Natural Electron Intensities

Few definitive measurements of the natural electron fluxes were made prior to the "Starfish" detonation. In particular, no measurements at all were made in the equatorial region at heights around 1.5 earth radii. Since there is no intrinsic difference between naturally and artificially injected electrons by means of which the natural component can be distinguished, it may be necessary to wait more than 30 years before the natural electron fluxes in the region around 1.5 earth radii can be measured with complete freedom from artificial effects.

The rate of injection of high-energy protons by neutrons produced by cosmic rays striking the atmosphere is adequate to produce the observed fluxes and also the apparent rates of injection. If cosmic ray produced neutrons turn out to be the only source of these fluxes, then the problem of understanding the fluxes of high-energy protons is reduced to that of finding mechanisms through which the trapped protons are perturbed in a manner which produces the spatial distribution that is shown in Fig. 1.

In addition to the high-energy protons, there are vast numbers of low-energy protons trapped in the geomagnetic field. For example, instruments on the Explorer XV and Relay I satellites have measured the fluxes of protons with energies greater than 5.1 and 1.1 Mev and have shown them to be greater than 10^6 and 10^7 particles per square centimeter per second, respectively, in the equatorial region around $L = 2.0$ earth radii. It is not yet known whether the intensity of neutrons produced by galactic and solar cosmic rays is adequate to explain such high fluxes.

The electrons on high lines of force are seen to be accelerated during some magnetic storms. Since there are always large numbers of very-low-energy electrons present which might be accelerated, the origin of the outer-zone electrons is probably irrelevant. In any case, the central problem is to understand the acceleration mechanisms.

Summary

Data on the time- and space-dependence of trapped particles in three categories have been obtained by detectors on the Explorer XV satellite. Some of the more interesting observations are as follows.

1) There is an unexpected secondary peak in the distribution of high-energy protons.

2) The fluxes of high-energy protons slowly increased with time but apparently were not affected by geomagnetic events which caused perturbation of the electron fluxes on the same lines of force.

3) About 1 or 2 percent of the electrons generated by the nuclear detonation of 9 July 1962 were found to be present in the geomagnetic field 125 days later.

4) The electron fluxes in the region between $L = 1.25$ and 1.65 earth radii varied by less than 35 percent over the period from day 110 to day 206 after the detonation of 9 July.

5) The spatial distributions of high- and low-energy electrons are quite different.

6) Electrons in the region above $L = 1.7$ earth radii are strongly perturbed by magnetic disturbances.

7) A "new" outer zone of both high- and low-energy electrons was formed by the magnetic storm which began 18 December 1962.

It is expected that these and other findings obtained by the Explorer XV detectors will be of substantial aid in discovering the mechanisms which control the behavior of geomagnetically trapped particles (*5*).

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Science Goes to Washington

Meg Greenfield

In the beginning, a current saying in Washington goes, were the lawyers; next came the economists; and then came the businessmen. Now it is the scientists' turn. This new breed, or more precisely, these new hybrids, who began their more or less reluctant ascent to power during the Second World War, are now so thoroughly enmeshed and infiltrated into every level of government that no one seems capable of stating with any precision just what their function is.

The role of the scientist-in-government as it has evolved in Washington in the past twenty years has been interpreted so loosely, by both the scientists and the administrations that have dealt with them, that each has inflicted punishment on the other, and neither, so far, seems to show any genuine understanding of the duties or requirements of the other. Invariably, science in Washington is science under pressure; it is science having to hurry along, science having to worry about what the Russians might do, what the Congress may say, what Bertrand Russell is likely to think of next. The government in turn has yet to get accustomed to this strange community whose members are given in the best academic tradition to squabbling, back-scratching, and casting doubt on one another's competence—a community that cannot help being politically minded and yet cannot possibly resolve its dissensions according to majority principle.

Miss Greenfield is a writer for the *Reporter*. This article is reprinted, with permission, from the 26 September issue of the *Reporter*.

It is a measure of the difficulty that nobody has—or could—come up with a readily comprehensible table of organization to explain the labyrinth of agencies, foundations, consultantships, academies, and committees that has grown up in Washington in recent years. A simpler guide might begin with the new Office of Science and Technology, created a year ago. The OST, which is directed by Jerome B. Wiesner, is part of the Executive Office and is accountable to Congress. It is charged, formally, with evaluating the programs of other agencies, and with helping to formulate national science policy.

