

ADDRESSING PUBLIC CONCERNS IN SCIENCE

If the public doesn't understand us, perhaps it's because we aren't listening. Answering the right questions in science policy depends on a sustained dialogue with the concerned public.

John F. Ahearne

Mistrust of technical experts by the general public is a growing problem in science policy. The National Science Board reports that whereas 80 percent of the public believes that scientists work for the good of humanity, 55 percent believes that their knowledge gives scientists a power that makes them dangerous. The image of the crazed scientist plotting to master and destroy remains a staple of both children's and adult fiction, as Spencer Weart explained in a recent article in this magazine (June, page 28).

Americans generally recognize that technological advances are changing their lives and the world. The public expects science to accomplish wonders, and our political system responds to public attitudes and provides funding for science and technology. Yet the public's perceptions of science and of policy decisions involving science often differ from prevailing attitudes in the scientific community. Scientists and engineers have not been much help in developing rational technology policies and bear significant responsibility for the public's confusion. We can do better.

In a survey conducted by the Harris poll for the Office of Technology Assessment in late 1986 (see the table on page 37), about 70 percent of the responding adult Americans described themselves as very interested or somewhat interested in science and technology, and the same proportion said their understanding of science was very good or adequate. More than 80 percent of the respondents said they were very concerned or somewhat concerned with science policy. Yet in a poll conducted for

the National Science Board (see the table), nearly half of the responding adults disagreed with the statement that human beings evolved from earlier forms of animal life, and about the same proportion agreed that rocket launches affect the weather.

Describing one aspect of science illiteracy, William Clark of Harvard University commented, "Society's attitudes toward risks such as cancer and nuclear reactors are not readily distinguishable from its earlier fears of the evil eye."¹

Technological factors are significant in many current questions of public policy, including:

- ▷ Should the Federal government fund the Superconducting Super Collider?
- ▷ Should the United States build a space station?
- ▷ Where and how can high-level nuclear wastes be disposed of safely?
- ▷ Can herbicides and pesticides be used safely?
- ▷ What can be done about AIDS?
- ▷ Should scientists have the unrestricted right to manipulate genetic material, and should altered material be patentable?
- ▷ How serious a health hazard is radon in homes?
- ▷ What kind of program, if any, should the United States have to develop space-based defenses against ballistic missiles?
- ▷ Can the United States regain (or maintain) a competitive position in world markets?
- ▷ How can the United States become a leader in emerging technologies such as those associated with high-temperature superconductors?
- ▷ Will the US education system, including research universities, meet the country's future needs for scientists and engineers?

The final decisions about such matters generally are made by politicians, who take a wide variety of political, economic and international factors into account. Scientists and organizations representing scientists have become quite adept at bringing their concerns directly to politicians. But political decisions are made in a broader context of interactions among scientists and engineers, the

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Public understanding and appreciation of science: Poll results

Harris poll					
	Very interested	Somewhat interested	Rather uninterested	Not at all interested	Not sure
How much interest do you have in scientific and technological matters?	23%	48%	11%	18%	1%
	Very concerned	Somewhat concerned	Not very concerned	Not at all concerned	Not sure
How concerned are you about government policy concerning science and technology?	32%	50%	11%	7%	1%
	Very good	Adequate	Poor	Not sure	
How would you rate your basic understanding of science and technology?	16%	54%	28%	1%	
National Science Board poll	Agree	Disagree	Don't know		
Human beings as we know them developed from earlier species of animals	45%	47%	7%		
Some numbers are especially lucky for some people	43%	53%	4%		
Rocket launches and other space activities have caused changes in our weather	44%	44%	12%		

managers and operators of technical systems, and concerned citizens, all of whom have considerable influence on the evolution of policy involving technology.

Having been a member of all three groups, I conclude that scientists and engineers have the most to learn about the process of making sound technology policy, but also that they can make a difference. I will therefore concentrate on scientists and engineers and will mention only briefly some of the problems associated with the other two groups.

The failure to communicate

Scientists, engineers and other technologists can be separated into three subgroups: those who know in depth the science and engineering associated with a given policy; those who know a lot of science or engineering but are not experts on the specific issues in dispute; and those who operate high-technology systems but do not truly understand the technology they are using.

