GOVERNING SCIENCE AND TECHNOLOGY:
RECONCILING SCIENCE AND TECHNOLOGY
AND DEMOCRACY

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Expenditure levels for federal research and development, the relative budgetary shares to military versus non-military projects, the level of damage to air and water quality that the community is willing to tolerate in the name of economic progress, or rules of informed consent to protect human subjects in scientific experiments are political, rather than scientific or technical judgments. They are political for at least four reasons: they involve questions of values and their allocation; they are made by individuals in positions of authority; they affect the society as a whole; and they accord with the dominant beliefs of major organized interests in society. We call these political judgments public policies.

In practice, these are problem-solving decisions that invariably involve settling disputes stemming from conflicting claims, all of which are, to some degree, valid and legitimate. One such dispute—the claims of autonomy made by those who "do" science and technology versus the demands for accountability from a wide range of individuals and groups who see their interests importantly affected by public choices about the funding and
direction of scientific research and the applications of scientific discoveries—will be explored in this paper.

In examining this dispute, I will propose a conceptual framework that uses the Jeffersonian ideal of direct citizen participation in public affairs and a modern version of a classical two-class system, where one class rules and another is ruled, as the boundaries within which a scheme for governing science and technology democratically can be developed. The line of argument is that science and technology by the people is infeasible, and science and technology without the people is unacceptable. Instead, there is a middle way—a political solution to what Hunter Dupree, in 1957, called "the unsolved dilemma of all attempts at central scientific organization." This political compromise balances the individual interests of scientists and technologists and the collective interests of society. The governing scheme for science and technology that I envision is designed to protect the autonomy of inquiry and preserve the integrity of the principle of social responsibility and accountability.

Indeed, there are a number of individual- and group-level impediments to the democratic governance of science and technology, for example, widespread apathy and scientific and technical illiteracy among the mass public, and powerful, organized interests who wish to maintain the current system of peer review and who are determined to block any moves to increase the quantity or quality of public participation in policy making for science and technology. In the second section of this paper, I will discuss these barriers and propose a set of conditions
that may help remove them and thus ease the tension between the elitism implicit in the philosophical conception of scientific inquiry and technological development, on the one hand, and the pluralism essential to most conceptions of democracy, on the other. These prescriptions serve as preconditions for a more specific scheme for the democratic governance of science and technology.

RELATIONS BETWEEN RULERS AND RULED

For centuries, political philosophers have debated the issue of who should and who does make and put into effect political judgments. In fact, it was over this question of citizenship—the present and future capacity for involvement in political judgments—that Aristotle had some of his greatest differences with his master. In Plato's ideal society, the trained elites—the philosopher-kings—made the political decisions for the community, with the citizen relegated to the position of sharing in the fruits of the Guardians' collective wisdom. Aristotle saw the relationship between rulers and ruled in an ideal society differently, however. As contributors to the civilized life of the polity, citizens were active members of "a community of equals, aiming at the best life possible". And one of the most exacting tasks of the Greek polis was to make legislative and judicial decisions.

That their views diverged on the question of the proper relations between the few and the many is a result of two different conceptualizations of citizenship and the importance of
political knowledge in exercising citizenship requirements. Plato reasoned that only the Guardians possessed relevant political knowledge. Expert knowledge was the preserve of the few; and expert knowledge was the only form of relevant knowledge for making political judgments. What was not political knowledge was either "opinion" or "incorrect belief".

Whereas membership in the Greek polis was not open to women or slaves, one obligation of those who enjoyed citizen status was meaningful participation in making and implementing political decisions. In this manner, areas of agreement among members of the polity were to be determined, and informed judgments rendered. Indeed, in Aristotle's ideal state, because of their diverse experiences, a collective decision by the many who were not experts might be better than a judgment made by the supposedly expert few, for the wisdom of the many was built upon diverse experiences. Thus, these experiences, when pooled, could provide insights not available to the more narrowly trained few.