Next, there would be the Federal Council for Science and Technology, a subcabinet group of which Wiesner is the chairman. The Federal Council is composed of a ranking member of each of eight government agencies along with a few official observers, and its purpose is to co-ordinate government programs in science. The task is a formidable one, since even such agencies of government as the Small Business Administration engage in some sort of scientific activity, while the giants such as the National Aeronautics and Space Administration (NASA), the Atomic Energy Commission, and the Department of Defense maintain their own laboratories, award their own contracts, and employ their own private armies of consultants. But the Federal Council's aims are modest. According to one staff aide, it is presently working against the day when ships from two of the twenty government agencies presumed to be involved in oceanography collide and sink while trying to take the same soundings.

In yet another of his capacities, that as Special Assistant to the President for Science and Technology, Wiesner and his staff of thirty-five function as personal advisers to the President. Here they work with the President's Science Advisory Committee (P-SAC), eighteen distinguished and more or less nongovernment scientists and engineers who meet monthly under their chairman, who, again, is Wiesner. P-SAC members are organized into standing committees and *ad hoc* panels, and for assistance they draw on a pool of around two hundred part-time panelists and consultants whose identity is kept secret. (Reportedly, about half the mystery guests come from private industry, and of these the largest single group is said to be from Bell Telephone Laboratories.) P-SAC may also receive what are known as "inputs" from committees of the National Science Foundation, which is concerned with the development of science and science education. Finally, the Foundation, P-SAC, the Federal Council, the individual agencies, and Wiesner in any of his multitudinous roles may request advice from the National Academy of Sciences, a quasi-official agency that has close ties to the Federal government.

One consequence of this chaotic institutional structure is that no one can be sure exactly what a government scientist is or, more to the point, when he is acting as one. It is not unusual to find a scientist like biologist H. Bentley Glass serving simultaneously as an adviser to the AEC on the effects of atomic radiation, as one of the independent experts selected by the National Academy to pronounce upon the same subject, and as a participant in such private groups as the Congress of Scientists on Survival and the Pugwash conferences, which on occasion deplore what the AEC is doing. One effect of the now-they-have-it-now-they-don't relationship many scientists enjoy with government has been to make remarkably vague the degree of their officialness at any given moment in terms of both their rights and their responsibilities.

The Status of Science

When is a government scientist speaking for government, and when is he speaking as a private citizen? Government has provided few guide lines, and those adopted by the scientists themselves have been, by and large, unsatisfactory. Last summer, for example, UCLA physicist Joseph Kaplan, who serves as an adviser to both the White House and the Air Force, was asked by a television interviewer for his opinion of the high-altitude nuclear test that had recently been conducted over Johnston Island. He emphatically regretted that the United States had been first to violate "an international agreement" to submit any such potentially harmful experiments in space to international scientific judgment. Yet questioning disclosed that United States government was not a party to the agreement at all. The "agreement" had been subscribed to by official delegates of the semi-official National Academy at a conference of the International Council of Scientific Unions (ICSU), an organization that is remotely connected with the U.N.

When the scientists are unable to distinguish between their private and their public areas of responsibility, it frequently is government that ends up being embarrassed. Regularly, for example, members of P-SAC go off to the Pugwash conferences. There on occasion they have agreed to disarmament schemes less stringent than those they presumably support as members of government. In explanation of this practice, it has been said that they are acting in their capacity as private citizens, and no doubt they are. The problem has been the Russians' persistent refusal to take the disclaimer seriously, partly because the concept of "private capacity" is unfamiliar to them and partly because it is logical to expect that the views of the President's advisers—public and private—may ultimately carry some weight and even prevail. The effect has sometimes been confusion over U.S. policy, a fact that has begun to trouble even some former enthusiasts of Pugwash. "I think," I was told by one, a P-SAC member presently trying to devise a new format for the conferences, "that Khrushchev may have been misled by some things that were said in private on Berlin in 1961." Not long ago, in fact, Khrushchev, in a correspondence with President Kennedy, alluded to the views of U.S. scientists at Pugwash to bolster his own position on the monitoring of a test ban. In reply, the President was obliged to point out that the scientists "were speaking as individuals."

