17 July 1964, Volume 145, Number 3629 SCIENCE

Can Only Scientists Make Government Science Policy?

Such policy has its own problems, but the scientist is not necessarily the best fitted to deal with them.

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The belief is prevalent that the policy problems raised by the rapid advance of science and technology are best dealt with when professional scientists are appointed to policy-making positions in the government. My own involvement in the business of science and public policy, both in Washington and in an international organization, convinces me that this is not necessarily so. Policy making, even when it concerns science, has its own problems and techniques, to the understanding of which scientists, I think, can lay no special claim.

I do not speak of individual people who happen to be trained scientists. Individual people who happen to be trained *anything* are often very good policy makers, and scientists are certainly no exception. Indeed, other things being equal, the presumption probably remains in their favor. But other things are never equal. The issue thus concerns scientists as a professional community, scientists as such. I am questioning the myth that science policy is best handled by scientists *because* they are scientists.

It is a curious myth. Few would claim that architects or bricklayers make the best housing policy, and doubts have been raised about whether doctors make the best medical policies. There have been other such myths—for example, that generals somehow have a corner on military policy making. Economists also, nowadays, are sometimes heard to argue that they are God's chosen policy makers, because all policy involves resource allocation in the light of alternative expected benefits. That is the newest of these myths. Policy making does involve that, of course, just as it often involves scientific issues or technical military questions, but it involves much else besides.

I believe that professional scientists have in fact done an indispensable policy-making job during the past two decades. In that sense, this article could not reasonably have been written much before now. The quick succession of fission and fusion and missiles and moon shots left the traditional policy-making machinery rather groggy, unable to deal with a new generation of unfamiliar policy problems. It is to the credit of the scientist—and perhaps to the salvation of the country—that he pitched in to help, willingly, quickly, and generously.

Why the Scientist Went to Washington

Of course, the scientist went to Washington for reasons probably very different from those that made him welcomed there. The *Bulletin of Atomic Scientists* and others at the time argued that the nuclear scientists, inventors of potentially horrendous new power, had a special moral responsibility to guide the nation in using it for good rather than for evil. The only hope of doing this, went the argument, was to introduce the precise, rational methods of science into the working processes of traditional policy making.

As far as moral responsibility is concerned, of course, we all have it. Those of us who are not professional scientists are therefore not above feeling an occasional twinge of resentment at the scientist's wanting to take it away and keep it all to himself. Does the electrician have a special moral responsibility for the electric chair?

The question of scientific method is a nicer one. That is another myth, this one perpetrated chiefly by philosophers. Does "scientific method" mean the method of the exact sciences, based on the controlled, repeatable experiment? If it does, then it is not transferable to public policy making. Does it mean orderly, systematic thinking, as against faith, tradition, or prejudice? That is what it has meant historically. But there certainly is no more want of that in Washington than anywhere else. If it sometimes seems that there is, it is because making good policy is a far more difficult job than making good science. It must, for one thing, deal rationally with the irrational, with faith, tradition, and prejudice.

I think the reason scientists were welcomed in Washington in 1945 and since is both less romantic and more compelling than moral responsibility and scientific method. They went because the policy makers who were there at the time yelled "uncle." And both deserve a lot of credit: the scientist for responding, and the government officials for knowing enough to yell.

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A Permanent Role

In one capacity the professional scientist never will and never should leave Washington. The technical content of major policy issues will not lessen. It will increase and get more technical. The professional policy maker at his best will never be able to do the job of the professional scientist. More and more, the best of professional scientists will have to advise on all policy that science touches, which is just about all policy. The scientist will forevermore have to participate in the policy-making process, along with the economist, the soldier, and the public official.

But advice is a two-way street: there must be those who know how to give it and those who know how to take it, where "to take" means to understand and to evaluate. One trouble during the last two decades has been that there have not been enough good scientific-advice-takers in government, not enough policy makers sophisticated in the new technical dimensions of policy. That is why many scientists had to go beyond their adviser role, to hold the fort by filling in also in the policy-making spots, in the White House, the Defense Establishment, the State Department, and elsewhere. It is a safe bet that most of these men would willingly go back to their own profession—to science, and to giving scientific advice to government—once they were convinced that competent professional policy makers would succeed them in the government jobs.

My argument so far is that professional scientists have been the best science policy makers available between World War II and now, but that they are not by nature the best for all time. This statement requires elaboration.

