Scientists and American Science Policy

Who speaks for science? The future offers more dilemmas than unequivocal answers in science policy.

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The phrase "scientists and American science policy" suggests other comparable formulations: soldiers and American military policy, diplomats and American foreign policy, farmers and American farm policy, businessmen and American business policy, educators and American education policy, labor and American labor policy, and a host of other variations. These parallels serve to remind us sharply of the limitations which a democratic order places upon the role of experts as well as upon special interests in the shaping of public policy. If it can be said, for example, that war is too important to be entrusted to the generals and peace too important to be left to the diplomats, then it may be asked whether science policy is not too important to be delegated wholly to the scientists. In a democratic order all policies of significance must secure a wide range of consent, not merely from the general public but also among the many organized groups and institutions that see their interests importantly involved. Scientists do have a special involvement in science policy, but under the rules of a democratic society they have no monopoly in its development or maintenance, nor have they inherently any greater legitimacy or relevance as participants than all the other claimants who aspire to influence the content of science policy.

Scientists, we may assume, aspire to be influential as a group in the determination of public policy over a wide range, especially those elements of public policy which may be described as "science policy." To exercise such influence the scientists must enter the political arena. Scientists in politics encounter the questions posed by the political process to all those who enter: who are they? who speaks for them? what are their goals? what are their strategies?

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Who Are the Scientists?

If scientists are to be influential participants in constructing an American science policy, they will need to be self-conscious participants—that is, they must have a visible and concrete identity. That identity is now vague and elusive—to many scientists as well as to the other groups involved in the policy process. "The scientific community," a phrase often submitted as an identification, is a world of uncertain boundaries.

Who are the members of the scientific community? Is it an open community, hospitable to all who desire to enter, or is it open only to those who meet severe tests of eligibility? More specifically, are there "hard scientists," whose membership is taken for granted, and "soft scientists," whose credentials are dubious? Are physicists and chemists members of the scientific community by right, while other natural scientists must submit additional claims for admission? Do all engineers qualify, or only certain types of engineers? Do doctors of medicine have entry, or only research scientists in medicine? Are social scientists full members of the scientific community? The answer of the moment appears to be that the natural scientists are the most fully accredited members of the science community but that the life scientists and the social scientists regard this as a transient condition of affairs.

The difficulties raised by these questions suggest that "the scientific community" is most often used as a strategic phrase, intended by the user to imply a large number of experts where only a few may in fact exist, or to imply unity of view where disagreement may in fact prevail. The phrase may thus belong in that class of invocations, so familiar to the political process, which summon up numbers and legitimacy for a point of view by asserting that "the American people," or "the public," or "all informed observers," or "the experts" demand this or reject that. There is nothing especially astonishing about this, since all participants in the political process indulge in the stratagem, and each participant learns to discount the claims of others, but there may be ground for mild surprise that the code of science permits its extensive use by scientists either as deliberate strategy or in genuine innocence.

If scientists are themselves uncertain as to who all their fellow scientists are, then some ambiguities attend their relationship to American science policy. Are they a small elite group (for example, the approximately 96,000 named in *American Men of Science* for the physical and biological sciences), or do they number several million (as they do if the engineers, the social scientists, and the medical profession are included)? If scientists want to be among the shapers of American science policy rather than simply the objects of that policy, then they must expect these and similar questions from the other participants in the making of science policy. The spokesmen of science will be asked: For whom do you speak? The scientists themselves confront a prior question: Who are to be the accredited spokesmen for the scientists?

Who Speaks for the Scientists?

The notion of an American science policy, a policy with which the scientists are to be influentially identified, requires the scientists to have leaders who can act as their representatives in that bargaining with public officials and other groups which accompanies the policy-making process. Not every scientist can participate directly in this

process; there is not room enough, nor time enough, for a town meeting of all the scientists with all the other groups that have equally legitimate claims to be present. Some few scientists must be selected to speak for the many, but the scientists may choose these few in many different ways. They may let the science spokesmen nominate themselves; they may let nonscientists select the leaders of science; they may develop nominating and electoral devices for choosing their leaders through the votes of all scientists in a single scientist constituency; they may choose their leaders in numerous specialized constituencies; or they may combine these methods in various ways, or invent still other methods.