Painful as such effects of the scientists' irregular status may be, there is little that is likely to be done about it. For most attempts to bring scientists further within the framework of ordinary governmental procedures are suspected as attempts to compromise them; and many scientists who have no trouble understanding, say, the need to "muzzle" the military on subjects that may affect the conduct of foreign affairs consider a call for restraint on the part of government scientists an attack upon their intellectual freedom. This confusion, institutionally blessed, that characterizes their relationship to government in general, leaving them never quite free but never quite responsible either, also characterizes their manner of functioning within it.

"Who is providing the facts. . . ?"

Representative Melvin Price (D., Illinois) demanded a while back. "By what authority do they act? . . . Are they qualified?" It was the familiar cry of a congressman who has learned that government scientists have lately put the kibosh on one of his favorite projects—the nuclear-powered aircraft in this instance—and who also knows that his questions will not be answered. For the system and its mode of operation are such that even well outside areas of security classification it is rarely possible to determine who has acted, for what reason, or even in what capacity.

What with everyone participating *ex officio* in everyone else's business and regularly exchanging an embarrassment of inputs, the point has finally been reached where it is no longer clear at a given meeting who is advising and who is consenting and, in either case, on behalf of whom. Thus physicist James A. Van Allen complained last winter that he had been "intimidated" by members of a P-SAC committee before which he twice appeared, only to learn that he had never appeared before a P-SAC committee. It turned out to have been an interagency group convened by Wiesner in P-SAC headquarters under the auspices of the OST. There were P-SAC members present in some capacity and outside consultants too, but they were agency advisers on this occasion. For having failed to grasp this distinction, Van Allen was later charged by one of Wiesner's aides with a lack of "sophistication." In other words, what began as a laudable exercise in co-ordination has ended by almost completely dissolving lines of responsibility in government science, a process that has been hastened by the informal out-of-channels way in which the Kennedy administration likes to operate. In contrast with the two Special Presidential Assistants who preceded him, for example, the somewhat stately James R. Killian, Jr., and the respected scholar George B. Kistiakowsky, Wiesner is widely and admiringly held to be "an operator" in Washington.

Whether or not, as it is claimed, Wiesner accomplishes more this way, there has been a further loss of visibility in an already dim area of activity, and government scientists themselves have begun to complain. What once might have been public reports, according to some consultants who prepare them, are nowadays treated as documents for Wiesner's own guidance, and panel findings that seem to be going the wrong way are apt to meet untimely and mysterious ends more often than was thought practical in the past. The secrecy of preparations for the Johnston Island shot, for instance, bothered many scientists more than the test itself. Joseph Kaplan, who thought the test a "very good experiment," claims to have written Wiesner some "rather frank and strong letters" on the subject. "You were quoted . . . ," Kaplan's TV interviewer said apropos of his displeasure, "that the only way to get any information on what we're doing in the scientific space experiments was to sit around the Cosmos Club in Washington. Is that an accurate quote?" "No," said Kaplan, "that's simply one of the better ways. . . ."

For each of the factors that tend to put the scientists beyond accountability and their work beyond review—the maze at the working level, the fuzziness of authority at the middle and the top, and the unorthodoxy of present operations—good reasons and even necessity can sometimes be adduced. But taken together with the part-time nature of many scientists' employment, they have undeniably encouraged on more than one occasion a quick, casual, and even sloppy approach to problems, one that the scientists themselves would be the last to tolerate in their own laboratories. And, as is often the case, an inadequate system has begun to become a justification for its own inadequacies. For even though the government scientists' footlooseness and relative obscurity tend to promote careless work and to make its discovery by others difficult, the possibility of such work occurring has been offered by Wiesner and others as a reason for making their activities even more obscure. The point, as it is often argued in Washington, is that government simply could not get scientists to come down to perfunctory, accident-prone, potentially embarrassing work if even so much as their identity were revealed.

Partly on the basis of such unreassuring logic, a kind of secrecy has been maintained about government scientists that is practiced elsewhere in Washington only on behalf of intelligence agents. Not only are the names of some two hundred P-SAC consultants kept secret, but so are those of other paid scientific advisers to government. Spokesmen for both the Air Force and the Arms Control and Disarmament Agency recently refused to divulge the identity of certain of their scientific advisers on the grounds that to do so would (1) expose them to "pressure," (2) ensure that they would receive unwanted mail, and (3) put them under public scrutiny, which was exactly where they did not want to be.

