Ralph Bunche Journal of Public Affairs

Volume 1
Issue 1 *Inaugural issue of the Ralph Bunche Journal*

Article 1

1976

Bringing science and technology to bear on public policy decisions

Herbert A. Simon
rbjpa@tsu.edu

Herbert A. Simon

BRINGING SCIENCE AND TECHNOLOGY TO BEAR ON PUBLIC POLICY DECISIONS

In the books and articles that were written ten years ago — the simpler books and articles of a simpler era — science and technology were usually cast among the good guys. Science and technology were those marvelous emanations from the human mind that had built our modern civilization, and had shown us the way to eliminate poverty from it. To be sure, there was still a distance to go along the road, but progress had been steady for a hundred years and there was no reason to doubt that it would continue.

There was also, it is true, a small cloud on the horizon — the mushroom cloud of the atomic bomb — that told us, if we still needed to learn, that science and technology were sources of immense power, and that power can be used to help man or to harm him. All in all, however, the mood was one of optimism, and science and technology were generally held in affection, and sometimes even adoration.

Today, the adoration of science has turned into a love-hate relationship. We still admire its intellectual beauty and elegance; we still are grateful for its contributions to human productivity, but we are wary, too, of the consequences it holds for us. Our concerns are focused particularly on three things: environment, energy, and the Bomb. In my remark today about the relation of science and technology to public policy, I will pay particular attention to the first of these — environment — to illustrate my points.

What are Science and Technology?

Science usually means basic knowledge about nature — the physical, biological and human world. Technology usually means knowledge about how to use the laws of nature to meet man's needs. For my purposes in this talk, I will not try to make a distinction between science, and technology, but will use the two terms interchangeably.

Isn't it a little peculiar to refer to technology as knowledge? Doesn't technology really consist of things, of the machines, materials, processes that man has invented? But the experiences of Japan and Germany after the Second World War showed that if the things are destroyed, as they largely were by Allied bombing, but the knowledge remains, the things are quickly reconstructed. Technology is not things; it is knowledge that is stored in hundreds of millions of books, in several billion human heads, and in the machines themselves. Technology is knowledge of how to do things, how to accomplish human goals.

What is the actual scorecard of science and technology? What have they done for us, and what have they done to us? I'd like to preface my remarks about science policy with some bald assertions on what I think have been the consequences of modern science and technology for society. These assertions will give us a framework for looking at the policy questions.

1. Technology has provided mankind, for the first time in human history, with the tools that would permit all men to live above the level of bare subsistence. To be sure, we are far short of that goal in the world, and a little short in this country. To be sure, also, we will not reach the goal without using effectively the technology of population control — the pill and the coil. But we must not forget that the potentiality is there, and that technology put it there.

2. Man has long caused major changes in his environment, often making it locally uninhabitable, then moving on — as nomadic herders and slash-and-burn farmers do. Man has now reached the point where his activities change the environment regionally and globally. He must fashion his technology so that he can live in continuing equilibrium with that environment.

3. The advance in science and technology has meant a corresponding advance in Man's ability to anticipate and predict how he is changing his environment. He can forecast the ecological effects of opening a sea-level canal or of inadvertently transporting bacteria to Mars. Columbus had no such problems or powers. The European explorers could bring tuberculosis and smallpox to the American Indian, in exchange for syphillis, in ignorance and innocence.

But they did bring it! The harmful side effects of new technology are not necessarily larger than they were centuries ago, but today our science forewarns us of them. This should be cause for celebration, not alarm.

4. As we have seen that our actions have wider consequences, we have been willing — gradually and with a lag — to assume responsibility for those actions over wider stretches of space and time. Modern science, by deepening Man's vision of the interconnectedness of things, has greatly enlarged his moral horizons. It has made Man a more thoughtful, hence a more moral, creature. Twentieth century man cannot treat the Stranger — the person outside his tribe — with the same moral indifference that earlier ages did. As in all history, actions fall far short of moral professions. But this gap is precisely the source of many of the "problems of technology." They are problems because we are willing to assume responsibility for a broader range of consequences of our actions than our predecessors were.