If Plato distrusted political participation in the ideal state, Aristotle glorified it. Yet both philosophers were well aware that in actual states, those who nominally govern were often controlled by others outside the visible government process, for example, the military or the wealthy. The relative merits of actual states and of competing, legitimate claims to power by several classes within states also puzzled Plato and Aristotle. Questions of the necessary and sufficient conditions of democratic citizenship and the nature of the relations between rulers and ruled have certainly confounded the political theorists who have followed in their footsteps. One way of
differentiating contemporary democratic theorists is according to their various conceptions of democratic citizenship.

There are at least two principal ways in which modern theorists have construed democratic citizenship. The first, which equates the public interest with the preferences and needs of all citizens, emphasizes the elements of participation and self-governance that are the essence of the democratic imperative. The second, which defines the public interest independent of the expression of the supports and demands of the majority, stresses representation via trusteeship and accountability through periodic elections. This conception of democracy recognizes the oligarchic tendencies that are so characteristic of groups in western industrialized democracies.

Citizen Democrats

The citizen democrat places his or her faith in the ordinary citizen. The emphasis is upon expanding participation and enlarging the ordinary citizen's share in governing. This view, of which John Dewey, C.D.H. Cole, and Harold Laski are modern representatives, presupposes the citizen's autonomy and improvability. Citizens are not only in the best position to judge what is in their own best interest but also, through education, are capable of improving their future competence to make informed, political judgments. Hence, according to this conception of democracy, the citizen is both interested and capable of self-governance. In fact, direct and indirect participation in making decisions on matters that affect all members of the polity is not only of instrumental but also of
consummative value: in addition to its procedural qualities, participation is desirable for its inherent social and psychological benefits to the individual as well. And, so goes the argument of the citizen democrat, the more responsible the ruled, the more responsive the rulers.

Elite Democrats

In contrast to the citizen democrat, the elite democrat puts his or her faith in political leaders. Influenced by the negative effects of mass movements—especially Hitler's mobilized participation of the masses to relieve the anomie of post-depression Germany, and Italian Fascism—and shaped by results of opinion polls of the American voting public in mid-century, faith in the ordinary citizen as the repository of democratic values waned in the immediate post-World War II period. Undifferentiated mass publics emerged as the dreaded enemy of culture. And the tyranny of undisciplined majorities was perceived as the principal threat to democratic institutions and values. Hence, apathy on the part of large segments of the voting population was a healthy sign; and any increase in level of participation might threaten order by upsetting the equilibrium of the system. According to an assessment of Bernard Berelson and his colleagues at Columbia University in the 1940s, up to a point, apathy serves a system maintenance function for society:

The apathetic segment of America probably has helped to hold the system together and cushioned the shock of disagreement,
adjustment, and change. But that is not to say that we can stand apathy without limit.

That elite democrats fear a tyranny of the majority and citizen democrats view a tyranny of the minority as the principal threat to liberty is but one difference between these theories of democratic governance. Other differences revolve around the assessment of the capacity of the average citizen to participate effectively in making political judgments for the community. Elite theorists, of which Walter Lippman, Joseph Schumpeter, and Bernard Berelson are twentieth century examples, assume that the masses are fundamentally incompetent. They are also incapable of improvement, even through education. Moreover, because mass publics were thought to hold authoritarian and undemocratic attitudes, they were perceived as lacking a democratic character. This assessment was informed by the results of surveys of American voters in Elmira New York in the 1944 presidential elections. The Columbia University pollsters observed that "certain requirements commonly assumed for the successful operation of a democracy are not met by the behavior of the 'average' citizen." The results of the survey showed that the average voter in Elmira was neither well-informed nor rational.