Of the true experts, unfortunately, many cannot communicate their knowledge. They are not able to simplify their discussions so that they can be translated by the media or understood by lay people. In some cases this lack of communication is due not to an inability but rather to a belief that the effort is not worthwhile. Some scientists believe that writing for the general public is a waste of their time because it is of little professional benefit and does little good.

Some good scientists do work at communication but do not deal effectively with the media. Many scientists are, quite properly, reluctant to say more than they know. Journalists have a tendency to treat this reluctance as equivocation and to describe it as such to the public. Many lay people believe that if you know something, you should be positive and unconditional about it. Therefore they conclude that when a scientist refuses to be definitive, it is equivocation or at least indicates that the scientist does not know much about the area.

Regrettably, what a scientist can be positive about is often not what the lay person is interested in. This difficulty faces all scientists and engineers who try to deal

with the media. Nevertheless my belief is that most representatives of the media will take the time to try to understand if it is obvious that the technologist is making an effort to help them understand.

My hypothesis is that when an expert does not communicate effectively, it usually stems from inability or unwillingness. Failure to communicate well also can be connected, however, with an overestimation or overvaluation of one's own expertise. People who are well informed about science and engineering in general but not about the specific policy questions in dispute should not be called experts, but often they believe they are experts. In contrast to those who are aware of all the complexities bearing on the issues at hand, the less informed often take a paternalistic or maternalistic attitude toward the general public. Sometimes they express the belief that controversy would disappear if only the public were better educated—if only, that is, the public became as well informed as they believe themselves to be. Sometimes they act as though the solution to conflict is simply for the public to trust them and what they claim.

The attitude that education is the answer to everything was apparent in articles in the 1970s that implored the public to understand "true risks" and to rank those risks relative to one another. This approach has not been abandoned, as was demonstrated by a 1986 book, *Improving Accuracy and Reducing Costs of Environmental Benefit Assessment*,² which presented a "health risk ladder" that included being hit by lightning, getting an x ray, being hit by a car, riding a motorcycle and smoking a pack of cigarettes a day.

The attempt to address technological risk management by ranking risks for different hazards has led to an attempt to define acceptable risk. I can sympathize with this approach because I participated in it for many years. When I was on the Nuclear Regulatory Commission, I tried unsuccessfully to get the National Academies to undertake a study of the comparative risks of coal and nuclear power, believing that the development of an objective view by a credible organization would help the debate on the risks of nuclear power. I am now shifting to

the position of those who have concluded, with social scientists Harry J. Otway and Detlof von Winterfeldt, that "the acceptable risk formulation has provided increasingly elaborate and precise answers to the wrong question."³ The questions are wrong because they do not arise from sustained dialogue with the concerned public.

In a recent study of the sources of conflict on environmental issues,⁴ the researchers sought to explain the conflicts in terms of the characteristics and views of the participants. They interviewed people who had been involved in developing environmental policy, including lawyers, scientists and government officials. Nearly three-quarters of those polled labeled "public misunderstanding" as a major source of such conflicts. But they did not agree on what the public did not understand. The respondents whose educations had given them "hard expertise [viewed] environmental conflict as scientific rather than political, while those . . . individuals educated in the humanities or social sciences reject[ed] knowledge differentials as a major source of controversy. . . . Physical scientists, as expected, endorse[d] knowledge differentials, and reject[ed] value differences." Thus those who understand technology see the conflict as being between themselves and those who do not understand technology. But those who do not understand technology do not see this understanding as central to conflicts about the environment.

Unfortunately, many people who are untrained in science and technology believe that understanding technology is not important to understanding the risks of technology.