Science Policy

Making policy relating to science—making "science policy," to use a shorthand term that is gaining currency—has two aspects. A government has to have a policy *for science*, a policy (or policies) concerned with the support, health, and growth of science and scientists. But a government must also be concerned with the role of science *for policy*—for policy in general—because the rapid advance of science and technology increasingly affects policies aimed at extrascientific national objectives, like military strength, economic development, international relations, and so forth. Actually, if pushed far enough, these two aspects collapse into the second, because few but professional scientists would much care how fast and where science went if it were not for its important extrascientific implications. The country certainly could not reasonably be expected to put billions of dollars into science just because science is good. Music is good, too, and it does not get a cent.

The science-for-policy aspect, then, is ultimately the core of science policy making. But one of the effects of entrusting science policy making to professional scientists is that the narrower, policy-for-science aspect can get emphasized out of proper proportion. That is, to put it very simply, scientists by and large tend to be much more interested in science than in policy, which certainly should surprise no one.

An example of this bias is a frequently disproportionate concern with the danger to scientific freedom implicit in the very idea of government policy making for science. Government research projects that carry rather funny titles, like "An Investigation of the Mating Habits of the South American Flea," are sometimes questioned on the ground of relevance to the sponsoring agency's mission, and because there is concern that irresponsible bandying about of such titles can compromise an agency's entire research budget. The scientists involved too often answer that this is evidence of anti-intellectualism in government, and that their professional dignity and scientific competence are being questioned. They sometimes threaten to resign if the projects are not retained, but happily they do not often do so. The interesting thing, of course, is that they rarely even try to justify their choices in the light of alternative projects that the money could be spent on. No sensible person can deny that the presence of government in scientific affairs carries a real risk of unwarranted interference and control, but crying wolf too often may weaken the response if and when the wolf really appears.

Such incidents reveal another bias: a conviction that the only criterion relevant to the making of science-policy decisions is whether a project to be supported is or is not good science. Down deep, very many scientists probably wish that the government would support all the good science there is, and otherwise keep hands off. Of course, government cannot do that, because there is more good science than there is money. Choices must therefore be made, and they must be made on grounds other than scientific. To spend a billion dollars on physics and a million on archeology, or the million on physics and the billion on archeology, is not an indifferent choice in America in 1964, even when the purely scientific claims and credentials of the archeologist and the physicist are equally good. It is perfectly clear that the government should not support bad science, but that proscription is not enough to build a science policy on.

Another source of a disproportionate emphasis on the narrower, policy-for-science aspect of science policy making has its source in the at times ineffective way in which scientific advice has been used by government, especially in the earlier days. An inevitable consequence of scientific spectaculars is that science becomes spectacular. It comes into fashion, becomes a fad. With the public uncovering of the atom bomb, everybody decided he needed his own private atomic pile, and his own personal nuclear-scientist-in-waiting. Different departments of the government all suddenly flowered with their own scientific advisory boards. No one could any longer afford to be caught with his science down.

Look at these advisory boards. By and large, they were staffed from the same small group of eminent men in science who tended to rotate from one to the other. Each was told, "Look, we know that science is wonderful, we know that we need it in this department, we don't know anything about it though, so please tell us what we should do." And the answer inevitably came back, "Support oceanography, or meteorology, or molecular biology," or, if this was still in the 1940's, "Support an atomic reactor." You ask the same question of the same people ten times, and you'll get the same answer ten times. And that is what happened. Oceanography programs, meteorology projects, and atomic reactors began to spring up ten at a time, whether or not they had any relevance to the missions and objectives of the agencies that sponsored them. Policy making thus tended at times to be replaced rather than refined by science.

Science policy making will come fully of age when science begins to serve policy, rather than the other way around. As yet, it is still missing more opportunities than it is exploiting.

When the National Science Foundation was established in 1950, it was given two principal tasks: to provide financial support for scientific research and scientific education, and to concern itself with formulating and coordinating government-wide policies relating to science. It never did the second job, despite a pointed Presidential reminder in 1954. Supporting research and education was relatively easily done, and was good for science. Making science policy was a new and murky area, little understood and likely to fan interagency rivalries. The foundation played it conservatively, partly for want of sufficient authority, and to that extent missed a chance to enrich the art of policy making and to make it adequate to the needs of the present time.