Why shouldn't government scientists be under public scrutiny? The prevalent view seems to be that since science is more or less objective truth, scientists themselves are all but interchangeable, and their individual identity need not be a matter of concern. It is a view that, oddly enough, the public and the press seem to share. "A noted biologist," the New York *Post* declared not long ago, had made a certain comment about radioactive fallout. The *Post* quoted his comment and proceeded to base a passionate editorial upon it, never bothering to reveal which noted biologist he was, one presumably being as good as the next. The government scientists' exemption from public responsibility, in other words their relative freewheeling and remoteness, are more than side effects of the curious ways in which most of them have been organized into government; it is thought that they should be thus exempt, freewheeling, and remote.

Not long ago, a press officer of the Arms Control Agency informed me that the identity of ten scientists working full-time as civil servants *within* the agency could not be disclosed to the press. He reluctantly produced their names only when he had come to understand the difference between managing the news and managing civil-service regulations. "We claim Executive privilege," he said quite seriously at one point. And at another: "What good would it possibly do you? Why do you want to know who they are?"

The Influentials

Well, who are they? Who are the government scientists? One answer, of course, is practically everyone who has an advanced degree in science or engineering. For taking account of government contracts with universities, industry, and nonprofit organizations, it is estimated that between sixty percent and seventy percent of the nation's scientists and engineers are directly or indirectly employed by Washington. According to the Science Foundation,

scientists and engineers account for 128,000 of the government's white-collar workers, or about eight percent of the total. But in discussing those of their number whom they consider "politically relevant," scientists do not speak in thousands but in hundreds. One study, after investigating the subject, posited an "elite" of nine hundred and an "active elite" of 392. Killian reportedly has arrived at two hundred as the number of government scientists who are "consistently influential."

Because of the mystery in which they move and the frustration of those who have tried to find the locus of scientific decisions in Washington, the "active elite" has become subject to vague and contradictory accusations. Characteristically, suspicion on the Right and despair on the Left have produced two abiding myths about where the weight lies in government science and who the Influentials actually are. They are, to hear it told on Capitol Hill, the "fuzzy-wuzzies," by which is meant, roughly, the do-good, left-wing, academic basic-research set. "Like Rabi," they say to cover the other few hundred; ". . . like Bethe." At least, however, proponents of the fuzzy-wuzzy theory can produce a name or two upon request. The same cannot be said for the other side, the believers in the omnipotence of someone called the Military Scientist, a heartless, scheming, and above all irresponsible fellow who would just as soon blow up the Taj Mahal as look at it.

Neither of these devil theories makes much sense. For while it is true that military experiments often develop from recommendations made by the working scientists in the labs of the AEC and the armed services, higher approval has often come from none other than the so-called fuzzy-wuzzies. This was true, for example, of the two experiments most loudly denounced as Pentagon plots in recent years—the Johnston Island test and Project West Ford, a communication experiment that involved creating an orbital belt of copper needles around the earth.

Actually, the academic-military distinction is a false one, and not only because "fuzzy-wuzzies" may claim credit for having invented much of the infernal modern machinery of war. Most of the "active elite" could qualify either as military scientists *or* as fuzzy-wuzzies, whichever they themselves found less disturbing in terms of their personal politics. For the main thing to understand about the "active elite" is what makes it so active in the first place: there are many more influential jobs, it would seem, than there are influential scientists to fill them. Indeed, one reason all the institution-building and committee-creating of the past few years has brought relatively little order to science advising is that the new positions have gone, by and large, to the same old frantic, multi-hatted, overworked, exclusive crew. There exists at the top in government science not an academic-military split but what political scientists have politely described as a "self-selecting group" that "intercommunicates," and what congressmen rather more bluntly have called a game of musical chairs. In part it exists by default, and in part it exists by design. "Only those who circulate . . . in the right circles," as an editorial in *Science* magazine puts it, "who have the right connections, are likely to be called on to give advice . . ." Not long ago a prominent government consultant with whom I was discussing the controversy about the effect of the Johnston Island test on the Van Allen Belt thought it relevant to point out that Van Allen was "just a little man from Iowa." The question I should have asked, he said, "was whether we would hire him at MIT."