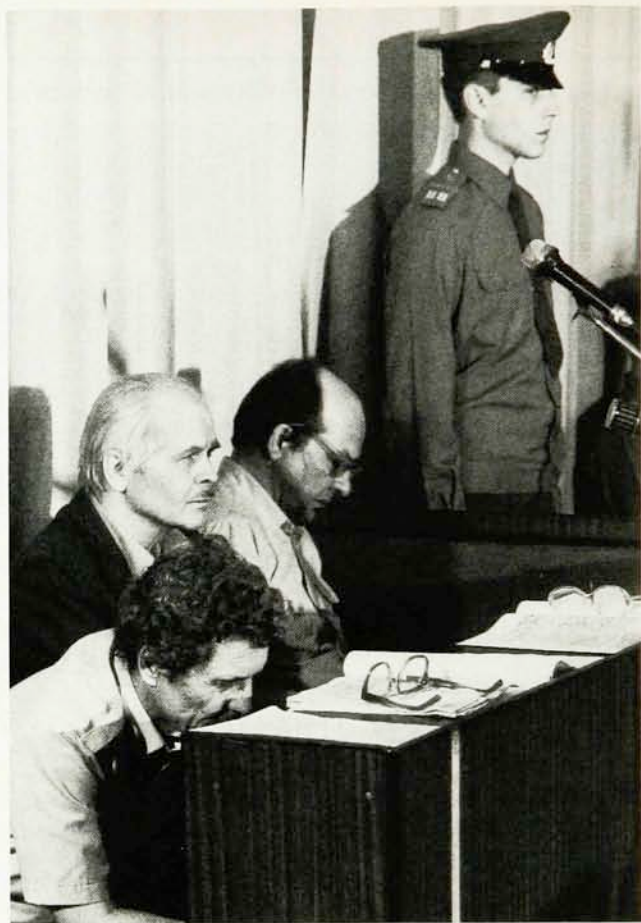
Trusting in trust

The accident at Three Mile Island destroyed a large reactor and nearly bankrupted a major company. The cleanup has been under way for nine years, is still not completed and will cost one billion dollars. But health studies done by the Pennsylvania State Department of Health and the US Department of Health and Human Services indicate that there have been no significant adverse *physical* health effects associated with that accident and that there are unlikely to be many.

The Chernobyl nuclear accident, the worst accident known at a nuclear power plant, led to at least 32 deaths, the hospitalization of several hundred people and a high radiation exposure to many thousands of Soviet citizens. Nevertheless, the immediate deaths in the surrounding region were far fewer than what some previous studies had estimated would result from such a massive release of radiation.

Consequently some members of the nuclear industry have said that TMI showed how well built reactors are and that Chernobyl showed that the worst accident would not be a calamity. While perhaps scientifically correct, this argument should not lead to the conclusion that nuclear power is now acceptable to the public. The flaw in that conclusion is that it avoids addressing the public's concerns and is based on the attitude that "if only the public were educated, they would agree with us."

"Trust me" is still used by US government officials



Managers of Chernobyl plant stand trial in USSR, July 1987. From left: Victor Bryukhanov, the ex-director; Anatoli Dyarlov, the former deputy chief engineer; and Nikolai Fomin, the former chief engineer. The Soviet judge who sentenced Bryukhanov to ten years in labor camp said there had been a lack of responsibility and control at the plant.

responsible for technology as the principal answer to the question, "Why are you doing that?" This attitude characterizes the approach the government has taken to locating nuclear waste sites, starting with the Atomic Energy Commission's efforts in Kansas, continuing with the Energy Research and Development Administration's search in the Middle West, and now seen for many years in the Department of Energy's efforts.

This approach has led to a highly polarized situation, as Clark Bullard observed last year in a seminar at Oak Ridge National Laboratory. "The lines are clearly drawn," said Bullard, a professor at the University of Illinois and the chairman of a committee responsible for advising a group of Middle Western states on the selection of a low-level nuclear waste site. "It is a battle between the technocrats and the public over whose values the technology will ultimately reflect."

Not only the general public is now skeptical about scientists and science officials. Many early advocates of nuclear power convinced executives at electric utilities of its advantages. These executives went ahead—aggressively—with ambitious nuclear programs, much to the chagrin of later executives, who found themselves saddled with adverse rulings on rates by public utility commissions.

The latest obstacles facing such utility executives are

prudence hearings. In these hearings, many years after construction of a plant began, public utility commissions examine whether it was wise for the electric utility to have built the plant. Frequently the commission decides it was not, and rate payers do not get charged for the plant.

Speaking at the annual convention of the Edison Electric Institute in Cincinnati last year, Jerry D. Geist, the retiring president of EEI, said, "Technology was the Siren who beckoned us to nuclear power—power that was supposed to be too cheap to meter but turned out to be too expensive to bill."

Managers and technicians

Those who are engaged in managing or operating high-technology systems often have had substantial technical training, often not. Their chronic weakness is complacency, and their failings lead the public to question the competence and judgment of the scientists and engineers who design such systems.

Complacency can be reflected in many ways: a lack of recognition by management that increased attention needs to be given to technologies whose use has potentially serious consequences; inadequate attention by operators, based upon a belief that the technology is so well developed that monitoring is not really needed; a belief that it is not important to understand the technology; and a lack of attention to mundane matters such as regular maintenance.