And next, I should mention the most basic point of all, which tempers both optimism and pessimism in our estimates of future change.

5. Man's basic satisfaction with his condition always adapts itself to what he perceives is possible. When the world shines on him, his aspirations grow; when he faces a bleak environment, he trims his

hopes to it. Social change in general, and technology in particular, may enable us to feed everyone well, to clothe them, to keep them in reasonable health, to protect their freedom and dignity, to give them opportunity to engage in productive activity. These are highly desirable social goals, which we should pursue vigorously. We should not confuse them with that elusive target we call "human happiness."

For a long time to come, I think we can be satisfied with trying to move toward a world in which fewer people live in hunger, fewer suffer the violence of war and crime, fewer are denied basic freedoms, and fewer are treated degradingly by the laws or social customs of their society. When we have come close to these goals, it will be time enough to worry about more subtle questions of the quality of life, and about Man's capacity for happiness.

Federal Science Advisory Channels

We are familiar with the ways in which new technology enters our society and our lives through the marketplace; how business concerns take up new products and new manufacturing processes and introduce them into the flows of commerce. We are all aware of the new products that have so profoundly changed our world and lives: the automobile and airplane, radio and television, antibiotics and pesticides, the computer.

It is less obvious how scientific knowledge flows into the policy-making processes of our political and governmental institutions. That is my main topic here today. I am going to proceed largely by example, for I don't have any body of general theory to propose. And I hope you will excuse me if most of the examples are drawn from my own limited experience in these matters. I don't want to exaggerate my own role in the process, which has been very modest; but most of what I know about it comes from my involvement in it — in recent years, mainly at the National level.

Policy making is the particular domain of the Congress and the President. Of course that is only approximately true. The Supreme Court makes policy, very important policy, and so do such Federal regulatory agencies as the Federal Communications Commission or the National Labor Relations Board. Nevertheless, I will limit myself to policy in the law-making process. Finally, I will not be concerned with policy **for** science, as when Congress appropriates money for scientific research to the National Science Foundation, deliberates about the adoption of the metric system, or considers changes in the patent laws. Rather, I will discuss situations where the wisdom of a law or policy rests to an important degree on highly technical considerations.

The debates about the ABM, the anti-ballistic missile, for example, were debates about our national defense, but the wisdom of deploying a missile system hinged on whether the system could be made to operate reliably and whether it would in fact provide an effective defense against enemy attack. These are scientific and technical questions, not political ones, yet they cannot be separated from the basic question of policy.

The supersonic transport, SST, is another example. Whether it was wise for the United States to pour billions of dollars into the development of such a plane (as the British and French now have into the Concorde) depended on one's estimate of what payload it would be able to carry, and how serious would be its environmental damage in the forms of excessive noise and threats to the chemical equilibrium of the upper atmosphere. These are technical matters, and sufficiently speculative ones that even the scientists and engineers can disagree about them.

If philosophers were kings, or in the more modern version, if scientists were Congressmen, there would be no problem in bringing scientific evidence to bear on questions like these. But most legislators are lawyers, not scientists. There are good reasons for this. One of the most important ones is that a lawyer can go back to his practice to earn his living if he fails to get reelected. It is not so easy for a scientist or an engineer to move out of or into a job with the rise and fall of his political fortunes. So there are very few scientists in our legislative bodies — only a handful in the present United States Congress — and the Congress must look outside itself for information and advice on scientific matters.

Traditionally, the Congress has turned to two sources when it needed help in such matters. One source was committee hearings, where it could call on the testimony of scientists and other technical people. The other was expertise in the Federal departments themselves, some of which employed considerable numbers of scientists: such agencies, for example, as the Department of Agriculture, the Geological Survey, the U.S. Forest Service, and the Bureau of Standards. More recent additions to this list, of special relevance to my story here, are the Environmental Protection Agency and the Energy Research and Development Administration.

Congress does not always trust the information on scientific and technical matters that it receives from departments in the executive branch, especially when — as has been true since 1969 — the President and a majority of the Congress belong to different political parties. This has led Congress to look for experts of its own. The Library of Congress serves as such a resource, although its capability in science and technology has never been large. Within the past several years, the Congress has also created its own agency for Technology Assessment, headed by former representative Daddario who, though not a scientist, was very active in science policy matters when he was a member of the House.