The "right connections," by all accounts, were made during and shortly after the war. Those most multifariously involved in government science are likely to be wartime veterans (or students of the veterans) of one of two institutions: Los Alamos or the MIT Radiation Laboratory (Rad Lab), which was run by Lee DuBridge during the war. After the war there was further commingling on military projects and science advisory committees. According to one scrupulous historian of these matters, some time around 1954 the "core group of the Rad Lab and the old Los Alamos people seemed to merge." Los Alamos as an institution has declined since then. California, on the other hand, has gained ground. And people have moved from place to place. At the present time, government science advising might best be described as a sort of Harvard-MIT-Bell Telephone-Caltech situation, with lines out to a few Eastern universities and to Palo Alto, Berkeley, and the RAND Corporation.

While the number of posts held simultaneously or in succession is one index of a government scientist's influence, it doesn't tell the whole story. Being appointed is one thing; being listened to is another. Friendship, skill, chance, willingness to work, and a little bit of auld lang syne have combined in various ways to make some of the elite more elite than others. Certain members of P-SAC are called on for advice more often than is P-SAC itself—Edward Purcell, Wolfgang Panofsky, Jerrold Zacharias, George B. Kistiakowsky, Harvey Brooks, who is Dean of Engineering and Applied Physics at Harvard, and Paul Doty, a Harvard chemist who is a close friend of the President's special assistant, McGeorge Bundy, and who has taken an active interest in disarmament and the test ban. Also, government has its favored businessmen-scientists, such as James Fisk, president of Bell Telephone Laboratories, and Emmanuel Piore, who is vice-president for research and engineering at IBM. Similarly, the advice of certain lab directors in the field often carries more weight in Washington than that of their nominal superiors. One of these is Norris Bradbury, director of Los Alamos. Another is John S. Foster, Jr. who is director of the Lawrence Radiation Laboratory in California and who, along with Richard and Albert Latter of the RAND Corporation, John Wheeler of Princeton, and a few others, represents what has come to be thought of as the scientific shadow cabinet or loyal opposition on questions having to do with nuclear armament and disarmament.

From the days of the Manhattan District Project there has existed within the community of government science a political split over the proper use and control of atomic weapons, a split that was exacerbated by the Oppenheimer hearings and subsequent controversies over fallout and the technology of a test ban. For several years after the war, power shifted from side to side as scientists of opposing views swept in and out of control. The hegemony of the General Advisory Committee of the AEC (I. I. Rabi, DuBridge, Fisk, *et al.*) ended with the Oppenheimer hearings and was followed by a period of hegemony on the part of the Teller group. The ascent of Sputnik in 1957, and a new interest in a test ban on the part of the Eisenhower administration, combined to bring on Period 3. Killian became Eisenhower's Special Assistant for Science and Technology and P-SAC, formerly part of the Office of Defense Mobilization, was elevated to the White

House. Its members included Fisk, Kistiakowsky, Rabi, Wiesner, and Zacharias, and for about two years they were again at the undisputed center of scientific power in Washington. The creation of other agencies and advisory groups in government—largely at their own recommendation—has dissipated P-SAC's power since then and given the loyal opposition at least a chance to speak if not always to be heard.

If most of those in the new positions have been around before, one reason may be lethargy and indifference on the part of the out-group scientists as well as finickiness and snobbery on the inside. "You sit on the sidelines and complain," Wiesner chided a convention of scientists in Washington recently. But, he added, it was "surprising" how many scientists when approached by the government made it plain that they only were willing "to come down and help out occasionally." Indeed, the chairmanship of the National Science Foundation went begging for nine months until Atomic Energy Commissioner Leland Haworth, still a member of the "in-group," finally took it this spring. And it took Wiesner more than a year after OST had been established by law to oversee all scientific operations in government to acquire the deputy director provided for in the act. Some people said he couldn't find one, others said he wouldn't; writ large, the argument was whether the dearth of government scientists was due to the fact that no one has been knocking at the door or to the fact that no one has been answering. But whatever has caused the scarcity, it still exists.

What has happened since Sputnik rattled the china in 1957 has been an elevation of scientists, who were for the most part already there, to posts of new responsibility with access to the top. P-SAC moved up to the White House; scientists were taken on by the departments for the first time at the secretariat level; advisory groups were established to communicate directly with Congress and with agency heads; a scientist, Glenn T. Seaborg, became chairman of the AEC. The movement has been upward, and the harassed few now constitute a new class in Washington. They are scientific upper-middlemen—translators, reviewers, communicators, monitors of what goes on below in the labs and agencies, as well as participants in what goes on above, namely policymaking.