Tradition and recent practice have already provided some important patterns of choice. The history of American science is rich with examples of the articulate, self-directing, individual scientist of high prestige who felt it his obligation to speak often and boldly in behalf of science and the scientists. Few scientists, and fewer nonscientists, have been inclined to question his representative role, although his peers in prestige and self-confidence have often publicly challenged his advice. Another pattern has been provided by the habit which high-ranking government science officials have of speaking, from their position of special eminence and authority, for the interests of science as they perceive them; this would seem to be, for example, the primary function of some government science advisers and advisory committees. If these advisers are the spokesmen of the scientists, it is relevant to ask: What role did which scientists have in choosing them? Still another pattern has been demonstrated by the role of the National Academy of Sciences since 1863. This quasi-governmental body of scientists, its membership small and its new members elected on the basis of scientific eminence by those who are already members, has for many decades acted upon the assumption that it could and should speak for the scientists in the realm of public policy. The scientists who are not members of the academy have not invariably agreed that the academy spoke for them, or that its silence was to be taken as neutrality on their part on contemporary issues of science policy.

These patterns of individuals and small, elite groups, some self-nominated and some the designees of government officials, speaking for the scientists have been accompanied by several efforts to establish more comprehensive scientist constituencies from which spokesmen might be chosen. The American Association for the Advancement of Science is the most durable of these constituencies. Its own membership is large, and its affiliated societies enlarge its base. Its officials, and especially its committees and its journal *Science*, often speak eloquently for the values and the priorities of science and the scientists. One of the most dramatic assertions of its representative role as spokesman for the scientists was its 1958 Parliament of Science, assembled in Washington, to consider the proposal for a government department of science and other issues. Some privacy surrounded the identity of the delegates to this "parliament," the method of their selection as representatives of the scientists, the record of their deliberations, and the extent of their agreement upon the terms of the published report of the "parliament." The sense in which the AAAS and its "parliament" are authentic spokesmen for the scientists as a scientific community thus cannot be easily determined, either by scientists or nonscientists. The Federation of American Scientists provides still another variation—an association of scientists quite explicitly committed to participation in the political process.

But the most prevalent pattern for choosing the spokesmen of the scientists is provided by the specialized associations of scientists. The officers and committees and journals of the American Physical Society, the American Chemical Society, the American Institute of Biological Sciences, the Federation of American Scientists, the Engineers' Council, the Association of American Geologists—and perhaps a thousand other specialized societies—provide the scientists with hundreds of spokesmen in their specialized areas of interest. These spokesmen do not often speak with one voice upon a given aspect of science policy, nor do they often if ever concern themselves with the elements of a comprehensive science policy. Instead, the leaders of each specialized society tend to express their views upon that segment of science policy which touches significantly the interests of the society's own members. As spokesmen for the scientists, their voices are often competitive, emphasizing separate priorities, asserting specialized rather than general goals. In this characteristic the associations of the scientists share the pluralistic, fragmented, and internally competitive attributes of the other group participants in the American political process —whether political parties, business, labor, agriculture, the professions, nationality groups, or the governmental bureaucracies.

The leaders of still other groups often speak confidently in policy discussions as surrogates for scientists. The Association of Land Grant Colleges and Universities, the American Association of University Presidents, science laboratories and institutes, and the science communication media are prominent among these groups. Do they, too, hold a watching brief for scientists by the scientists' own choice?

Who, then, speaks for the scientists? The answer would seem to lie somewhere in a broad zone of ambiguity. Only the scientists themselves can identify their authentic spokesmen. If they have already done so, it would seem to have been done privately and to have been kept confidential. When and if the scientists undertake an explicit identification of their spokesmen, it is not improbable that they will conclude that no one can speak for all of them, and that in a democratic society we will all, perforce, continue to be confronted by numerous, competing spokesmen for science, each often claiming to speak for more of the scientific community than he in fact represents.

