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Faith in Science

To make its research readily available to a broad audience, the Center for Philosophy and Public Policy publishes a quarterly newsletter: *QQ—Report from the Center for Philosophy and Public Policy.* Named after the abbreviation for "questions," *QQ* summarizes and supplements Center books and working papers and features other selected work on public policy questions. Articles in *QQ* are intended to advance philosophically informed debate on current policy choices; the views presented are not necessarily those of the Center or its sponsors.

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In this issue:

America is in love with scientists. The personal prestige of research scientists is high, and science consistently ranks toward the top of the list in polls surveying the esteem in which we hold various institutions (with government consistently trailing behind). The Apollo space program remains, for many, the crowning American achievement, the standard of success against which other aspects of American life are judged—and found wanting. (As in: "If they can put a man on the moon, why can't they fix the potholes on my street?")

We tend not to blame scientists and engineers for the social and environmental problems that are the by-products of new technologies. Instead, we rely on the scientific community to tell us what the problems are and what can be done to remedy or prevent them. Increasingly the most pressing contemporary problems seem irreducibly technical and scientific. What should we do about acid rain? The answer depends on what combination of pollutants can be pinpointed as its cause. What technological advance can prevent future industrial disasters like the one in Bhopal or future famines like the one in Ethiopia? Even the most urgent question of all, how to avoid nuclear war, is seen to be scientific at its core. Are strategic defenses technologically feasible? How bad would nuclear winter be? What do the weapons do, and what will be left after they have done it?—technical questions all.

We have an extraordinary faith that science can provide the needed answers, due, perhaps, to a picture

of scientists as detached from the world of conflicting values and competing interests. Science seems a touchstone of objectivity; whereas politicians are accountable to their constituents, and often to powerful interest groups, scientists are accountable only to the truth. Small wonder that opinion polls show that on technically intensive policy issues, most people believe that the final say should be left to the experts.

Many of the thorniest controversies arise where there is scientific uncertainty, however, and it is not difficult to find scientists who will defend claims that lend support to opposing positions. Scientists and policymakers, often hoping that scientific progress will in the end dissolve the disputes, are concerned in the meantime that our faith in the objectivity of science and the ultimate emergence of truth remain unshaken. Their goal is to separate facts from values in these debates as much as possible, to isolate the scientific elements from the value questions, which are then left to the political process to resolve.

According to this understanding of the issues, technically intensive policy problems can be broken down into two distinct components: an "objective" technical component and a "subjective" policy component. The scientific component is the province of the scientific experts, who lay out the facts: the nature of the problem and how it might be solved. The policy component is where we weigh and assess rival interests and struggle to formulate common values.

This faith in scientists might be unwarranted, however, and the model of science it presupposes—science as the detached quest for truth—has itself been challenged. Perhaps scientists are more like the rest of us than we have been willing to admit, and science more kin to the rest of human intellectual endeavor. If this is so, perhaps scientists should play a different role in helping to resolve policy controversies—different, but no less essential.

Overconfidence

A large body of literature in the psychology of judgment and decision making shows that people are strikingly overconfident in their judgments. Over 95 percent of us, for instance, think we are better than average drivers. While the same literature shows that scientists and engineers, particularly those skilled in dealing with risk and probability, are somewhat more likely than the rest of us to realize these mistakes and correct for them, scientific experts by and large tend to be subject to the same biases as the rest of us.

In one study on dam safety, a group of seven engineering experts was asked to estimate how high the water level would have to rise for a given dam before the dam would fail. They were asked to give a range of estimates such that they were 90 percent confident that the true failure height fell within that range. The surprising result was not only that the seven estimates did not agree, but that when the dam later failed, not one of the experts' ranges of estimates included the actual failure point. Such studies exhibit dramatically how the confidence of experts—and our confidence in experts—can be exaggerated and misplaced.

It is perhaps natural that technical experts should be especially prone to overconfidence in the area of their expertise, and in their own faith in science. Harvey Brooks, Professor of Technology and Public Policy at Harvard University, argues that scientists, of all people, can hardly be expected to be objective about the implications of their own research: "In practice, if an expert has any qualifications to deal with an issue at all, he or she cannot really have a completely open mind. . . . An engineer who has chosen to devote his or her career to the perfection of a particular technology is more likely to be skeptical of any evidence of possible adverse effects of this technology than somebody less expert in that particular field."

The Intrusion of Values

Scientists are like the rest of us in other important respects as well. Unavoidably they filter their scientific judgments through their other attitudes, beliefs, and values. Brooks points out that even when experts agree on the facts, they can disagree on what the facts can be taken to prove. Some experts view a single finding of possible danger as sufficient to trigger alarm; others defend new technology as safe until

Public Attitudes Toward Science and Technology

General reactions to science and technology

Reaction	Percent
Excitement or wonder	23
Satisfaction or hope	55
Fear or alarm	6
Indifference or lack of interest	9
No opinion	7

When science and technology cause problems, who is most at fault?