The elite democrat, then, distrusts the judgment of John Q. Public, an uninformed, apathetic, and undemocratic citizen who is devoid of the "wisdom" of those political elites whose superiority rests in their excellence in manipulation. Based on this assessment of the capacity of citizens, elite democrats have advocated a "plebiscitary" style of government whereby members of
the voting public are limited to periodically saying "yes" or "no", and in the interim leaving the important decisions of government to a few capable, knowledgable elected officials. In this system, the many choose among competing elites. The few decide for ordinary citizens what is in the public interest.

THE MEANING OF GOVERNANCE IN MASS SOCIETY

How to strike a balance between elite autonomy, on the one hand, and accountability to a popular sovereign, on the other, has puzzled American democrats since the Founding. This issue shapes the principal line of inquiry of this essay. One aspect of the issue is how science and technology are used in the complex decision processes that translate society's preferences for a particular kind of science- and technology-driven environment, health care or educational system, defense strategy, or economic arrangements into public policies and programs. A second aspect of the issue is the nature of the specific policies that are preferred relative to expenditure levels, levels of acceptable risk, or patterns for allocating scientific and technical benefits and burdens in a modern, "mass" society that is not only radically different from the political communities that spawned "classical" and "representative" forms of democracy, but is even distinctive from the industrial society of the first half of this century. Hence, in piecing together the puzzle of democratic governance, science and technology can be both the instruments and the objects of policy. Before examining these semantic differences, however, a prior set of questions will be addressed. Just what is meant by governance and what social activities are
to be governed and in what ways?

Governance as Mediation

Derived from the Latin, *gubernare* and the Greek, *kybernan* to govern means to steer or pilot—in this case, the polity on a particular course, one designed to solve community problems. And while the activities of governments—governance—are diverse, they are, according to Heinz Eulau and Kenneth Prewitt, the political means of settling disputes—mediating—between man and man and between man and his environment:

The focus on governing conceived as problem-solving (but also problem creating) and therefore mediating the relationship between units and their multiple environments make governance not a routine to be administered but a set of issues to be solved.

At the Founding of the Republic, there were, indeed, many issues to be solved, the first of which was the set of institutional arrangements for governing, or steering, the Republic. Writing and adopting a constitution was no easy matter. But, in the end, the Founders balanced elite autonomy with accountability to the majority through popular elections. The novel, and yet untried "republican" system of government stressed the protection of minority rights, but institutionalized incentives for rulers to be responsive to the preferences of the ruled. One incentive was to adopt majority voting as the operative rule for making political judgments on behalf of the
collective. The many could always kick the rascals out! But in the constitutional democracy of the United States, rule by majority is not absolute. There are, in essence, certain rights that are so essential as to be off limits, even to majority will. The priority of one of those rights—the freedom to inquire—is central to any discussion of the democratic governance of science and technology.

Some would argue that whatever problems confronted the governors in the nation's first hundred years or so pale in comparison to the problems that political leaders of the twentieth century must face. Many contemporary problems are the result of the unanticipated, untoward side effects of an advanced science- and technology-based industrial state that is characterized by "the exponential growth and branching of science, the rise of a new intellectual technology, the creation of systematic research through R & D (research and development) budgets...and the codification of theoretical knowledge." Governors in "post-industrial" societies have enjoyed many benefits of scientific and technological progress. But they have also had to contend with at least three system-level barriers that make it difficult to satisfy the citizenship requirements of a working democracy.

First, the size and complexity of the units of government have alienated many citizens and made direct participation in public affairs problematic. Second, the growing tendency to make problems that were formerly state and local problems national problems—and the concomitant rise of the administrative state—further removed public issues from the average citizen and
undermined many traditional, local non-hierarchical, non-bureaucratic participatory institutions. And, third, the complex nature of the science and technology that are partly the cause of many of the problems of advanced, industrial states and partly their salvation requires a high level of scientific and technological literacy that is not easily obtained through the United States system of public education.