An American Science Policy

Uncertainty thus surrounds the questions: Who are the scientists and who speaks for them? Ambiguity also characterizes the phrase "American science policy." It is not difficult to cite examples of particular science policies; these exist in abundance—from the patents clause of the Constitution to yesterday's progress reports of the National Science Foundation. But the unity and comprehensiveness implied by the phrase "American science policy" are not achieved by merely consolidating and codifying all these separate items of science policy. Something more than this is quite clearly implied and evidently desired by many of those who speak for the scientists. It may be assumed, then, that an American science policy is something aspired to but not yet achieved by the scientists: a unified, comprehensive, coherent, rational statement of goals and methods for science

in the United States, accepted by and binding upon all the participants in the policy process, and including agreement upon the rules by which the policy may be changed.

The main elements of such a policy might include the following.

1) A preamble, asserting the values of science to society and the nation; a statement defining the boundary line between the governmental and the private sectors in science.

2) A statement of the priorities for science in each of these sectors.

3) A ranking of the competing claims of science education, basic research, and applied research, as well as an assignment of priorities among the fields of science—chemistry, engineering, physics, biology, psychology, economics, and perhaps a score of others.

4) A statement of agreement and action upon the structure, location, and assignments of the science agencies in the Executive branch—for example, a unified science department (or, alternatively, decentralized science agencies) and the relation of such a department or such agencies to the President and the Congress.

5) Explicit statements of governmental procedures intended to reflect the values of scientists in such matters as secrecy, personnel loyalty and security, government contracts and grants for research, definitions of "basic" research, and provisions concerning the "chain-of-command" in science activities, including protection for the autonomy of individual scientists.

If such a body of public policy existed, accepted by the scientists and legitimatized by the President and the Congress in a statute, thus attesting the consent of the nation, then an American science policy in the fullest implications of that phrase would have been established.

Is such a unified and comprehensive policy a feasible goal for American scientists? Do they in fact desire it?

If a 1961 Town Meeting of Science were to be assembled, despite the problems of deciding which scientists were eligible to attend, agreement could no doubt be reached on the preamble to an American science policy. Preambles, like political party platforms, are usually triumphs in ambiguity. A viable consensus could probably also be reached on item 5—the "working conditions" for scientists—although ambiguity would overshadow precision here, too. But beyond these two items the available evidence suggests that there are no other major elements of an American science policy upon which one could expect unanimity, or even a clear majority agreement, among the scientists themselves. The document which might emerge from the work of such an assembly of science would most likely be an unstable mixture of vague agreement and sharp minority dissents, a testament to the pluralism of science and the scientists. And if the scientists are not likely to agree upon a unified science policy, the prospects that the nonscientist participants might develop such a policy are even less convincing. There are no apparent powerful incentives for any other great interest group in the American society to develop a unified, comprehensive science policy. And even if agreement were possible among the scientists, there is no persuasive evidence that they could win consent without major concessions to the competing claims of all the other interests that must, in a democratic order, agree to such a significant allocation of social values and resources.

Unity and comprehensiveness are thus not likely to be the hallmarks of American science policy. Talk of a single, comprehensive "American science policy" has an essentially fictitious quality. There will be many science policies, rather than a master science policy. Diversity, inconsistency, compromise, experimentation, pulling and hauling, competition, and continuous revision in science policies are more predictable continuing characteristics than their antonyms. This has been the history of American science policies and this describes their present state. We are accustomed to view this state of affairs as deplorable. But to live with diversity and accommodations of policy, and yet to be impatient of them, may be the process by which a democratic society achieves progress in science as well as in other fields. In any event, the future seems to offer American scientists more dilemmas than unequivocal answers in science policy.