The Nature of Science Advising

In a series of Godkin Lectures delivered at Harvard a few years ago, C. P. Snow related a story of conflict between two British science advisers during the war, laying stress on the intractable mysteries of scientific knowledge and its inaccessibility to those in government who had to base decisions upon it. Though Snow's lectures were widely challenged, this chilling and romantic version of science advising dies hard. For the least argument, accident, or admission of uncertainty related to science these days continues to bring on that now familiar host of editorial warnings about how the nation and its leaders must learn science while there's time, or it's curtains for the democratic process. Are the warnings justified? Is radiophysics, like democracy, really everybody's job?

According to those who give and receive advice in Washington, the answer is "No." Wiesner, speaking of the President, and Harold Brown, Director of Defense Research and Engineering, speaking of Secretary McNamara, both concede that there have been times when they had trouble communicating information because of its technical complexity. But such trouble is said to be rare and relatively easy to overcome. "If you can't put it into English," as Jerrold Zacharias has summed up the prevailing view, "it means you don't understand it yourself." Far more troublesome to those who receive advice from Washington's new class of scientific watchdogs, consultants, and policymakers has been the seemingly simple matter of figuring out what is a scientific question in the first place, and what is a scientific answer.

No one was in a mood to make such discriminations in the period immediately following Sputnik I. "They gave us a flabbergasting array of responsibilities," Killian has recalled of those days in 1957 and 1958 when a kind of desperate blur characterized official thinking about the scientist's newly announced purpose of bringing their wisdom to bear on such policy matters as military security and the space race. They were looked upon by the White House and by many in Congress as saviors and miracle workers who could solve, rather than merely assist in, the problems of defense.

The problem of determining what exactly is a scientific question was nowhere so acute and is nowhere better illustrated than in the general field of disarmament and the test ban, largely because science slips so easily and imperceptibly into nonscience at almost every point on both issues. Last spring, for example, the following statement was made before the Joint Committee on Atomic Energy by Air Force seismologist Carl F. Romney: "Based on all the information now available, we can conclude that it is feasible to design a detection system, based entirely outside the Soviet Union, which is capable of detecting explosions of about 1 kiloton in granite, 2-6 kilotons in tuff, and 10-20 kilotons in alluvium." As a statement of fact, it was agreed to by government scientists. Yet the old quarrel over our detection capabilities immediately broke out anew among them. Why? They were arguing about many things—whether the Soviet Union would go to the expense of developing weapons below that threshold of detection, whether such weapons would be worth not only the cost of them but the opprobrium of getting caught—whether, in fact, such weapons would have any decisive military value at all. In other words, they were arguing about Soviet intentions and Soviet strategy, not about science. Failing to appreciate the distinction, many people continue to invoke the scientist of their choice in support of their own test-ban and disarmament positions in the happy belief that they are citing unchallengeable scientific authority.

The associative process whereby a physicist's special knowledge of nuclear weapons is transformed into an equally special knowledge of all the political, military, and diplomatic problems in which they figure has got the government into trouble often enough now to be fairly widely recognized for what it is—though not by everybody. In one case, when I asked a member of P-SAC not long ago if he could describe the extent to which government scientists found themselves marshaling facts in support of decisions already taken, he replied with great feeling, though a little off the point, "Never! Because we have always told them what's coming. *They* ask *us*."

His subsequent account of the astuteness and foresight scientists have displayed as instructed military thinkers has been challenged lately by a number of non-scientists in and around government. Albert Wohlstetter, formerly of RAND, in a recent speech, presented an imposing collection of mis-

taken predictions and judgments made by such scientists as Bethe, Teller, and Rabi on such subjects as air defense, civil defense, Soviet behavior, and military strategy in general since the onset of the cold war. "I believe neither Dr. Teller nor Dr. Bethe has done . . . systematic analysis of the military worth of these weapons they talk about," he said. "Both are experts on the technology of bomb design. But that is quite another matter."