Size and Complexity

There are few, if any, historical examples of classical democracies. And even if we could find a democratic state in which access to political power is shared equally and in which rulers govern by consent, power would eventually be concentrated in the hands of a few. Perhaps the Greek polis (more a city-community than a city-state), the Swiss canton, and the New England town meeting come closest to the democratic ideal. Yet they flourished for only a fleeting moment in history.

Because of the small size of the autonomous 16th century Swiss canton, and the relative simplicity of the problems that confronted its members, the tasks of initiating, formulating, and making policy for the community remained wholly with the citizenry. The same can be said for the New England town meeting, where direct, participatory democracy was the rule. But modern conceptions have redefined democratic governance to conform to what Benjamin Barber labels "cosmopolitanism" --those conditions of division of labor, functional specialization, the decline of the autonomy of subnational governments, and growth in the power of bureaucracies which are the result of a science- and
technology-based industrialism.

With industrialization and urbanization have come not only economies of scale and increasingly complex and sophisticated problems which require increasingly complex and costly technical solutions to them, but also increases in the size and complexity of units of government. According to Robert Dahl and Edward Tufte, these changes in the character of political units over the years have created a trade-off between citizen effectiveness--citizens acting responsibly to control the decisions of the polity--and system capacity--the ability of the polity to be responsive to the collective preferences of its citizens. Increased size, complexity, and heterogeneity of the polity's members place serious limitations on the ability of citizens to manage their own affairs. On the other hand, small size, while enhancing citizen capacity for self-government, makes it exceedingly difficult for the polity to maintain its independence. Size and complexity, then, are the first major impediments to democratic governance.

The Rise of the Administrative State

A second obstacle to democratic governance is the nationalization of many problems, a characteristic of modern, industrialized nations. For some time now, public policy making and responsibility for its results have become increasingly nationalized. Between 1954 and 1978, for example, the federal government tripled its share of total state-local general revenue from its own sources, with the most dramatic increases in education, highways, public welfare, and housing and urban renewal. Federal aid as a percentage of state and local
expenditures peaked in FY 1978 at 26.9%.

Until the election of Ronald Reagan to the White House in 1980, there had also been a dramatic rise in the number of federal to state categorical grants-in-aid, complete with federal strings which set conditions for spending; and the federal courts also curbed the states' discretion over such activities as defining eligibility requirements for social programs. The penchant for passing state and local problems to the federal government for solution and delegating to federal technoscience agencies the responsibility for making decisions about which science and technology policies to support and to what degree is typical of what is going on in other policy areas. Nationalization of problems and opportunities in the area of science and technology, which has been especially true in the era of "big" science, has obvious implications for the possibilities of democratic governance.

Scientific and Technological Illiteracy

Of these three impediments to democratic governance perhaps the most serious problem facing the community today is scientific and technological illiteracy, for science and technology have become so powerful and complex that ordinary citizens have difficulty comprehending, and representative institutions have difficulty controlling, them.

Aristotle warned that a knowledge gap among members of the polity undermined the political integrity of the state: when knowledge discrepancies among citizens reached a point at which citizens no longer had the same "virtue", the state would cease
to be constitutional. The depth and extent of scientific and technological illiteracy is alarming, especially when one considers that a majority of public policy issues that get on the governmental agenda have scientific or technical content. For example, a 1979 National Science Foundation survey of more than 1,500 adults showed that only seven percent of the respondents were scientifically literate; and it is estimated that in 1985 there are over 27 million Americans now classified as functionally illiterate.

This has a number of implications for and raises many questions about the possibility of the democratic governance of science and technology. Does the average American know enough to play a role in public policy making, especially about something as esoteric as science and technology? Partly because of scientific and technological illiteracy in the legislative branch, many important policy decisions are now made in the executive branch (technoscience) agencies, or, increasingly, in industries, universities, and consulting firms. Are lay members of the public going to have access only to the democratic institutions of Congress, or will they have opportunities to influence policy wherever it is made? Will non-experts take an active part in shaping only the ends of science and technology policy, as they do now in the councils of the National Institutes of Health, for example, or will they also have a voice in choosing the most appropriate means to those ends? Will they invariably serve in the capacity of a minority? Will their participation be more than ceremonial, designed to legitimize decisions made by others? How these questions about the wisdom
and civic virtue of average Americans are answered has a lot to do with how one is likely to define the important issue of the power relationships between those who govern and those who are governed.