Persisting Dilemmas for Scientists

Some of these dilemmas may be illustrated by a brief exploration of a few of the choices concerning governmental arrangements for science—choices which some scientists have helped to make in the past, or which nonscientists have made for them, and still other choices which must yet be made.

Science advisers. One of these choices involves the aspirations of scientists to give advice to officials at the highest levels of the national government—advice not simply in an area defined as "science policy" but also concerning those elements of foreign policy, defense policy, and domestic policy to which many scientists believe their specialized knowledge is relevant. These aspirations of scientists were reflected in the establishment of the National Academy of Sciences a hundred years ago and in the creation of the National Research Council almost fifty years ago. They are reflected today in the existence of the office of Special Assistant to the President for Science and Technology, the President's Science Advisory Committee, the office of Science Adviser to the Secretary of State, and the General Advisory Committee of the Atomic Energy Commission. The Council of Economic Advisers is still another example.

Attempts to define the role of these advisory institutions raise several important questions. Is their primary responsibility to advise the officials as an autonomous voice of the scientists, or are they, as agents or colleagues of the officials, to explain official policies to the scientists, or are they to participate in working out those accommodations in policy which will build a bridge of collaboration between scientists and officialdom? The history of these institutions of advice reveals the tensions, as well as the temporary adjustments, between these inherently competitive conceptions of the advisory role. For the scientists the dilemma remains unresolved: an autonomous science adviser is soon at the periphery rather than at the center of policy making; an involved adviser is soon the advocate of all official policy rather than its critic, an ambassador from the officials to the scientists rather than the scientists' spokesman, or at best a broker between the scientists and the officials. The scientists who are dismayed by these hard choices may perhaps find some consolation in knowing that all other groups in a democratic order confront similar frustrations.

A department of science. Another choice involves the recommendation for a unified department of science, or for a department of science and technology. This proposal to concentrate most of the talents and other resources of the scientists in a single agency,

and "to give Science a voice at the Cabinet table," is a strategy supported by the precedents of comparable aspirations in agriculture, business, and labor. But the proposal encounters today, as it has since John Wesley Powell advocated it before the Allison Commission in the 1880's, the stubborn pluralism of the scientists themselves, the uncertainties of the scientists about the boundaries of their interests, and the opposition of government scientists more willing to endure their existing, familiar organizational environment than to risk the unknowns of a new and untested arrangement. With the scientists thus embattled among themselves, neither the nonscientist interest groups nor the public officials now seem likely to take a determined initiative on a question the scientists, as such, cannot decide. A department of science, then, waits upon the unlikely event that the scientists will soon be able, and will find it desirable, to decide who they are, who their accredited spokesmen are, and what their common goals are, and, most important, able to conclude that they are sufficiently unified to risk their separate interests to the leadership and fortunes of a single government institution.

An autonomous science agency. An alternative choice—the creation of an autonomous science agency, but with a limited assignment—has been at least temporarily decided upon. The National Science Foundation has completed its first decade; its durability now appears convincingly demonstrated. The independence of the agency from the supervision of officialdom is not as great as was hoped for by those spokesmen for the scientists who piloted the proposal through the hearings, the amendments, the debates, and the votes of the 79th and 80th Congresses, past the shock of a Presidential veto indicting excessive autonomy, to the eventual compromise enacted by the 81st Congress. Some of the form, and more than a little of the substance, of autonomy was lost along the way. Annual budgets and annual appropriations are continuing reminders that autonomy is limited, even in decisions about kinds and amount of basic research, and even after sputniks gave the agency higher priorities and the scientists greater authority.

A close look at the composition of the National Science Board since 1950 also raises the question of whether the agency does not more nearly reflect the autonomous voice of university and other administrators of science, alumni from the ranks of scientists though they be, than it does the voice of scientists in the classrooms and laboratories. The task of representing the scientists on the Board has apparently, with the passage of time and with the entry of Presidential and other preferences, been entrusted more to surrogates for scientists than was the expressed expectation of the sponsors and the officials in the discussions accompanying the passage of the National Science Foundation Act of 1950. Surrogates perhaps provide "virtual" or "existential" representation for the scientists; other groups in American society must often accept a similar settlement.

