacturing Chemists Association (MCA) in the United States initiated its own research and in October 1972 entered into an agreement with the plastics manufacturers, who sponsored the European research, to share information but not to reveal it without the consent of the European manufacturers. In August 1972 Dr. Cesare Maltoni of Bologna found angiosarcomas and various tumors in experimental animals exposed to vinyl chloride concentrations as low as 250 parts per million (ppm). At that time the allowed exposure limit for workers in the United States was 500 ppm. In January 1973 U.S. scientists visited Dr. Maltoni and learned of his findings. However, they did not notify the National Institute of Occupational Safety and Health (NIOSH) concerning these extremely ominous findings, nor did they make any attempt to warn the public or the workers exposed to vinyl chloride. In late January 1973 NIOSH requested information on possible hazards associated with occupational exposure to 23 chemical substances, including vinyl chloride. On 7 March, MCA re-

sponded by recommending a precautionary label that made no mention of toxic effects on animals or people; in other words, it appears to have deliberately deceived NIOSH regarding the true facts. Apparently MCA has claimed that the withholding of data was due to their agreement with the European manufacturers to keep the data confidential until an agreement for their release could be worked out. The fact remains that, because of the suppression of these data, tens of thousands of workers were exposed without warning, for perhaps some 2 years, to toxic concentrations of vinyl chloride. On 22 January 1974, B. F. Goodrich announced that three polyvinyl chloride workers, in just one of their plants, had died of angiosarcoma of the liver since 1971. On the same day MCA revealed the Maltoni data to NIOSH. The Occupational Safety and Health Administration, on 5 April, in an emergency action lowered the permissible exposure level from 500 to 50 ppm; drastic further lowering, to 1 ppm or less, is in prospect (16).

The evidence here seems clear: a considerable number of scientists were aware of the hazards of vinyl chloride long before the facts were made available to NIOSH or to the public; yet they kept quiet and gave no warning. As the Federation of American Scientists states, "... industrial scientists who fail to challenge conspiracies of silence within their firms are not rebuked; rather, they are often quietly rewarded for their loyalty."

In industrial medicine and public health similar situations often arise. In recent books Paul Brodeur (17) and Rachel Scott (18) have described the medical problems of workers exposed to asbestos particles, beryllium dust, and other hazards. Many of these workers develop cancer, or fatal respiratory or other diseases, over the course of 10 or 20 years; the risk is high. Yet the company physicians who look after the workers sometimes join their employers in minimizing the need for more rigorous standards of health protection. This appears to be a clear abdication of the prime responsibility of physicians or public health workers to place the health of the people for whom they are responsible before all other considerations. Obviously a doctor who is paid by a commercial enterprise will find it very difficult to act contrary to the policy of the company. The doctor who works for an independent inspecting agency will be in a much stronger position. Even so, we know from experience that regulatory agencies often become the subservient allies of the organizations that they are supposed to regulate and may collaborate with the commercial organization in concealing the hazards.

## Criteria and Procedures for the Resolution of Conflicts

Having now indicated the character of the problems, we now turn to criteria and procedures that may aid in resolving them. We approach the problem of establishing criteria by asking questions rather than by offering answers. How will the proposed decision or procedure affect human health and safety, and the general quality and amenities of life, for all the people concerned? Will a decision to require a drastic cleanup of operating conditions in a certain industry cause much of the industry to close down, with loss of jobs and production? How should such risks be balanced against considerations of safety and health? What are the possible large-scale environmental effects of the present operations and of the proposed changes? Have possible future effects been carefully considered, as, for instance, with the widely used aerosols, which liberate Freons that, in a decade or two, might (but again perhaps might not) destroy much of the ozone in the stratosphere? These are some of the problems that will have to be faced in the formulation of criteria. Obviously it is far easier to impose suitable regulations on a new enterprise than on a powerful industry that is already established, with a huge capital investment and with faults of operation and production that are already deeply entrenched. Thus the need for foresight in technology assessment is overwhelming; yet foresight is always imperfect and needs constantly to be corrected by further experience.