The President, too, has not always wanted to rely on the executive departments for his scientific advice. This might seem surprising, since science and technology are supposed to be neutral, and free from value biases. That is perfectly true, but it does not mean that, in the application of science to public affairs, it is always, or even usually, possible to divide

10

the technical issues sharply from the value issues. This is especially true (as in the ABM and SST examples mentioned earlier) when the facts are not firmly settled and competent and honest technicians can disagree among themselves.

Presumably, the answers of scientists can be trusted if they are asked to give their best estimates of the speed of light, but estimating how large a payload a plane of highly unconventional design, like the SST, will be able to carry is a different matter. An engineer who, for whatever reason, wants to see such a plane built might honestly arrive at an estimate twice as great as an engineer who was worried about the possible damage the plane could cause to the environment.

It is reasonable to predict that someone who is committed to a particular course of action will tend to resolve uncertainties in favor of that action, and he will do that without any intent to deceive or any awareness that he is doing so. Of course, I do not mean that technical people are never guilty of bias or deception; I simply want to emphasize the important fact that the slanting of conclusions can and will occur even without intent to deceive. For that reason, a President (or a Congress) is prudent in seeking advice on technical matters from outside the agencies that are already involved in such matters. From the Eisenhower administration until nearly the end of the Nixon administration, the President's chief independent source of scientific and technical advice was the President's Science Advisor and two small organizations in the Executive Office of the President associated with him: the President's Science Advisory Committee and the Office of Science and Technology. The first of these, PSAC, consisted of about fifteen prominent scientists, serving on a part-time basis, who met for several days each month as a committee, and also set up numerous panels to deal with specific problem areas. The second of these, OST, consisted of about thirty or forty government employees who represented the White House in science policy matters within the executive branch, whenever these matters required interagency coordination, or when the President needed a representative who was independent of the agency position.

I have not quite finished listing the resources to which Congress and the Executive Branch turn for technical advice. There remains the National Academy of Sciences and its affiliated National Research Council. The Academy is not a government agency, although it operates under a charter granted by Congress. It is a self-perpetuating body of about one thousand of the Nation's most distinguished scientists, elected for their scientific contributions. Under its charter, the Federal government may turn to it for advice. The Academy, in turn, exercises direction over the National Research Council, which is too complex an organization to be described in detail here, but which can simply be regarded as the executive arm of the Academy, providing staff services for the Academy committees that do the actual advising. In its advisory activities to the government, the NAS-NRC does not rely solely, or even mainly, on the

11

members of the Academy, but call on the whole body of the nation's scientists and engineers, thousands of whom serve on one or more of the advisory committees in the course of a year.

So here is the whole confusing picture of where the advice comes from — at least the formal, official channels. The executive departments have important scientific capabilities. The Congress can hold hearings, can turn to its legislative reference service in the Library of Congress, or can use its own Technology Assessment Staff. The President had (I will come to the past tense of that verb in a moment) his science advisory structure in the White House, and both Congress and President could seek advice from the National Academy of Sciences.

Protecting the Environment

But these dry facts about organization are not very interesting, except to show, if you need that demonstration, that Washington is indeed a labyrinth. The sketch of organizational structure is simply a background to the story I want to tell of how scientific information was brought to bear on the problems of protecting our environment. As far as I know, no one has written the history down. My account of it will be personal rather than scholarly. I am sure that professional historians will someday come along and straighten out the facts. This is the partial view of someone who lived through part of it.

I suppose there has never been a time, at least in this century, when some small minority of persons did not have a special concern with the environment, and what man was doing to it. I recall that in my boyhood, the conservation of our timber resources was a prominent environmental issue, and a little later, municipal sewage treatment to restore the purity of our water supplies. During the years of the drought that created the southwestern Dust Bowl, soil conservation became an issue of major importance. But it cannot be said that any one of these issues held for long the center of the political stage, or that they merged into a general concern with the environment.