Specialized science agencies. Most existing government science organizations represent a different kind of choice for scientists. These science agencies are immersed in the political system of a large department or "independent" agency, the degree of autonomy of the science unit in that system varying widely. The life scientists, for example, occupy many special units in Agriculture, in Health, Education, and Welfare, and in Interior; the nuclear scientists are found in the Atomic Energy Commission, and other physicists and chemists, in the Bureau of Standards; meteorologists staff the Weather Bureau; scientists of many varieties inhabit Defense Department units; while the geologists have their sanctuary in the Geological Survey, the space scientists have theirs in the National Aeronautics and Space Administration, and the economists have theirs in the Council of Economic Advisers. The other social sciences are less visibly accommodated, but they do staff numerous units in Agriculture, in Commerce, in Health, Education, and Welfare, and in Labor.

The leaders of all these science units have links, strong or attenuated as the case may be, to the associations and institutions of scientists outside the government, but inside the departmental or agency system they share the powers of decision and compete for priorities with other members of the executive hierarchy, and they report to congressional committees whose concerns are not confined to questions of science or the preferences of scientists. In these many science enterprises the scientists are partners with nonscientists rather than autonomous decision makers. They may employ the *mystique* and the *expertise* of science as strategies to maximize their autonomous role, but they cannot realistically expect to be more than senior partners. Most frequently they will be compelled to accept the status of equal partner with nonscientist officials; not infrequently they will find they are actually junior partners. Their hopes for autonomy are, in practice, curbed not only by nonscientist officials in the executive hierarchy and by congressional committees but also by the activities of the interest-group associations in the science bureau's own special constituency. Thus, the Bureau of Mines must listen attentively to the American Mining Congress and the United Mine Workers; the Bureau of Standards, to many industry associations; the Weather Bureau, to the Air Transport Association and the Farm Bureau Federation; the Public Health Service, to the American Medical Association and the American Cancer Society; NASA, to the aviation industry associations; the Atomic Energy Commission, to the electric power associations and many contractor groups; and agricultural research bureaus, to the Cotton Council and numerous other commodity associations. Rare is the science bureau which is not required by its political environment to bargain continuously with, and accommodate its aims and its priorities to, the interest groups in its constituency.

Advice to Congress. Science agencies in the Executive branch have occupied most of the attention of scientists. If they are to pursue their aspirations for a more distinctive and influential role in science policy, the scientists will find it necessary to formulate a general strategy concerning advice to Congress from scientists. No congressional committee is now organized and staffed to give exclusive and comprehensive attention to science policy and to listen continuously to scientists, although the House Committee on Science and Astronautics takes a broad view of its science role, and its Senate counterpart may follow suit. Most scientists must pursue their congressional interests across almost the whole range of committees and subcommittees in both Senate and House. If unity and comprehensiveness in congressional action on science are desired—unity such as is sometimes proposed for science in the Executive branch—scientists will be required to choose among several apparent alternatives: they can propose

a joint committee on science and technology, with a wide-ranging jurisdiction over all the concerns of scientists; or they can propose a comprehensive committee on science and technology in each House, rather than a joint committee; or they can aim at the creation of a joint committee on science policy with a more limited assignment, or of such a committee on science policy in each House. If changes like these were to be made in congressional science committees (an event to be anticipated only after long and determined effort), the scientists still could not expect to enjoy a monopoly of attention from the new committees. Those other groups who now share power with the scientists' spokesmen in the numerous specialized committees and subcommittees would follow the scientists into the new arenas of influence. The scientists might, however, hope to have, at least for a time, higher status and legitimacy as spokesmen before such new committees, and they might also hope that their competitors in the new setting might compete with each other as well as with the scientists. The question which would soon confront the scientists, however, would be, could they establish and maintain their own unity of goals and priorities before the new committees? The odds in favor of an affirmative answer do not seem to be high.