We turn now to procedures: how is the whistle blower to be assured of a fair hearing, without fear of reprisals, and with a good prospect that his recommendations, if they are found to be sound, will actually be put into practice? Many scientific and engineering societies have developed codes of ethics relating to the responsibility of employers and to the professional and personal conduct of scientific and technical employees. A highly articulate expression of such concerns is to be found in a statement on "Employment Guidelines," which has now been adopted by at least 20 engineering and scientific societies. For the most part, it is concerned with the general principles that should govern relations between employers and employees, but it also contains the significant statement: "The professional employee should have due regard for the safety, life and health of the public and fellow employees in all work for which he/she is responsible. Where the technical adequacy of a process or product is involved, he/she should protect the public and his/her employer by withholding of plans that do not meet accepted profes-

sional standards and by presenting clearly the consequences to be expected if his/her professional judgment is not followed" (19, p. 59).

The formulation of such a declaration is a significant event. How much it means depends, of course, on the effectiveness with which it is applied. Moreover, these guidelines, like most such codes of ethics that we have seen, lack a very important ingredient, namely, a provision for the arbitration of disputes. The protection of individuals from arbitrary action by authority is deeply ingrained in English common law, and the U.S. Constitution provides that "no person shall . . . be deprived of life, liberty, or property without due process of law." We believe that some form of due process should be an essential part of any employer-employee agreement or contract, to protect the employee from arbitrary action by the employer, allegedly based on professional or personal misconduct. A minimum requirement for such due process would involve a hearing by a board, including independent members, with the right of appeal to some reasonably neutral but professionally qualified higher authority. Codes of professional ethics are likely to be ineffective unless some type of due process is provided for the resolution of disputes. Without this, scientific freedom is likely to be abridged. We therefore strongly recommend that all employment contracts involving scientific or professional employees include such provisions for the review of disputes through hearing and appeal processes. Provision for neutral or third-party participation is important, particularly when issues of public interest are involved.

### Professional Societies as Protectors of the Public Interest

How active can, and should, professional societies be in actively fighting on behalf of their members who are attempting to defend the public interest? Most such societies have in the past remained aloof from conflicts of this sort and have often taken the attitude that the purity of their devotion to the advancement of their respective sciences would somehow be contaminated if they entered the public arena to contest such issues. We believe that such attitudes are no longer appropriate. The scientific community can no longer remain apart from the conflicts of our time, where so many technological decisions are being made that vitally affect the well-being of society. We are not proposing that professional societies should take public stands on large general political issues, such as the legitimacy of the Vietnam War; individual

members of the societies, when their concern is aroused, should deal with these matters by other mechanisms. However, in matters directly related to the professional competence of members of the society, where the public interest is clearly involved, we believe that the societies can and should play a much more active role than they have in the past. They can deal with such issues by setting up committees of inquiry in cases where a serious violation of scientific freedom or responsibility is suspected; by publicizing the results of the inquiry in professional journals, and, if necessary, in the more popular journals and in the news media; and by calling the matter to the attention of governmental bodies, as with the California Legislature in the BART case. They can on occasion launch lawsuits on behalf of their members who have apparently suffered injustice when acting on behalf of the public interest.

In stating this, our major new proposal for dealing with "the objective and impartial study of these problems," we are aware of the difficulties that the proposal will face. The most serious problems are those of time and money. Most professional societies have limited funds; many operate more or less on a shoestring. They keep members' dues fairly small; otherwise members drop out, particularly in times of economic hardship. The fighting of difficult cases, on behalf of members involved in controversies, can be a very expensive business, especially if the case goes into the courts. In any event, responsible scientists would be required to spend substantial amounts of precious time serving on hearing panels, studying large bodies of evidence, and preparing reports.

When a professional society does fight for the rights of its members, it is more likely to be concerned with defending their status and pay than to be acting primarily on behalf of the public interest as its primary motive. The impetus to take actions of the latter sort is likely to be much less strong than the desire to provide direct help to members of one's own professional group.