The Environmental Movement, with capital "E" and "M," apparently did not start in government circles at all, nor, for that matter, in the community of science. It began when a talented writer, Rachel Carson, herself not a scientist, published a series of articles in the New York Magazine and then in a book entitled, **Silent Spring**. The prospect of a birdless world produced by indiscriminate use of DDT and other insecticides somehow produced great alarm — I will not say in the whole public, but in a large number of persons to whom the world of nature mattered intensely. Perhaps there were other stirrings of concern at the same time, and Rachel Carson's book simply resonated with sentiments that were already abroad. It is always difficult to trace the origins of a popular movement; and especially to know whether its visible leaders

were actually initiators or only guides of a tour that had already picked its destination and was started on its way.

A problem is not really a problem until it is on the public agenda — until we notice it, until it pricks enough so that we give it priority in our attention over other problems. At any given time, there is an enormous number of problems to which our society could attend. There is a story of an air force colonel who was presented with a new problem of spare parts supply for his aircraft. "Problems," was his reply, "What do I need with new problems? I've got old problems I haven't even used yet." Rachel Carson's book started, or accompanied, a chain of events that put the environment on the public agenda.

The next part of the story with which I am familiar took place within PSAC, the President's Science Advisory Committee. A panel on environmental problems was set up within PSAC, and that panel set about preparing a report that apppeared about 1967 with the title, **Restoring the Quality of our Environment.** The chairman of the panel, and principal author of the report, was a Princeton mathematician and statistician named John Tukey.

The PSAC report did not attempt to recommend a complete legislative program for dealing with environmental problems. It concentrated on identifying and describing the major problem areas: air quality, water quality, pesticides and chemicals, changes in climate, and so on. For each problem area it tried to summarize what was known, scientifically, about the problem, and to highlight priorities for attention. A further important characteristic of the report is that it was not directed just to the President, making recommendations for his personal action, but to the entire Federal establishment.

If it is hard to tell whether a book like **Silent Spring** was a cause or merely an accompaniment of a growing concern with environmental quality, it is doubly hard to assess whether a particular report like **Restoring the Quality of Our Environment** brought about the movement of the ponderous bureaucratic machine, or simply accompanied the whole series of legislative and administrative actions on environmental matters that took place within a couple of years of its publication. My own guess is that it had two effects. First, it accelerated matters; it brought about action sooner than it would otherwise have happened. Second, it provided to the new actors, legislative and executive, a set of definitions of the problem, and of the facts relevant to its solution.

It is worth pondering as to how this was brought about. The report of the PSAC panel did not enter any official channels of communication — at least not at first. It was simply a public report, printed by the government and open to public distribution. It could only have influence to the extent that it attracted attention, and it could only attract attention either by virtue of its contents or the reputation of the organization that issued it and its members. The PSAC report did receive attention, and it received it because it was a report on a topic that was already at least in the corner of the public eye, and because it came from a body that was believed to have technical competence, as well as freedom from special interest, in the topics it discussed.

Except in one particular, there is no reason to believe that the report's issuing from the Executive Office of the President had much to do with its reception. That one exception relates to the Office of Science and Technology, which we saw was closely associated with PSAC, both being headed by the President's Science Advisor. It was the job of the OST staff to take the recommendations of the PSAC report, item by item, to determine what federal department or agency had jurisdiction over these matters, and to bring that recommendation to its attention for review, recommendation, and perhaps action. Again, the main mechanism we see at work here is an attention-directing mechanism. If OST told a federal agency that a problem was important, then that problem had to receive some attention from the agency, had to be placed on the active agenda.

I'm going to skip over most of the events that led the Congress to establish the Environmental Protection Agency and subsequently the Council on Environmental Quality, and to pass the Clean Air Act. These were highly political actions, not in the sense that they were unprincipled — I don't know how "politics" has come to be treated as a dirty word — but in the sense that highly controversial issues were involved, both with respect to the content of the Clean Air Act, and with respect to the balance of Congressional and Executive controls over the administrative arrangements.