International scientific cooperation is another case in point. Why do countries cooperate in scientific programs? Sometimes, as in the case of CERN (the European Organization for Nuclear Research), because equipment is too costly for them to support singly, in order to make up for their individual weaknesses in certain areas by calling on the strength of others. Sometimes because the field—like astronomy, meteorology, or space science—does not respect national boundaries. The first of these reasons, in particular, does not apply to the United States. No single European country may have enough money to buy the latest particle accelerator, but the United States could buy ten. Belgium may be weak in physics, and Italy, perhaps, in biology, but the United States is pretty strong in all departments. In other words, the United States can do without European science. But it cannot do without Europe. It needs it as an ally, and it needs it increasingly as a market. Conversely, Europe needs and wants science from America, but is no longer dependent on this country for economic aid, and is increasingly going its own way in foreign and defense policy.

Now, if each of two people has something that the other wants, they are likely to start talking about a trade. But no! The argument that too often greets proposals for increased U.S. participation in international scientific cooperation is, "But European countries are not cooperative these days, either in NATO or in tariff negotiations. If they're anxious to cooperate in science, it's only because they want our science, and we get little in return."

This is looking at the issue solely from the point of view of probable *scientific* benefit to the United States. The real payoff to this country from international scientific cooperation may be more *political* than scientific: science may offer an important and viable channel of international communication at a time when more traditional diplomatic, military, and economic channels are faltering. Failure to recognize the full extent of this can amount to using science to obstruct policy rather than to advance it.

Science—or rather its name—has also sometimes been used to obstruct or confuse policy in other ways. One very eminent scientist will say that we should build bigger and better and more H-bombs more quickly, because he is a great scientist and he says so. Another equally eminent scientist will say that we should destroy all our weapons immediately and unilaterally, because he is a great scientist and he says so. Congress, which can be short on science but is very long on politics, plays such people like poker chips. My scientist can lick your scientist. In the meantime, of course, the really useful work is done by the man who invents the detection device that makes the test-ban treaty possible, and by the scientists who work hand-in-glove with the disarmament negotiators in Geneva. I cite this instance only to show that professional scientists are no more immune than anybody else to bias and special pleading. Scientist A's supporters, of course, argue that Scientist B is not representative of the scientific community, and B's associates argue that A is not. Probably neither is, but it is unlikely that it matters one way or the other. The problem is not to distill the true essence of the scientific community, and then listen. It is to distill the essence of particular policy problems at particular times, and to call on scientists, among others, to help deal with them.

An Interdisciplinary Effort

Such examples and arguments cast doubt on the idea that professional scientists have a special competence as policy makers because they are scientists. That is not to say that being a scientist is a disqualification for a policy-making role. It just is not a special qualification, any more than being a professional economist is, or a professional philosopher. Rather must all these specialists, and more, participate together in making policy, because making policy is as truly interdisciplinary an effort as there is.

The economist as such must contribute his special expertise in cost-benefit analysis to guide the allocation of scientific resources. The physical scientist as such must determine the purely scientific priorities: how manpower and money should be divided according to the intellectual demands of each branch of science. The political official must introduce the extrascientific considerations. The engineer must perform his unique function of translating scientific theories into useful objects, and the political scientist must help design the institutions that can convert this variety of contributions into viable policy.

Because the job is so complex, talented policy makers are rare. Talented policy makers who are also competent professional scientists are therefore necessarily rarer still. This sometimes means that important policy jobs are filled by good scientists who are relatively insensitive to policy when they could be better manned by competent policy makers sophisticated in the facts of science. That is why we should not assume without examination that scientists as such are better qualified than anybody else to deal with science-policy problems.

Am I preaching to the converted? I believe not. Most scientists will agree up to a point with what I have been saying, and still believe that, when all is said, a scientist is really better fitted by training than anyone else to do the policy making. In their souls they feel that policy making in government is a messy, disorganized, and irrational business, and that only the clear eye and trained mind of the professional scientist can clean it up.

Too often the effect of this is that the policy problems are simply not tackled. The full-time scientist-adviser in the government can sometimes be indifferent to the value and need for detailed examination of the specific ways in which science and technology enter into the often delicate policy questions with which his agency struggles. Unused to thinking in political terms, he tends to concentrate still on the subjects that occupied him in his university laboratory.