These are powerful obstacles to our proposals, but they are not insuperable. Societies that share common interests, but which may be individually too weak financially to support such activities, may band together in groups to finance the necessary operations. There are increasing pressures upon scientists, engineers, and other members of the scientific community to face these public issues and deal with them effectively. These pressures come both from the public and from within the ranks of the scientists themselves. We are well aware of the mistrust and hostility toward science

that is manifest in many quarters; one reflection of this attitude is the decline in government support of scientific research in recent years. Such hostility will almost certainly grow unless scientists exhibit greater concern for preventing the misuse of science and technology. As these concerns become more intense, it should become easier for the professional societies to obtain additional funds to finance the expenses of lawsuits, hearing panels, and other activities undertaken in the defense of the public interest. Whether government funds could or should be available for such purposes is open to question; but it is likely that some of the major private foundations, either those now in existence or those yet to be created, will see the urgency of supporting such public service activities. The need for these activities may also lead to the creation of other social mechanisms for dealing with these problems, of a sort that we cannot now foresee. We look to increased activity of the professional societies as the most hopeful approach to the problem in the immediate future.

#### **The Role of the AAAS in the Defense of Scientific Freedom and Responsibility**

We now consider the third charge from the AAAS to this Committee: "To recommend mechanisms to enable the Association to review specific instances in which scientific freedom is alleged to have been abridged or otherwise endangered, or responsible scientific conduct is alleged to have been violated." The domain of the AAAS is very broad, including all of the sciences and a large number of professional societies which belong to it as affiliates. Hence, by its nature the AAAS cannot undertake the role that we have envisaged for the professional societies in the preceding section. The number of possible appeals to the AAAS, if it were to undertake the responsibility of reviewing particular instances of alleged threats to scientific freedom and responsibility, would be immense. If it were to agree to handle some such cases, it would have to be rigorously selective and deal only with those that were at once so important and so broad in scope that they would fall outside the domain of any individual society.

Because of its multiple affiliations with the professional societies, the AAAS can play an important part in coordinating many of the activities of the societies. A number of the societies, for example, are now formulating, or revising, codes of ethics for their members, which will involve policies for dealing with issues such as we have been discussing here. The AAAS can

help to provide an exchange of information on these matters among the different societies and thereby promote a more unified approach to these complex issues.

The AAAS is already playing a significant role in dealing with alleged abridgments of scientific freedom, and alleged violations of responsible scientific conduct, through active discussion of such matters in *Science*, chiefly in the News and Comment section, but also in some of the lead articles and in the Letters section. Since *Science* is so widely read, both inside and outside the scientific community, this is one of the most important channels now available for bringing such problems to the attention of the public. To focus public attention on such problems, of course, is not to resolve them, but it is an essential step toward such resolution. We recommend that *Science*, without any drastic change of its present editorial policies, enhance its coverage of such matters, particularly by inviting distinguished academic, industrial, and government scientists who are well informed on some of these controversial issues to set them forth in its pages. In some cases, it will be desirable to present two or more articles by different authors, expressing more or less contradictory points of view. In scientific controversies, it should not be necessary for the champions of different views to operate like adversaries in a court of law; the opposing sides presumably should be able to find a large area of agreement about scientific facts that are not in dispute. The real disagreements in such cases usually turn not on the scientific facts but on the relative weight to be given to different *kinds* of scientific facts, and on extrascientific issues involving political judgment and broad general perspectives on human nature and human motives. These factors always enter into the practical decisions that must be made in applications of science and technology. When a scientist or technologist states a case for action of a certain sort on such an issue, it is important that he make clear the general presuppositions from which he starts. He may, of course, be unconscious of these presuppositions; if so, *Science* should as a matter of editorial policy bring them to the surface. This is important, both for the rational discussion of the issues involved and for the maintenance of public confidence in the honesty and objectivity of scientists.

On rare occasions the AAAS may and should become actively involved in broad issues that are important and controversial, as it did when it decided to conduct an investigation of the effects of defoliants and herbicides in Vietnam. This was an important attempt to obtain scien-

tific evidence on an issue that had aroused passionate controversy (20). The National Academy of Sciences, at the request of Congress, later undertook a more extensive study of the same problems, with increased financial support provided by the Department of Defense. The resulting report of the National Academy committee (21) greatly extended and amplified the AAAS report; the findings of both are for the most part reasonably concordant, but some discrepancies have given rise to controversy (22). These disagreements can be resolved later, when it is possible to conduct studies of the Vietnamese forests on the ground in a peaceful setting; as long as war continues, only aerial observations are possible. In any case the AAAS study performed a valuable service and was in no way rendered superfluous by the later study of the National Academy of Sciences.