Politics Inescapable

Scientists influential in the creation, maintenance, and modification of American science policy are scientists in politics. The spokesmen for the scientists need not be party officials nor candidates for, or occupants of, elective public office, but they will have to be active participants in other phases of the political process—as high government science officials, as science advisers to executive officials, as spokesmen for science policies before committees of Congress, as organizers of opinion through the communication media, as officials and leaders of science associations and institutions. The leaders of the scientists cannot escape politics and remain leaders in science; since their leaders cannot escape politics, the scientists as a whole are in politics too—even their silence is interpreted as acquiescence.

Leading American scientists have long entered the political arena with boldness and success. Convincing examples are provided by the zeal and skill with which the Scientific Lazzaroni piloted the National Academy of Sciences through the Congress and secured Lincoln's signature in 1863; by the subtlety and determination with which Powell secured the establishment of the Geological Survey in 1879 through an appropriation bill rider (a technique that is of the essence of politics); by the frequency with which the Cosmos Club has served as the meeting place of an informal caucus of scientists planning the strategy for a scientists' *coup d'état* in the public interest; by the magisterial role of Vannevar Bush in national science policy; by the sophistication of the Federation of the Atomic Scientists in their 1946 attack upon the May-Johnson bill and their shaping of the terms of the McMahon Act.

Scientists in politics share the problems of other participants in the political process. No special dispensation exempts the scientists from the hard choices and continuing difficulties which the political process imposes upon all those who aspire to shape public policy. One course is to seek to maximize the unity of all scientists and to establish legitimacy for the spokesmen of a unified science community. An alternative is to accept diversity and competitive priorities among scientists and to establish the identity of the separate groups of scientists, establishing the legitimacy of their respective spokesmen. Whichever of these two main roads is chosen, the united or the separated scientists will face the necessity of recruiting allies from among organized groups of nonscientists; the scientists cannot exercise a unilateral dominance in the making of science policy. Alliances are created and maintained at a price; the price takes the form of mutually acceptable accommodations in policy or priorities. Scientists in politics meet with varying fortunes in the process of bargaining with allies and opponents: in the Bureau of Agricultural Economics they find an environment too severe for survival; in the National Institutes of Health, an embarrassment of riches; in the Weather Bureau, high-velocity cross-winds of pressure; in the Geological Survey, an atmosphere of quiet and modest benevolence which has existed for a half century, since the belligerent initial decades; in the Bureau of Standards, a favorable equilibrium of forces, but in the Public Health Service, an unsteady equilibrium. Such variations are the common experiences of most participants in the political process. The conditions which determine the range of variation are best understood, anticipated, and managed by those who are politicians—that is, by those who are expert in the political process.

The 1958 Parliament of Science states the scientists' hopes and fears in persuasive terms.

> This scientific revolution will totally dwarf the Industrial Revolution and the other historical instances of great social change. It will be more compelling, and will pose more urgent problems, because of both the pace and the magnitude of the changes which now impend.
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> What faces man is not, in any restricted sense, a scientific problem. The problem is one of the relation of science to public policy. Scientific issues are vitally and almost universally involved. The special knowledge of the scientist is necessary, to be sure; but that knowledge would be powerless or dangerous if it did not include all areas of science and if it were not effectively pooled with the contributions of humanists, statesmen, and philosophers and brought to the service of all segments of society.
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> What is to be done? Scientists certainly have no arrogant illusion that they have the answers. But they do want to help. They are, moreover, convinced that the time is overripe for a more understanding collaboration between their special profession and the rest of society.

The scientists are now inescapably committed to politics if they hope to exercise influence in the shaping of public policy, including science policies. The leaders of the scientists, then, are perforce politicians. As politicians in a democratic order, they are effective in the degree to which they understand the political process, accept its rules, and play their part in the process with more candor than piety, accepting gladly the fact that they are in the battle rather than above it. The spokesmen for science have occasionally lectured the nonscientists, sometimes sternly, upon their obligation to understand science. Perhaps the advice may be reversed: the scientist has an obligation to understand, and to play his significant role forthrightly in, the polity (*1*).