Response	Percent citing
Scientists	5
Technologists and engineers	7
Government decision-makers	60
Business decision-makers	14
Some other group	5
No opinion	9

Source: Opinion Research Corporation, Princeton, N.J.

proven otherwise. Where the burden of proof is lodged often depends on a submerged policy agenda. Brooks observes: "Experts have their own political preferences, and if experiments or analyses point to conclusions or policies different from those with which the experts entered the discussion, they tend to demand a higher standard of proof than they would have if the available new evidence supported their starting position."

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William D. Ruckelshaus, former administrator of the Environmental Protection Agency, agrees that "values appear as important influences on the outcomes of risk assessment." He cites as an example a National Academy of Science report which estimated that over the next 70 years the number of cases of bladder cancer caused by saccharin would be somewhere between 0.22 and 1,144,000! Since, as Ruckelshaus comments wryly, "This sort of range is of limited use to the policymaker," scientists are under pressure to opt for some narrower point on the spectrum. "Such choices," according to Ruckelshaus, "are influenced by values, which may be affected by professional training, or by ideas about what constitutes 'good science,' and, of course, by the same complex of experience and individual traits that gives rise to personal values in all of us."

A different and more troubling problem is that "the facts" cannot be lifted directly from the scientific journals and plugged into the policy debate. They must first be expressed in a way that the public can understand, and how they are expressed can affect—and distort—the policy outcome. No matter how "neutral" the scientific work is, there may be no neutral description of it that can be incorporated into policy discussions. The psychological literature on decision making shows that people's preferences are often determined by the way a choice is described to them and can change under different descriptions that appear to be equivalent. For example, lung cancer patients face the option of treatment by surgery or radiation. In one recent study, statistics about the effects of these two treatments were presented to different groups of people, including lung cancer patients, students, and physicians. In all groups, the choices changed markedly according to whether the expected results of the treatments were described in terms of the chances of living or the chances of dying. (And the most significant preference reversals were recorded among the physicians!) The seemingly trivial choice of terminology significantly influences the life-and-death choice of treatment.

In policy debates, how the experts present the facts often has a good deal to do with what they want the policy outcome to be. Brooks gives a classic example: "the debate, just prior to the atmospheric test ban treaty of 1963, over the effects of nuclear bomb testing fallout. Those who favored testing expressed health damage estimates in terms of the increased chances of cancer for an individual exposed to fallout. Expressed as a fraction, such increases were minimal. The critics of testing, however, often expressed the identical facts in terms of the extra deaths that would occur worldwide within a period of fifty years . . . as a result of current fallout. Such figures were very high and could be especially intimidating when quoted without comparison to other types of fatalities that occur randomly in large populations. How commentators presented the same objective hazard often depended on how they valued the societal benefits of the activity causing it."

There might also be situations in which any description of the facts is value-laden, and in such situations the bias might come in the very detachment that is sometimes associated with the model of science described above. Douglas MacLean, Director of the Center for Philosophy and Public Policy, points out that simply knowing that some action or policy will result in the deaths of some people who would not otherwise have died does not tell us whether the act is murder, killing, allowing some people to die, or even saving lives. Many factors enter into the proper description of "the facts," and so the language, say, of physics might be an utterly inappropriate way to describe the choice between two policy options. Thus MacLean cautions that "Some redescriptions of a choice situation . . . although equivalent in the sense of not altering the probabilities or outcomes, will nevertheless be rejected for social or even psychological reasons, because they are inappropriate and distort the problem." The two-stage model—first the "objective" facts, then the "subjective" policy context—cannot deal with cases in which our understanding of the facts cannot be separated from the policy context in which they are embedded.

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The Objectivity of Science

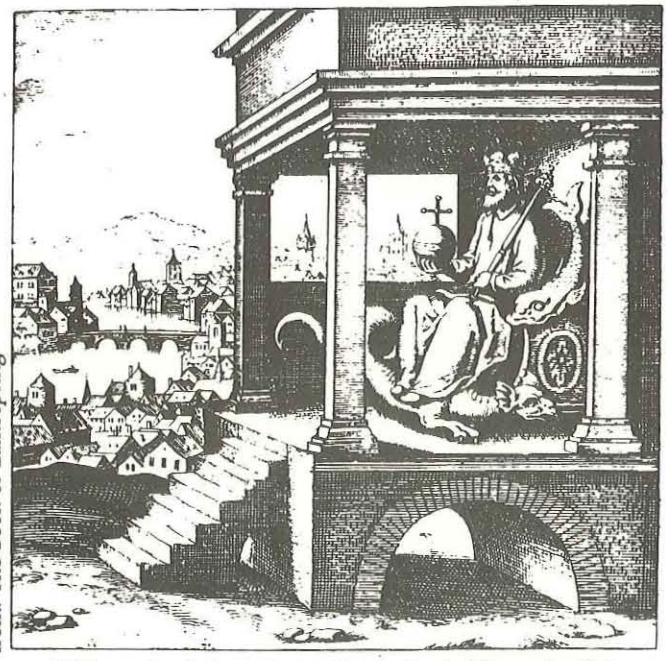
The deepest objection to this model, however, chal-