This raises the more general question: What should be the relation between the AAAS and the National Academy in matters such as we have considered in this report? The National Academy has special prestige and a unique relation to the U.S. government. It, and its committees, can speak on many issues with far more authority than the AAAS, and it can generally command much more financial support for its investigations. However, the AAAS, with its much broader membership, is more widely representative of American science in general, and its greater independence from governmental ties gives it a greater freedom of action. Both organizations clearly have very important and somewhat different roles to play in the maintenance of scientific freedom and responsibility.

The problems we have been considering here will certainly continue and will probably become more numerous and more acute in the years to come. We hope that the concern of the AAAS will continue. We suggest that, not more than 5 years hence, the AAAS should reexamine the whole problem, perhaps by setting up a committee similar to this one, to see where we stand at that time. Alternatively or in addition, it might set up a committee to receive complaints concerning violations of scientific freedom and responsibility and refer them, when possible and desirable, to appropriate bodies for further study and possible action. Such a committee should not itself serve as a judicial body; its functions should be to refer complaints for possible action elsewhere and to analyze the information received, with an eye to possible recommendations concerning future policy initiatives by the AAAS in the light of this information. The terms of reference



of such a committee would need to be very carefully drawn, to prevent the committee from being overwhelmed by a mass of unmanageable complaints.

#### References and Notes

1. *Perspective on Chlorinated Dibenzodioxins and Dibenzofurans* (Environmental Health Perspectives, Experimental Issue No. 5, Department of Health, Education, and Welfare Publication No. NIH 74-128, National Institute of Environmental Health Sciences, Box 12233, Research Triangle Park, N.C., September 1973). Several articles deal with the toxicity of the dioxins. See particularly table 4 in the article by R. Baughman and M. S. Meselson, pp. 27-35, which summarizes the results of earlier workers.
2. V. Earle, Ed., *On Academic Freedom* (American Enterprise Institute, Washington, D.C., 1971).
3. P. Berg *et al.*, *Science* **185**, 303 (1974); N. Wade, *ibid.*, p. 332.
- 3a. In February 1975, an international conference of experts at the Asilomar Conference Center in California devoted several days of intensive discussions to this problem and concluded with a recommendation to lift the voluntary moratorium on most of these proposed genetic experiments. However, such experiments were to be done only subject to rigorous precautions for containment of the possibly hazardous organisms, the stringency of the precautions increasing with the estimated risk in different categories of experiments. Indeed, for many of the possible experiments, the required conditions cannot be met without the development of new organisms and new techniques, so that the moratorium is in effect being continued for such experiments. See N. Wade, *Science* **187**, 931 (1975).
4. J. Katz, Ed., *Experimentation with Human Beings* (Russell Sage Foundation, New York, 1972).
5. "Clinical Studies in the Human: The Ethical and Scientific Problems," symposium by A. C. Barnes, R. Q. Marston, B. Barber, and J. Katz [*Fertil. Steril.* **23**, 593 (1972)].
6. B. J. Culliton, *Science* **185**, 426 (1974).
7. E. F. Behrman, *New York Times* (9 June 1974), opposite editorial page.
8. AAAS Committee on Science in the Promotion of Human Welfare, "The integrity of science," *Am. Sci.* **53**, 174 (1965).
9. For a useful short history of the use of DDT, see G. McIntire, *Environment (St. Louis)* **14** (No. 6), 14 (1972).
10. These figures are from *World Health Organization Relevé Épidémiologique Hebdomadaire* (8 August 1969).
11. R. Garcia, *Environment (St. Louis)* **14** (No. 5), 2 (1972).
12. For numerous examples of this and many other problems in international development schemes, see *The Careless Technology: Ecology and International Development*, M. T. Farvar and J. P. Milton, Eds. (Natural History Press, Garden City, N.Y., 1972).
13. C. Sterling, *Atlantic Monthly* (May 1974), p. 98; N. Wade, *Science* **185**, 234 (1974).
14. Report of the Advisory Committee on the Biological Effects of Ionizing Radiations, *The Effects on Populations of Exposure to Low Levels of Ionizing Radiation* (Division of Medical Sciences, National Academy of Sciences-National Research Council, Washington, D.C., 1972).
15. Our description is taken from a more detailed report by S. H. Unger ["The BART Case: Ethics and the Employed Engineer," *Inst. Electr. Electron. Eng. Comm. Soc. Implications Technol. Newsl. No. 4* (Sept. 1973), p. 6 (V. Klig, Ed., 497 Park Avenue, Leonia, N.J. 07605)].
16. Our discussion is based on *Fed. Am. Sci. Prof. Bull.* **2** (No. 8), 1 (1974).
17. P. Brodeur, *Expendable Americans* (Viking Press, New York, 1974). Concerning the hazards of asbestos, and steps taken to control them, see also: A. K. Ahmed, D. R. MacLeod, J. Carmody [*Environment (St. Louis)* **14** (No. 10), 16 (1972)].
18. R. Scott, *Muscle and Blood* (Dutton, New York, 1974).
19. Statement on "Employment Guidelines," *Inst. Electr. Electron. Eng. Spectrum* **1973**, 57 (April 1973). The statement has been adopted by at least 20 engineering and scientific societies.
20. M. S. Meselson, A. H. Westing, J. D. Constable: Herbicide Assessment Commission of the American Association for the Advancement of Science, Background Material Relevant to Presentations at the 1970 Annual Meeting of the AAAS [reprinted in the *Congressional Record* **118** (No. 32), S3226-S3233 (3 March 1972)].
21. Committee on the Effects of Herbicides in Vietnam, *The Effects of Herbicides in South Vietnam* (National Academy of Sciences, Washington, D.C., 1974).
22. Concerning this controversy, see, for instance, D. Shapley [*Science* **183**, 1177 (1974)] and C. Norman [*Nature (Lond.)* **248**, 186 (1974)].