Note

1. In the preparation of this article I have drawn upon the bibliography given below and upon data developed through an extensive series of interviews with science officials in Washington during 1959 and 1960 and from a study of pertinent official and unofficial documents—a project supported in part by the Council for Atomic Age Studies, Columbia University.

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Harry H. Goode, System Engineer

Harry Goode was born in New York City 1 July 1909. The vigor and the alertness to intellectual challenge that characterized his whole life provided very early the motivation and drive that made a university education possible, in the face of difficulties that would have discouraged a lesser spirit. His bachelor's degree in history from New York University, granted in 1931, came just at the beginning of the depression years. During some of those years he was employed as statistician for the New York City Department of Health, for which he became statistician-in-charge in 1941. At other times, like many other young men in those difficult times, he turned informal talents to advantage—he found himself a good shoe salesman; he was for a while a part-time editor; and he not infrequently played a dance-band saxophone for both pleasure and profit.

To another the Department of Health statistical work might have seemed routine, but to him nothing was ever routine. He discovered, for example, a large number of cases of advanced illness which could have been corrected had the patient seen a doctor earlier. Because of a shortage of physicians available for the department's work, the patients had been unable to see a doctor sooner. By elementary statistical techniques (he would never use sophisticated mathematics where elementary or heuristic techniques would suffice) he was able to show conclusively that the effectiveness of the department would be greatly increased if the physicians would see more people and spend less time with each. His recommendations to this effect were not well received because of the risk of an occasional wrong diagnosis. A lesson from this experience he never forgot: that systems have people and people have prejudices.

During this period his characteristic breadth of interest and motivation toward tangible value for society in anything he might do directed his attention to engineering. He attended night school at Cooper Union and graduated with a Bachelor of Chemical Engineering degree in 1941. This educational venture, combined with his experience as a statistician, brought the realization that for him the enduring intellectual challenge would be in applied mathematics, which he then began to study at Columbia University, receiving the M.A. degree in 1945. He started a doctoral dissertation in statistics under Abraham Wald (on the distribution of noncentral t), but the evident importance of the scientific and professional work that was by then engaging his attention drew him away from work for the doctorate, which he ultimately bypassed completely, in that his achievements without the degree carried him far beyond the accomplishments of most people who hold it. These later achievements suggest that, at least in Harry Goode's life, the wide range of intellectual interests covered in his three distinct and contrasting experiences of higher education, together with his exposure to human and social problems in the New York City Department of Health, provided a richness of early experience of much greater value in preparing him for a life work in systems study than could have come from any intensive concentration in a narrow specialty.

Between 1943 and 1945 he and another young mathematician, Leonard Gillman, were the principal staff of a special project for Tufts College for the Navy's Special Devices Center. Their work, in an office in New York City, would today be called "operations research," but that term was not yet in wide use. For example, they set up a scoring system for a gunnery trainer and included the concept, sophisticated for that time, that the value of a hit late in the run should be less than that of one early in the run because the gunner might not survive. Goode and Gillman were an enormously effective team, producing in two years over 100 memoranda and a major treatise on pursuit courses and the mathematics of guidance and interception, which appeared as a 250-page book.

After the war Goode joined the staff of the Navy's Special Devices Center, where he rose rapidly through successive responsibilities to be head of the Special Projects Branch. His work during this period was on flight control simulation and training, aircraft instrumentation, antisubmarine warfare, weapon system design, and computer research. He was among the first to see the great importance computers were to have, and he was instrumental in initiating several major projects, including the Typhoon computer (the world's largest analog computer) and the Whirlwind computer at Massachusetts Institute of Technology, the first truly high-speed digital computer. Understanding the power of computers, he began at this time to formulate some of the principles of what he later called "system engineering," although he later broadened the system approach considerably beyond the computer.

At the beginning of 1950 he came to