lenges not the ability to separate the two stages of scientific input and policy output, but rather the objectivity imputed to the first stage. What is it that scientists do, it is asked, that is so much more objective than what the rest of us do, as social "scientists," humanists, ordinary citizens?

The standard answer, so frequently assumed that it is seldom explicitly stated, is that scientists are in the business of discovering truth—in the words of philosopher Richard Rorty, "truth as correspondence to reality, the only sort of truth worthy of the name." The idea is that there is a way that the world is, "out there," independent of human thought and desire, and this provides an objective standard against which scientific progress can be measured. Scholars in "softer" fields, and policymakers in the midst of the political fray, have no such clear and unbending standard against which to measure themselves. In ethics, politics, literature, there is no independent "way the world is." *We* make the ethical rules, work out the social contract by which we enforce them, create the works of art that illuminate them.

Rorty, an influential critic of this view, suggests that, in our secular culture, science understood in this way acquires a religious dimension. "The scientist replaces the priest. The scientist is now seen as the person who keeps humanity in touch with something beyond itself. . . . truth is now thought of as the only point at which human beings are responsible to something non-human."

But this attitude, and the underlying view that inspires it, are, according to Rorty, both mistaken. There is no "way the world is," independent of our investigations into it, and by which we measure their success—or at least it is not helpful to talk as if there were. For we have no way of ever getting beyond our own constructed system of theories and beliefs to check the correspondence. We have no way of standing back from our view of the world and matching it against how the world "really" is. All we can do is to compare certain portions of our world view with other portions, and compare our world view with possible alternatives. The triumph of science, on Rorty's account, is not that it agrees with reality, but that scientists have managed to agree with one another: "the presence of unforced agreement . . . gives us everything in the way of 'objective truth' which one could possibly want: namely, intersubjective agreement." But on this view, "'truth' applies equally to the judgments of lawyers, anthropologists, physicists, philologists, and literary critics." There is, then, no special objectivity that the scientist alone can boast.



from: *The Book of Lambspring*

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The Role of the Scientist

What follows from our defrocking of the scientist as priest? Where will the scientist now fit into the policymaking process? One promising answer is that we should rely less on scientists to work alone dredging up and neatly packaging the facts—and rely more on scientists to work together with the rest of us formulating and articulating our shared values.

Barton J. Bernstein, professor of history at Stanford University, has looked at early research into the feasibility of the artificial heart as an example of misplaced reliance on unaided and untempered technological expertise. Scientific and medical consultants speculating in the mid-1960s reached extraordinarily optimistic conclusions about the prospects for developing a totally implantable artificial heart. Twenty years later the most conspicuous success of the $200 million research expenditure is the artificial heart implanted, with great media fanfare, in Barney Clark. Clark, Bernstein reports, "struggled through 112 painful days linked up to [a 350-pound] console before he died—hardly a testament to technology triumphant."

The experts' speculations were noteworthy for ignoring the possible psychological and social effects of the artificial heart on the recipient, the family, and the community, and the economic strain on the nation's health care system. More surprisingly, they also "did not adequately explain four serious technological problems: those of developing appropriate biomaterials, a pump, and a power source, and of stimulating the autonomic nervous system."

In 1972 a second committee appointed by the federal government considered the same set of problems—

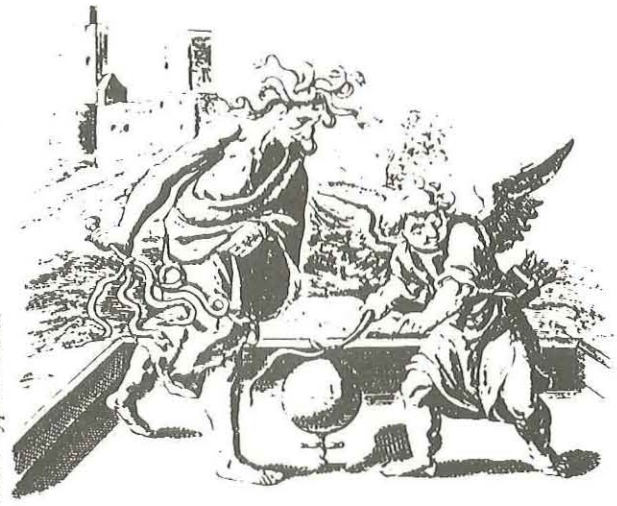
and came to very different conclusions. "This committee," Bernstein argues, "composed of people in fields such as law, sociology, ethics, and political science, proved more realistic, more probing, and less optimistic about the artificial heart." It defined "the profound ethical, economic, personal, and social problems" the first committee sidestepped; moreover, it showed greater sensitivity to the technical problems as well. Bernstein concludes: "The contrast suggests the danger of allowing medical experts almost exclusively to shape policy."