Aircraft accidents have been attributed to complacency in the cockpit. In 1978, for example, a DC-8 crashed in Portland, Oregon, when the plane ran out of fuel. The plane had been circling the airport while the crew tried to solve a landing gear problem. The flight engineer mentioned that the plane was running out of fuel, but apparently the message did not register with the captain and cocaptain, and the plane crashed. Last year a plane crashed in Detroit, probably because the crew had neglected to extend the flaps during takeoff.

Underlying the problems that led to the space shuttle Challenger disaster was a disbelief that the technology was hazardous—complacency on the part of people who did not fully understand the shuttle system. "In 1971," the Rogers commission on the Challenger accident found, "NASA went back to the drawing board, aware that development cost rather than system capability would probably be the determining factor in getting the green light for shuttle development."⁵ Another study concluded that the shuttle represented "an effort to build one vehicle to serve many roles" and that "the inevitable result [was] a very complex and somewhat fragile vehicle."⁶

The pressures on NASA increased under the current Administration. The same day that the initial orbital tests were concluded, President Reagan announced a national space policy. "The first priority of the [space transportation system] program," he stated, "is to make the system fully operational and cost effective in providing routine access to space." But under the new policy, "resources were strained to the limit," the Rogers commission found. Astronaut Henry Hartsfield told the commis-

sion: "Had we not had the accident, we were going to be up against the wall. . . . Somebody was going to have to stand up and say we have got to slip the launch because we are not going to have the crew trained." Arnold Aldridge, the shuttle program manager, said, "Intentional decisions were made to defer the heavy build-up of space parts procurement in the program so that the funds could be devoted to other, more pressing activities." The Rogers commission concluded: "Those actions resulted in a critical shortage of serviceable space components. To provide the parts required to support the flight rate, NASA had to resort to cannibalization. Extensive cannibalization of spares . . . became an essential *modus operandi* in order to maintain flight schedules."

In a revealing visit to the Marshall Space Flight Center, the late Richard Feynman found a drastic difference in the estimates of accident risk made by shuttle engineers and by a middle-level manager. Taking a secret ballot, Feynman found that the engineers estimated the risk of an accident as about 1 in 200, the manager as 1 in 100 000 (see PHYSICS TODAY, February 1988, page 26).

Many reports on the Three Mile Island accident showed that operator misunderstanding initiated the accident. Similarly, reviews of the Chernobyl accident have highlighted the complacency that had afflicted the crew of that plant.

In my published examination of the two reactor accidents, I suggested that the more serious similarities between them stemmed from general complacency: "The operators of both plants took a series of steps that were deliberate and defeated safety systems. The operators at Chernobyl had no simulator training for the accident sequence that occurred. Similarly, TMI operators were never trained for the sequence of the stuck-open [valve], and instructions on how to handle such an event were not written in their emergency procedures. Both the TMI and Chernobyl accident reviews found weaknesses in the approval of operating procedures. Another common feature was that the operators did not understand their plants."⁷

The Soviet judge, in sentencing the director of the Chernobyl plant to ten years in a labor camp, said, "There was an atmosphere of lack of control and lack of responsibility at the plant," adding that "workers on duty played cards and dominoes or wrote letters."⁸

The concerned citizen

Some people are against all technology; some are afraid of technologies they do not understand; and some are opposed only to the technologies that affect the local environment. Many concerned citizens, however, try sincerely to understand confusing and complex issues.

People who are against technology or against anything new tend to be the most dedicated opponents of projects. They sincerely believe that technology is wrecking our culture. The attitude is not new. Consider how contemporaries of Galileo commented on his discovery of the moons of Jupiter: "Jupiter's moons are invisible to the naked eye, and therefore can have no influence on the

Earth, and therefore would be useless, and therefore do not exist."⁹

Members of this group can be quite sophisticated; in many cases they subscribe to E. F. Schumacher's view that "small is beautiful." These concerned citizens perceive that large-scale technologies such as nuclear power plants have been sold by deceit and tend to change society in undesirable directions.