There is one aspect of the Clean Air Act on which I must comment, however, because it reveals a great deal about the relation of science to policy. One of the most controversial issues that had to be settled was how strict were going to be the controls imposed on automobile emissions. Not surprisingly, the automobile manufacturers held out for more lenient controls than were demanded by the environmentalists. The Muskie committee heard extensive testimony on these issues from both the industry and from scientists outside it. The standards finally arrived at, recommended to the Congress and adopted were considerably stricter than most people, including many scientists and engineers unconnected with the automobile industry, thought could be achieved in the time allowed by the law. The committee was quite aware of this, but took the extraordinary position that where matters of health were involved, technical feasibility was simply irrelevant.

This sounds like Congressional irresponsibility at its worst — if the Congress of the United States does not like the laws of physics and chemistry, it will simply repeal them! But I do not think that is a fair interpretation of what was done. The committee was resolved not to let the automobile industry lie down on the job. Correctly or incorrectly, they thought that the industry would respond more vigorously to a burr under the saddle than to a gentle "Giddap." This was a political judgment that

had nothing to do with science — at least not with physical science, but perhaps with psychology. By hindsight, it may have been a correct judgment, because the mandated standards came close to being met.

The incident is instructive because it illustrates that the statesman must exercise more than just scientific judgment. It is rarely indeed that the scientific fact is decisive for the choice of policy. The legislator must view the issue within a broader framework than that of the technical issues alone. And what seems, especially to the scientist, as legislative ignorance or defiance of fact may actually be a broader statesmanship.

The Death of PSAC

The next set of events I was able to observe at first hand, for I was appointed to PSAC by President Johnson in February of 1968, and asked to serve as chairman for a new panel on environmental quality. There is not much to tell about my panel, except that the situation was entirely changed from the time of the Tukey panel. There was no need for a new public report saying that environmental problems required attention. What was needed now was to see that the new Environmental Protection Agency and other Federal agencies did their jobs, and that the President got good advice when environmental issues arose. It was not easy to bring advice to the President, because the relation between him and his Science Advisor was not then close; and after the Nixon administration took over John Ehrlichman and the staff of the Domestic Council in the White House were not eager to receive advice from anyone.

So I suffered from the usual frustration of someone coming to Washington who thinks he will have an influence on events. I believe our Panel did make some useful inputs into the environmental situation, particularly in drawing up the initial agenda of the cabinet committee on environmental matters that President Nixon maintained for some months. However, it is not my main purpose here to tell you about my adventures in Washington, but only the lessons I learned from them.

Early in the Nixon administration, PSAC became involved in providing advice on the ABM deployment and Federal financing of the SST development. It advised the President not to deploy ABM's and not to subsidize the SST. Neither piece of advice was welcome, because the White House already had a settled policy on both issues. The advice was technically sound, but again I do not mean that the President was wrong in refusing to follow it. Many issues were involved beside the scientific ones. With respect to the ABM, there was the question of the Administration's bargaining position with the Russians — a point much emphasized by both the President and Mr. Kissinger. The SST was a gamble (we thought it was a bad gamble); there was a chance that it might succeed. If the United States abandoned the project while the French and British succeeded with the Concorde, what would that do to our exports of aircraft, much less to our national pride and reputation for technological leadership? The evidence, of course, is not yet in.

At any rate, advisees seldom like advice from their advisors when the advice doesn't fit their own views. Often they also begin to dislike the advisors. You will recall that a whole generation of talented experts on Asian affairs in the State Department was destroyed professionally because they persisted in sending back information — it happened to be correct information — about Chiang Kai Shek's government that their superiors in Washington, and Senator Joe McCarthy, didn't want to hear.

However, one member of PSAC went farther than giving the President unwelcome advice. He went up to the Hill and testified before Congressional committtees on the ABM and SST legislation, opposing the Administration position. This was a little much for the White House staff. PSAC had little access to the President thereafter, and shortly after my term ended, at the beginning of 1972, President Nixon abolished the whole science advisory apparatus in the Executive Office, and turned over its functions to the National Science Foundation. President Ford has had some second thoughts about this, and the apparatus, in a modified form, is likely to be revived this year. But it is not yet clear exactly what form it will take.