To the suggestion that his principal concern should now be with policy rather than with science as such, he has too often been known to reply, "Yes, I see that, and I suppose it's right. I hadn't quite thought of it that way before. I generally leave these political questions to others, and concentrate my own efforts on the things

I know how to do; for example, our efforts in oceanography and our new program in meteorology."

I have at times, after frustratingly frequent encounters with this kind of reaction, asked knowledgeable friends in Washington when we will learn that we don't absolutely *have* to appoint scientists to these jobs irrespective of their political sophistication. "Not in the foreseeable future," is the answer I get, "because the entire scientific community would be up in arms if we considered nonscientists for them. All these jobs have to go to scientists, even when we can't attract our first or second choices to them."

Conclusions

Two comments seem in order. (i) The failure of the traditional policy-making machinery to grapple with the new technically rich problems that have arisen over the last 20 years is adequate explanation for the development of this attitude on the part of the scientific community. By and large, it has until now been better to have scientists than nonscientists in these jobs. (ii) The country's progress in dealing effectively with the important problems of science policy will be measured by the degree to which the scientific community progressively abandons this attitude. Military policy making has on the whole been better done since the professional military man gave up his special claim to omniscience and began to cooperate rather than dominate. The analogy with science policy is clear. The specialist *may* be the best man to deal with the policy implications of his field, but he is not always or by nature the best.

Of course, professional policy makers must first become more adept than they have been in dealing with issues that touch science before the government can safely lessen its encroachment on the scientist's time. It is not clear that physicists and chemists have to be in the policy-making jobs, but it is clear that these jobs must be manned by people who know what physicists and chemists do when they do physics and chemistry. The modern public servant, in other words, has to be scientifically literate. He must be able to understand a scientist when he talks. He has to be able to sift good from bad scientific advice. He has to be able to make his superiors in the Executive branch and in the Congress understand what science is really about, understand that it is more than modern sorcery. He must also be able to explain government and its special problems to the scientist, so that the scientist can provide more relevant advice to the government. He must function as the communications link, missing up to now, between the professional scientist and the professional politician.

This is no mean task. It is one to which this country is only now beginning to awaken. It is one to which public officials, professional scientists, scholars in general, and educators perhaps above all must henceforth devote themselves explicitly and systematically, in order to understand the problem and to help breed the new, technically sophisticated public servant who can deal with it. It is only when that is done that the scientist can reasonably be asked to yield to the new professional in government. But it is doubtful that he will even need to be asked. He will probably do so willingly—perhaps even eagerly—once he is convinced that the policy-making job will not be bungled by scientific illiterates.

Spectroscopy of Solids in the Far-Infrared

Studies of superconductors, magnetic materials, and ferroelectrics in this spectral region are rewarding.

M. Tinkham

By "the far-infrared" I mean here that awkward region of the electromagnetic spectrum between the microwave and the conventional infrared region. Until recently, this region had remained largely unexplored since the pioneering work of Rubens and his collaborators shortly after the turn of the century. To be specific, I use the term *far-infrared* to refer to the wavelength region of 0.1 to 1 millimeter, or 100 to 1000 microns. This means that $\bar{\nu}$ in spectroscopic wave-number units is between 10 and 100 cm^{-1}, or that the actual frequency, ν, lies in the range 3×10^{11} and 3×10^{12}. Put in more physical terms, photons in this region of the spectrum have quantum energies $h\nu$ corresponding to thermal energies kT for temperatures T of 15° to 150°K. (Here h and k denote the constants of Planck and Boltzmann, which are respective constants of proportionality connecting energy to frequency and temperature.) This energetic equivalence suggests one reason why the spectroscopy of solids at these wavelengths is interesting; namely, any phenomenon of ordering on the atomic level within a solid which has a characteristic temperature T_c lying in the convenient range 15° to 150°K may be expected to have characteristic energy-level separations which may be studied spectroscopically in the far-infrared.

An example of this is the transition of a metal to the resistanceless superconducting state, characterized by an ordered electronic state. We now know that a material which becomes superconducting at a critical temperature T_c has a characteristic energy gap of width $E_g \approx 3.5\ kT_c$ in its excitation spectrum at low temperatures. Since most known superconductors have T_c in the range 1° to 18°K, these gaps fall either in the far-infrared or the millimeter microwave region of the spectrum. Another

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