Certain members of this group, those opposed to nuclear power, have been characterized by a political scientist as seeing themselves "standing with nature against the insensitive engineer. . . . Nuclear power is seen as an ultimate transmutation of matter. . . . It is man's manipulation of nature, expressive of an arrogance unknown in earlier technologies. It is viewed as an unnatural act. . . . Just as Prometheus took fire from the gods and was punished for all eternity, the nuclear opponent believes nature will make us suffer for a parallel transgression."¹⁰

Although the people who oppose technology may not be many, they are sincere and strong in their beliefs. They participate, often effectively, in debates, public meetings, letter writing and other activities that number among the advantages of living in a democracy.

The members of the second group, people who are afraid of technology essentially because they do not understand it, tend not to trust anyone who argues the citizen should not be worried, whether or not they understand the argument. The corollary is that they tend to believe anyone who says things are worse than they seem. Organizations that lobby against local waste dumps or nuclear power plants include many individuals who belong to this group. They believe they are being asked to accept on faith the safety of a technology.

Some concerned citizens have a special agenda that they prefer not to state explicitly. This agenda is based sometimes on opposition to big government, other times on protecting the local environment. Often these citizens are affluent and prefer to have costs imposed on others while they reap the benefits. "Not in my backyard" is the way political scientists and sociologists characterize their customary attitude. Something of this attitude was evident when California opposed siting a nuclear plant inside the state but was quite willing to let Arizona build the Palo Verde stations and export power to California, or when it opposed siting coal plants in-state but endorsed the idea of the Rocky Mountain states building large coal plants that would supply electricity to California.

Of course, affluence does not necessarily coincide with selfishness. Sometimes affluence enables one to take a more objective view of costs and benefits. The situation is similar to the debates between less developed countries and the highly industrialized countries concerning the costs and benefits of environmental regulation versus economic growth.

Perhaps the largest group of concerned citizens is the last—the people who do not fully understand the technologies at issue and are skeptical about strong claims by participants on either side of the debate. They do not believe that technology is automatically bad, nor do they believe government is automatically wise. These people will enter a proceeding or hearing with reasonably open minds. They will listen to arguments. They will value

substance more than the appearance of sincerity. They will focus more on rationality than on rhetoric. In the end, they will be forced to reach a decision based on incomplete information. And they will decide. This subgroup of concerned citizens has not been well served by many technologists.

Lies, lawyers and leanings

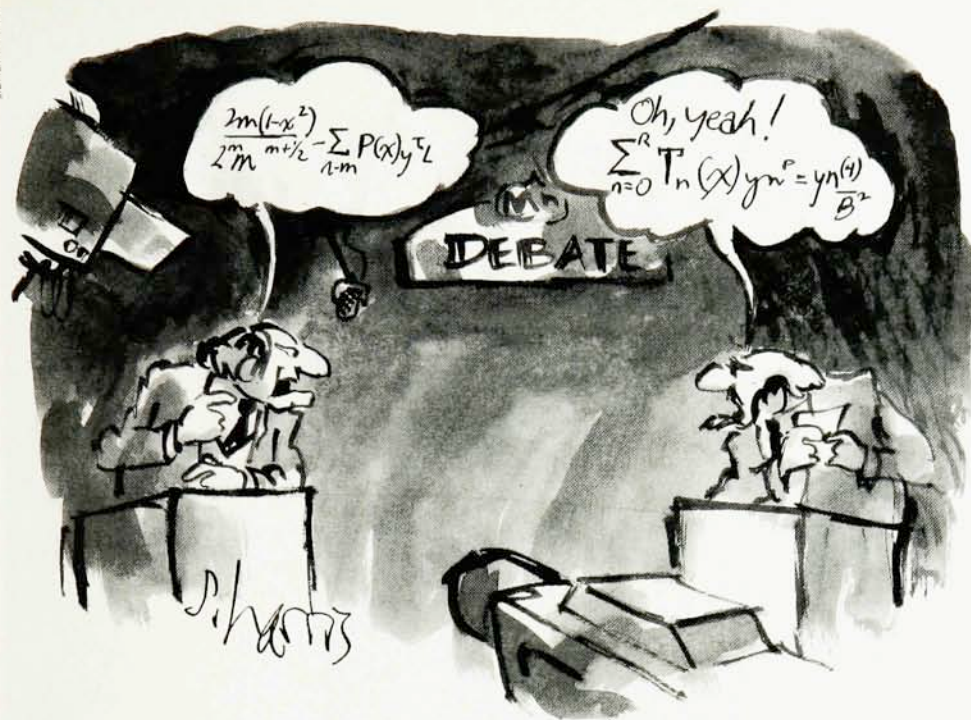
Government officials often are responsible for implementing policies made elsewhere, and even though these officials can have a very important impact on science and technology policy, they often serve only fleetingly in decision-making positions. Problems associated with technology may not figure importantly in evaluations of their performance in office, and they may not be well trained for their jobs in the first place.