Congress Eyes the 'Experts'

Predictably, the newly gained insights into what is and what is not a scientific issue in government have suggested to some that time is ripe for that classical counter-revolution against the government scientist—back to the bevatron and speak only when spoken to. Something of the sort, for instance, was in the mind of Congressman Craig Hosmer (R., California) last March when he demanded that a statement made before the Joint Committee on Atomic Energy by scientist Jack Ruina be stricken from the record since, even though Ruina had identified the statement as an opinion, it dealt with aspects of a test ban that were outside his special competence as an electrical engineer. "This witness is stating an opinion in an area in which he is not an expert," as Congressman Hosmer summed up the New Thinking, "and therefore it clutters the record." Ruina, who was then Director of the Defense Department's Advanced Research Projects Agency, has probably been one of Washington's most careful and sensitive scientists where infringements of this kind are concerned. At the level of government where he operated, it would be highly impractical to try to keep science advisers in bottles. The genuinely scientific part of most issues in government is so thoroughly entwined with and dependent upon other considerations that it is at best an imperfect, partial science. Thus, Wiesner, at the time of the United States' resumption of atmospheric nuclear testing in 1962, was not called upon to deal absolutely with the question of how much radioactive fission release would be permissible or safe. Rather, he is said to have mediated a behind-the-scenes dispute on the matter between the Public Health Service on the one hand and the AEC and Defense on the other, balancing potential risks to health against potential risks to military security in the light of what the Russians were thought to have achieved in their tests.

The word "potential" was the key on both sides of the radiation dispute, since the ultimate effects of radioactive fallout were—and are—if anything more a subject of conjecture among scientists than the achievements of the Soviet test series. But the sacred distinctions that scientists normally make between scientific fact and scientific theory, or that which is known because it has been proved and that which is still a matter of speculation, have all but gone by the boards in government.

Even making allowance for the fact that government scientists are often pushed into making such premature judgments, however, too often they seem to volunteer them as well. Accordingly, some people have begun to speak wistfully of the need for some sort of self-enforced fair labeling practice among scientists, one that would require them to indicate (as Ruina, in fact, did) when they are departing scientific fact for scientific speculation and when they are departing science altogether. Take the affair of the "black boxes"—the unmanned detection stations that were set forth last winter as a means of policing a test-ban treaty. The scientists had said they were "safe," as people liked to point out. But what exactly had they meant by "safe"? "There never was much enthusiasm around here for the black-box concept," an Arms Control Agency scientist explained to me. "But after the Russians made it plain that they wouldn't take internationally manned stations, we began to find the idea more attractive. Black boxes aren't very reliable when you compare them with manned stations. But they are reliable when you compare them with nothing."

So much for the policy judgment and the meaning of "safe." What precisely had the scientists meant by "black box"? There was and still is no such thing—except in theory. Understandably, this bit of news came as something of a shock to legislators who were pondering its place in our then current test-ban proposal last March. Was the black box real or was it "imaginary," as Senator John Pastore (D., Rhode Island) finally put the question to J. H. Hamilton, who is responsible for the project. "I think this system is essentially within the state of the art," Hamilton replied. ". . . I would say to assemble these components, to test, and be reasonably sure of yourself, we are talking about eighteen months."

Such canny questioning of scientists is a relatively new development on Capitol Hill, and its meaning has not been lost on the administration. The plummy days of the hushed hearing room and the reverential "Well, now, Doctor . . ." are becoming a thing of the past. And for once, the narrowing squint of Congress has been turned on the scientists' science rather than on their political upbringing. Consequently, not only have the President and his advisers themselves learned that the phrase "The scientists say . . ." may carry any number of meanings and degrees of authority; they have also learned that simply to quote them will no longer do to persuade Congress of the wisdom of a particular decision. For the Congress has learned that a scientist's own emotions and his personal politics may well affect the advice he gives.

The repugnance with which most people respond to the idea that a scientist may even have such things as emotions and politics, let alone that either might influence his work, is a tribute to the durability of some rather odd beliefs about both science and politics, and about any encounter that takes place between them. Science is the man in the white coat, the thinking goes, and politics is the man with the stale cigar, from which it follows that a politically motivated scientist must be a venal one, a passer along of equations that don't prove out. The truth is considerably less dramatic. P-SAC, for example, has a reputation for scientific rashness where the test ban is concerned and for scientific skepticism about proposed military weapons systems. Among Defense Department scientists, quite naturally, it has been the other way round. "It's hard to separate emotion from hard facts," an Arms Control Agency scientist explained. "We can get agreement on the facts, but not on what we could do on the basis of them. We can't get agreement on the scientific promise, on where it will lead."