## Social Indicators

Social science researchers are developing concepts and measures of changes in society.

Eleanor Bernert Sheldon and Robert Parke

A statistical report entitled *Social Indicators, 1973* was published last year by the U.S. Office of Management and Budget (1). *Social Indicators* contains charts and tables presenting statistical time series selected and organized around eight "social concerns," namely, health, public safety, education, employment, income, housing, leisure and recreation, and population. The report is the first of its kind to be issued by the U.S. government. Its publication is symptomatic of the widespread interest in social indicators.

This interest is further reflected in a social indicators bibliography that was published in late 1972 (2). More than half of the 1000 or more items listed in the bibli-

ography were issued in 1970, 1971, and 1972. Government agencies both in the United States and abroad (3), as well as private scholars and research institutes, are concerning themselves with social indicators, as are international organizations such as the Conference of European Statisticians (4), the Organization for Economic Cooperation and Development (5), the United Nations Research Institute for Social Development (6), the United Nations Educational, Scientific and Cultural Organization (7), and the United Nations Food and Agriculture Organization (8).

"Social indicators," and allied phrases, "social accounting," "social reporting," and "monitoring social change" came into use by social scientists, commentators, and policy-makers in the mid-1960's. These phrases and the ideas they represented emerged from an awareness of rapid social change, from a sense of emerging problems

with origins deep in the social structure, and from the ambience of the early Johnson Administration which encompassed a commitment to the idea that the benefits and costs of domestic social programs are subject to measurement and to the belief that each newly perceived, albeit ancient, inadequacy in the society should, and would, call forth a corrective response from a federal government whose efficacy would be assisted by social measurement, planning, and new management analytical techniques. Impetus was provided by a handful of social scientists and public administrators. The enthusiasm elicited responses from economists who saw a role for their skills as theorists and measurers of welfare, sociologists who saw the relevance of their own research tradition in the measurement of social trends, political scientists who sought ways to rationalize government programs, social workers, public administrators, and a broad array of social researchers and practitioners. Out of this emerged what came to be known as the "social indicators movement," an apt designation in that, as in all movements in their initial stages, the participants were ill-defined as to membership, had little organization, and shared few specific objectives, but sensed great needs and opportunities for change, celebrated shared but necessarily ambiguous symbols, and were led by able and articulate idealists.

From the ambiguity of the early discussions several distinguishable types of research activities have emerged.

*Social indicators.* Conceptual, method-

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