Like the scientists and engineers who consider themselves more expert than they really are, government officials have a tendency to adopt a "trust me" posture. These people do not understand democracy. They do not understand the concept of the consent of the governed, and they do not accept that the people have a right to be wrong. Thus, in a recent proceeding on AIDS, one author suggested: "In presenting information to the public, it is at least an open question as to whether or not honesty really is the best policy. The opposite of honesty is, of course, dishonesty or lying. No one can advocate lying as a public policy. . . . But there are at least two other options: exaggeration, underplaying."¹¹

Law schools promote two beliefs that adversely affect technology policy: that the adjudicatory process is the best and possibly the only way to establish facts; and that a lawyer can learn enough about anything in a short time—a few days, or weeks at most. Although many lawyers are committed to improving the lot of society, these attitudes can lead to significant problems in developing sound technology policy.

The attitude of the adjudicatory process is abhorrent to science, since it seems to be based on the premise that people will not tell the truth unless pressured under oath. George Bernard Shaw is quoted as having said, "The theory of the adversary system is that if you have set two liars to exposing each other, eventually the truth will come out."¹² Informed discussion is not possible in that climate. Consequently, many scientists and engineers shy away from involvement in such conflict resolution approaches, leaving the public to be ill served by less than the best people.

The second legal belief stems from the need for lawyers to master a case quickly. Their high intellects often make this possible in nontechnical areas. But where science or technology is critical, lawyers tend to make bad policy. Lawyer-managers learn the issues at a superficial level, and often they want people around them who talk at that same level. Therefore lawyer-managers populate their staffs with bright young people who are articulate and industrious, but know little and unfortunately do not realize it. These lawyer-managers usually get along very well with members of the media, who also often learn an issue only at the same superficial level. This syndrome is captured in something Kierkegaard said in *Fear and Trembling*: "He had in addition a most unusual gift for explaining what he himself had understood. There he



When scientists get into really heated arguments, people prick up their ears, sensing that material interests and not merely scientific truths are at stake. As disputes have proliferated between "expert witnesses" representing opposing sides in court cases, the public has begun to be skeptical about the objectivity of science and technology.

stopped. Nowadays, one goes further and explains more than one has understood."

Worse still are the ideologues of the right and the left—those who know what the right decision is before analysis has been done. Beginning with the 1972 reelection of President Nixon, administrations have stressed ideology before competence to a disturbing and increasing degree.

From 1969 to 1983 I worked for Cabinet officers, in the White House, and on a Federal commission. After Nixon took office, resignations were requested from many assistant secretaries, who were replaced with choices more in sympathy with the White House ideology. Competence was still desired. When the Carter Administration arrived, belief in the position of the left became a critical test for White House and assistant secretary positions. The Administration did prefer bright people, but substantive knowledge was less important than ideological conviction. The Reagan Administration swung back to requiring right-wing views and placed even less emphasis on competence and much more on true belief.

Recommendations

Scientists and engineers can help improve public understanding of policy issues and policy itself by doing the following:

- ▷ Be responsible for understanding the technology you deal with, and be alert for surprises. Understanding that many scientific discoveries resulted from intelligent observation of experimental accidents should alert technologists to watch for the unexpected.
- ▷ Do not tolerate complacency.
- ▷ Listen to and discuss issues with the public. The public's resources will be used and their lives will be affected by your technologies. This listening should be a true dialogue. A public hearing should be a *hearing*, not, as a recent New York City Board of Estimates meeting was described in a news account, only a "public talking."
- ▷ Do not accept incompetence in government. The government often is derided by academic technical experts. But academic technologists understand technology

and should not allow superficial treatments of technology to pass for understanding on the part of government officials.