I don't think I need draw any lengthy moral from this story — or perhaps I have already drawn it. PSAC performed, during its lifetime, an important function, more important when the Science Advisor was trusted by the President than when he was not. But it is clear that there is no simple or clean separation between policy issues and the scientific consideration that underlie them. When science advises politics, it is very hard for it not to enter politics.

The National Academy Gives Advice

Let me now give an example, which also relates to automobile emissions, of the way in which the National Academy of Sciences provides advice on science and technology. The standards for air quality and automobile emissions fixed by the Clean Air Act were based on very incomplete information about the health effects of such chemicals in the air as carbon monoxide, sulfur oxides, hydrocarbons, and oxides of nitrogen. It simply wasn't known, except in the sketchiest way, at what concentrations those chemicals became harmful to health. The Act provided that the law's standards should be reviewed on the basis of the best scientific evidence. It also provided that the EPA should re-examine the feasibility of achieving the specified limits on auto emissions.

In 1974 the government turned to the National Academy for help with both of these questions. The EPA asked for a study of the technical aspects of the motor vehicle standards, while Senator Muskie asked for a study on the health effects of the pollutants. The Academy, which draws upon the part-time and unpaid assistance of America's scientists, set up a whole cluster of committees to deal with the various scientific aspects of

these questions, and a coordinating committee, which I rashly agreed to chair, to put the whole jigsaw puzzle together. There was a committee on motor vehicle emissions to study the technical feasibility of attaining the standards, the dates when they could be achieved, and the additional costs they would impose on motor vehicle manufacture. A second committee, itself made up of a whole series of subcommittees, was to look at the medical and epidemiological evidence on health effects of each of the pollutants.

But there are very complicated chemical processes in the atmosphere that intervene between the emission of pollutants from autos, and the actual concentrations of those pollutants in the air. These atmospheric processes are as poorly understood as the processes producing the physiological effects of the pollutants. So a third committee had to be established to investigate the atmospheric aspect of the problem. Finally, there was an important economic question, of whether the benefits to the American people that could be expected from reducing auto pollution were large enough to justify the heavy costs, in higher auto prices and possibly greater gasoline consumption, that the pollution controls could impose. So there had to be a fourth committee to deal with the economics of the matter.

I report to you with a certain awe and disbelief that each of the committees and subcommittees was able to produce a report, and that the coordinating committee put these reports together into a set of recommendations that it delivered to Senator Muskie's committee at the end of August, 1974. Now the scientific evidence on certain of the crucial points — for example, the soundness of the standards for oxides of nitrogen — was very incomplete. Not enough was known about either the atmospheric or physiological aspects of the matter to be certain at what levels these materials became dangerous. What position should the committee take? Should it say to the Congressional committee: "We're sorry, gentlemen, we can't give you any advice until the evidence is all in"? That would be like the family doctor saying, "I won't treat you because I can't diagnose your disease." Sometimes, in the face of uncertainty, we want the expert to absorb the uncertainty — to give us his best judgment in spite of his doubts and the inadequate evidence.

Our committee tried to assume that responsibility. We tried both to be honest about the insufficiency of the evidence, and at the same time to make a recommendation that we thought was most consistent with the weight of evidence. When one does that, there is always a danger that his values are going to show through his science — that he is going to respond as an environmentalist, or as a person who is fond of automobiles. We accepted that risk, and we must leave to readers of our report the judgment as to whether we managed to keep our own personal values out of the recommendations.

I'm not sure that we satisfied anyone with our report. The **Wall Street Journal** said it was wishy-washy, and called for "one-armed scientists who would give advice on one side, and not on both sides, of the question. I suspect that they did not so much think our advice to be wishy-washy as that they disagreed with it; for the auto manufacturers, even more unhappy, did not think we straddled the fence at all. But I think we managed also to make the environmentalists somewhat unhappy, in suggesting that the standards on oxides of nitrogen probably could be relaxed somewhat. If the soundness of advice is measured by the number of people who find it unpalatable, then we scored very high marks. On looking back at the report, more than a year later, I find nothing in it that I want to change.