But if we give a less free hand to scientific experts in "objectively" defining our policy options, at the same time we may be meting out a greater freedom. The scientist's priestly garb doubles as a straitjacket, and traditional notions of the scientist's role may limit the contribution the scientist can make in the policy process.

An instructive example is drawn from the relatively youthful science of ecology. Mark Sagoff, Research Associate at the Center for Philosophy and Public Policy, presents a dilemma ecologists face as consultants on environmental policy. Most ecologists believe that they have an important role to play in shaping policy by providing arguments and reasons for why we should respect and protect the integrity and health of functioning ecosystems. But they feel that as ecologists they can promote environmental goals only by dredging up "hard," "objective" findings that show why these goals make good policy (i.e., economic) sense.

Thus ecologists have felt driven to marshal every available scientific hypothesis that uncovers quantifiable benefits to be derived from preservationist policies. Two that Sagoff cites as having been particularly influential in mobilizing public support are the "outwelling" hypothesis—that salt marshes support an abundance of marine life by pumping a rich supply of nutrients into coastal waters—and the diversity/stability hypothesis—that a diverse collection of species contributes to community stability, and, conversely, that a loss of any individual species increases the risk of ecosystem collapse. Unfortunately, both hypotheses are highly dubious and counterexamples to both abound. But ecologists have been reluctant to disavow these hallowed creeds for fear of forfeiting all leverage in lobbying for environmental protection.

A way out of the dilemma is available, however, which Sagoff endorses. It is to realize that the task of ecologists is not just to draw up scientific-sounding arguments for the economic benefits ecosystems can produce. As ecologists, as scientists, their task is also to find "a vocabulary or conceptual framework . . . that helps us to *evaluate* not simply to *control,* to *appreciate* not simply to *manipulate,* to *protect* not just to *manage.*" Our society recognizes—and has codified into law—ethical, cultural, and aesthetic reasons for protecting the natural environment, and Sagoff's point is that the scientist—*as scientist*—has something to say about these as well. The ecologist's professional expertise gives him a special vantage



from: *Typus Mundi*

point for making sense of notions such as the "health" and "integrity" of ecosystems, and he can participate in the policy process by helping us to define and interpret these goals. This task is just as objective, and just as properly scientific, as the task of collecting data and making predictions.

Conclusion

Our goal, then, is to both retrench and enhance the scientist's role in policymaking and to make room for the fuller participation of social scientists, humanists, and the lay public at all stages in the policy process. Brooks concludes, "Perhaps the principal lesson from our experience with the interaction of experts and laymen in public policy decisions of high technical or scientific content is the need for greater introspection into the nontechnical values and preferences that affect both the selection of evidence and its interpretation by all the participants, both laypersons and experts." We need a frank, open, public discussion of these values and preferences, in which both experts and the public can participate. We will be better citizens for such a debate, and the policies that emerge from it will be better policies.

The sources used in preparing this article are: Harvey Brooks, "The Resolution of Technically Intensive Public Policy Disputes," *Science, Technology, & Human Values,* vol. 9, issue 1 (Winter 1984); M. Hynes and E. Van Marcke, "Reliability of Embankment Performance Prediction," in *Proceedings of the ASCE Engineering Mechanics Division Specialty Conference* (Waterloo, Ontario: University of Waterloo Press, 1976); William D. Ruckelshaus, "Risk in a Free Society," *Risk Analysis,* vol. 4, no. 3 (1984); Barbara J. MacNeil et al., "On the Elicitation of Preferences for Alternative Therapies," *New England Journal of Medicine,* vol. 306 (May 27, 1982); Douglas MacLean, "Rationality and Equivalent Redescriptions," unpublished paper; Richard Rorty, "Science as Solidarity," unpublished paper; Barton J. Bernstein, "The Misguided Quest for the Artificial Heart," *Technology Review* (November/December 1984); and Mark Sagoff, "Environmental Science and Environmental Law," Center for Philosophy and Public Policy Working Paper FE-2 (1985).