Scientists and engineers often have not demanded competence from officials. Worse, they themselves have sometimes demonstrated a willingness to depart from their normal standards of professional behavior when policy is at stake. Harvey Brooks, the former dean of applied science at Harvard University, once pointed out: "Scientists inexperienced in the political arena, and flattered by the unaccustomed attentions of men of power, are often inveigled into stating their conclusions with a confidence not warranted by the evidence and... not subject to the same sort of prompt corrective processes that they would be if confined within the scientific community."¹³

▷ Provide impartial "friends of the court" to give expert testimony in proceedings involving controversial technological issues. In the United States, all controversial issues seem to end up in court. "Expert" witnesses proliferate—and often they strongly disagree. The public senses that these are often conflicts between contending interests, not competing objective views. As a result the public has become skeptical of the objectivity of science and technology. Recently a controversy regarding whether the large funds spent on cancer research have accomplished much heated up the pages of *Science* and the general press. Observing this controversy, Daniel Greenberg wrote: "When scientists become abusive, pay attention. The departure from professional decorum means something important is at stake."¹⁴

Heinz Pagels, one of our most prominent writers on science and science policy until his tragic death in July, suggested last year the establishment of a bureau similar to the Office of Technology Assessment to serve as a "friend of the court" when needed.¹⁵ The American Physical Society has provided advice on major public policy issues via reports by special panels such as the 1976 study group on light-water reactor safety, the 1978 study group on nuclear fuel cycles and waste management, and the 1987 study group on the science and technology of



Nuclear Regulatory Commission meets (below) with the public in Harrisburg, Pennsylvania, on 9 November 1982 to consider the proposed restart of the Three Mile Island Unit 1 nuclear plant, which had been shut down since the TMI accident in March 1979. From left: NRC commissioners Thomas M. Roberts, John F. Ahearne, Nunzio J. Palladino, Victor Gilinsky and James K. Asseltine. Inset: Ahearne confers with Palladino, NRC chairman at that time.



NUCLEAR REGULATORY COMMISSION

directed-energy weapons.

Professional societies such as APS, the American Chemical Society and IEEE should identify and assemble experts who are able and willing to do *pro bono* service for the courts. A panel from the appropriate society could use consensus agreement to address issues that a court needs addressed. These friends of the court should be paid through the court system. If a scientist is needed to address a scientific issue, or an engineer to address an engineering issue, one of these friends of the court would appear. If a scientist or an engineer wanted to appear for one of the sides in the case, he or she could appear not as an "expert" witness but rather as an "advocate" witness.

References

1. W. C. Clark, "Witches, Floods, and Wonder Drugs," R-22, Institute of Resource Ecology, University of British Columbia, Vancouver, B. C. (January 1980).
2. W. Schultz, G. McClelland, B. Hurd, J. Smith, *Improving Accuracy and Reducing Costs of Environmental Benefits Assessment*, vol. IV, Center for Economic Analysis, University of Colorado, Boulder, Colo. (1986).
3. H. J. Otway, D. von Winterfeldt, *Policy Sci.* **14**, 255 (1982).
4. T. Dietz, P. C. Stern, R. W. Rycroft, "Definitions of Conflict and the Legitimization of Resources: The Case of Environmental Risk," *Sociological Forum* (in press).
5. Report of the Presidential Commission on the Space Shuttle Challenger Accident, Washington, D. C. (6 June 1986).
6. National Commission on Space, *Pioneering the Space Frontier*, Bantam, New York (1986).
7. J. F. Ahearne, *Science* **236**, 677 (1987).
8. "Chernobyl Officials Are Sentenced to Labor Camp," *The New York Times*, 30 July 1987, p. A5.
9. A. Williams-Ellis, *Men Who Found Out*, Coward-McCann, New York (1930), p. 43; quoted in Congressional Research Service Report CB-150 (29 May 1969), p. 32.
10. A. Hacker, *Electric Perspectives*, Summer 1980 (Edison Electric Institute publ. no. 07-80-22), p. 11. See also S. Weart, *Nuclear Fear: A History of Images*, Harvard U. P., Cambridge, Mass. (1988).
11. H. M. Sapolsky, in *AIDS: Public Policy Dimensions*, United Hospital Fund of New York (1987), p. 108.
12. G. B. Shaw, quoted in M. J. Saks, *Technol. Rev.* **90**, 43 (August/September 1987).
13. H. Brooks, *Proc. Am. Philos. Soc.* **119**, 259 (1975).
14. D. Greenberg, quoted in *The Public Interest* **88**, 151 (Summer 1987).
15. H. R. Pagels, *Science Focus* **2** (1), 2 (Summer 1987).