He was talking about the test ban, and his first point was illustrated—and continues to be—in the scientists' quarrel over the meaning of the element of uncertainty in test detection. To those scientists, such as Teller, who oppose

the ban, the uncertainty meant danger: we could not be sure of detecting Russian evasions. To those who favored the ban it meant increased safety: the Russians could not be sure of evading detection and therefore would be less apt to cheat.

The test ban serves equally to illustrate the way in which the scientists' political inclinations have affected their intuition and inventiveness—their actual scientific creativity. In Washington the process is known as "finding ways that things won't work." Both Teller and Bethe have proved masters of the art. Teller, as Wohlstetter has pointed out, has been particularly adept at imagining weapons that the United States could not develop under the terms of a test-ban treaty. Bethe, on the other hand, has generally responded to such imaginings with imaginings of his own—"enemy countermeasures which would reduce their military worth to zero." The scientists' advice has not only been affected by their political preference. Their curious status between and betwixt government and private roles has left room for any number of interests to inspire their advice in both areas. As presiders over the national science purse, are the scientists speaking in the interests of science or in the interest of government or in the interest of their own institutions? Is their policy advice, on the other hand, offered in furtherance of national objectives or agency objectives—or their own objectives based on their political thinking? It has begun to become apparent that wherever they have favored the more private aim over the more public one, they have not only limited their usefulness to government—except as checks and balances to each other—but undermined their own influence as well. The extent of the confusion that exists on the subject became apparent at a meeting of the Federation of American Scientists not long ago when Wiesner was asked rather imperiously from the floor how he could justify the way in which government annually disposed of its $12-billion budget for science when there were so many neglected projects more worthy of support. The funds, Wiesner pointed out, were not being spent *for* science but *on* it. They were being spent *for* government, he said.

Shooting the Moon

Despite its many achievements, the present balancing act has proved inadequate for the chores the scientists in government set for themselves. It has not been possible to make even a start on the establishment of scientific priorities and long-range plans for science. Agency monitoring proceeds on a helter-skelter basis. And chaos and frenzy are at least as common to the process of advising as order. "Valuable as such [*ad hoc*] advice is," as Kistiakowsky has summed up the problem, "it does not fill today's requirements for a continuing and intimate involvement in the policymaking process of competent people who understand science and its significance to policy . . ." Indeed, six years after the ascent of Sputnik, what might be called the state of space in Washington is a fairly good index of what the scientists have and have not been able to achieve—and why.

"The scientists cringe when you call it science," a NASA administrator recently told me on the subject of Project Apollo, the moon-flight program. He added that of course it wasn't supposed to be "science"; science was only one part of the program. In return, many scientists have pointed out that while science is a relatively small part of the program, the program will still have an enormous impact, by reason of money spent and manpower committed, on the future of science itself.

But to some extent the fault was their own. The point has been made that the initial response of the newly elevated P-SAC and of other leaders of the scientific community in 1957 to the post-Sputnik space emergency was almost entirely geared to the interests of science—from the original proposal for a research-oriented space agency to the casual dismissal of both the military and diplomatic ramifications of a space program. "There is plenty to do without trying to nail the American flag on the whole solar system by next week," Lee DuBridge put it at the time. By speaking mainly for science conceived as basic research, P-SAC saw its power over the program diminish and with it the chance to influence the program's impact on science.

The moon program was worked out over a hectic weekend in May of 1961 at the Pentagon following Alan Shepard's successful suborbital flight. It was a political response to the Gagarin venture and to the Cuban disaster, among other things. Reportedly, Secretary McNamara, James Webb of NASA, and a few others met round the clock starting Friday evening and worked out the crash program that was presented to the President for a decision the following Monday. "We had been told," as one of the participants puts it, "not to fool around." What was Wiesner's role? "Jerry was associated with the decision. He was called in. He was there. He wanted everything to be done right by the administration. And he had his constituency of scientists he was worried about too. As I remember, he was torn."

In Washington these days, the definition of a truly hip science adviser is one who knows that the moon money could be better spent on other scientific projects and who also knows that Congress won't appropriate it for any of them. The kind of passive in-betweenness this suggests is more or less the state of science advising now. "The scientists think you are a tool of the administration," Wiesner told me in summing up the predicament not long ago, "and the administration thinks you are a tool of the scientists."