The Role of the Social Sciences

As my last example shows, the problems of air pollution are not only problems of medicine and physics. They are also questions of economics — where can we best allocate our social resources to meet the most pressing human needs? So advice on many scientific and technical questions calls for the economist and the sociologist to participate along with the physicist and biologist. To many people, the word "science" means one of the physical or biological sciences. The study of human behavior, of individuals or social groups, is not always admitted as a scientific pursuit. I do not share that view. My own training is in the social sciences — originally in political science, then in economics, and later in psychology — and I see the same need for, and the same possibilities of, objectivity and clear thinking about human affairs as about animate and inanimate nature.

Fortunately, the view that the social and behavior sciences are, or can be, sciences is being more and more widely accepted by natural scientists. Ten years ago, the social and behavioral sciences were not part of the Federal science advisory apparatus. Except for anthropology and physiological psychology, which are sometimes regarded as biological sciences, they were not included in the National Academy of Sciences, nor in the National Research Council. No members of PSAC were social scientists, and none of the professional staff of OST. Of course economists had their own advisory apparatus in the Council of Economic Advisors. But that body was concerned only with broad questions of economic policy, specifically government monetary, fiscal, and unemployment policy. It was not involved in that whole range of modern problems where technology is entwined with economic and social questions.

All of this has changed in the past ten years. Social scientists are now elected to the Academy on an equal footing with other scientists, and now comprise about ten per cent of that body. They make up one of the major divisions of the National Research Council. They were represented on PSAC during its last years, although that gain may be lost if a new three-member Council of Science Advisors is appointed, as seems fairly likely. The National Science Foundation now funds research in the social

and behavioral sciences on the same basis as in the other sciences. Today it is up to the social sciences to justify the confidence that has been placed in them. It is vital that they do so, for the problems that face our society are more and more social and human problems, or technological problems with a crucial social component.

Conclusion

I have tried to illustrate in my remarks how important it is that the organs of government be able to bring sound scientific information to bear on their policy decisions. I have spoken mostly about the Congress and the President, but my remarks would apply equally to the courts — although the procedures would be somewhat different. We have made considerable progress in establishing advisory organizations and channels of communication, but I have tried to show by my examples that the process is not a simple one, and we cannot expect magic results from it.

Scientific advice for public policy will always be subject to the limits of all advice — the patient will not like to take the medicine if it is bitter, and may even turn against the doctor. The scientist will not be called upon just in those cases where the evidence is clear. Where there is uncertainty, he will have to decide just how much of that uncertainty he should absorb, and how much he should pass back to the political process — and he must be aware of his own biases in absorbing it. Seldom will the scientific issues in a policy problem be separated cleanly from the questions of value; the scientist-advisor will have to work very hard to keep them apart and not to let his expertness stray beyond the limits within which it is genuine.

I said earlier that "politics" is a dirty word in this country. That is unfortunate, for politics is just democracy by another name. In a society where there are many people, not all with identical tastes and interests, there must be processes for negotiating and mediating, for forming majorities. That is what politics is all about: the reconciliation of conflict and disagreement. To reach satisfactory results in our modern, complex, highly technical world, the political process must be informed with scientific knowledge. The best intentions, without knowledge, will not solve social problems.

There are many channels, some formal, some informal, through which scientific and technical information can flow into the political process. I have tried to illustrate some of them, ranging from Rachel Carson's commercially published book to official positions like the President's Science Advisor. But for the information to flow, the information must exist. There are still many fields, like air quality control, where the limits on reaching sound decisions are more the limits of the scientific knowledge itself than limits on the willingness of the political process to listen to the voice of science.

And so there is an important role for the scientist as a participant in the political process. His is a specialized role, not a substitute for the role of the politician. But he must learn to work with the politician, to respect him, to understand his problems, to understand the division of labor between the two of them. The scientist who does this effectively can accept with pride the label of "science politician." It is an honorable label for a citizen of a democracy.

HERBERT A. SIMON is Richard King Mellon Professor of Computer Science and Psychology at Carnegie-Mellon University. He is widely known for his publications, particularly his book, Administrative Behavior.

He is a member of the National Academy of Public Administration and the National Academy of Sciences. A graduate of the University of Chicago, Simon has received honorary degrees from Yale and other universities in this country, Canada and Europe.