THE MEANING OF SCIENCE AND TECHNOLOGY IN MASS SOCIETY

Whether or not members of mass publics are perceived as autonomous, educable, or wise has a bearing on their influence relative to that of elites. Whether or not science and technology are viewed as subject to elite, rather than democratic criteria of governance, and whether or not scientists and technologists are viewed as politically neutral will affect the relative influence of those who do science and technology and the Senators and Congressmen who sit on science and technology committees in the legislature, the Directors and Secretaries of the technoscience agencies such as NIH, NSF, DOD, and FDA, members of scientific and technological advisory committees, and the President. Before discussing the nature of science and technology governance in a democracy, however, the two social activities we call "science" and "technology" will be distinguished in terms of what activities, who, and which organizations are to be governed.

Science and Technology as Social Activities

Rather than independent and deterministic forces, science and technology are social activities, each with its own workers, usual work place, reference groups, and norms. Science and technology are, however, inextricably linked, and in the areas of
research and development such as biotechnology, they are, to use the term coined by Edward Layton, "mirror-image twins". For analytical purposes it is often convenient to distinguish between knowing and know-how, but as the historians of science and technology have noted, these distinctions are overdrawn. They have less currency today, especially in physics, computer science, and molecular biology. In these disciplines, the lines between science and technology are blurred. For example, recombinant DNA research has been conducted primarily in university laboratories, but increasingly, is being carried out in the laboratories of private industry. Moreover, the profit motive in the new biology has undermined the scientific norms of what Robert Merton has called "communism", "universalism", "disinterestedness", and "organized skepticism", part of the "ambivalence" of scientists.

Science celebrates the triumph of knowledge over ignorance. In its narrowest sense, science is a descriptive study of the laws of nature, with discovery of the truth of physical and biological reality—man, the universe around him, and man's relationship to the universe—as its ultimate aim. Harvey Brooks, in an influential essay on the functions of scientific advisors in science-government relations, distinguishes between "science in policy" and "policy for science". In the former, science is an instrument of policy, "concerned with matters that are basically political or administrative but are significantly dependent upon technical factors." An example of "science in policy" is the recent use of experts and informed laypersons in Cambridge Massachusetts to decide whether or not chemical weapons
testing should be continued in a private laboratory within the city limits. "Policy for science", on the other hand, is concerned "with the development of policies for the management and support of the national scientific enterprise and with the selection and evaluation of substantive scientific programs." Here, science is the object of policy. Discussion of experiments that release genetically altered organisms into the environment and their regulation is an example of a policy for science. But clearly there are also elements of the use of scientific knowledge in deliberating about which regulatory structure is optimal.

If science is synonymous with knowledge, technology is synonymous with the application of knowledge for useful purposes. Narrowly defined, technology is the science of the industrial arts, the collection of production possibilities, techniques, methods, and processes by which resources are actually transformed by man to meet human wants. One of the most dominant forces in modern life, technology is, according to Jerome Weisner, "the engine that propels modern society".

Scientists are the source of new discoveries. Claiming to be objective and precise, scientists supposedly pursue knowledge without regard to ends. Technologists, on the other hand, apply the discoveries of scientists in the service of economic and political ends. They see knowledge in the interest of solving socially defined problems. Actual behaviors, however, belie these textbook definitions of the scientist and engineer.
THE RELATIONS OF SCIENCE AND TECHNOLOGY TO DEMOCRATIC GOVERNANCE

The conventional view of science and technology as a strictly logical processes, and scientists and technologists as apolitical, is overdrawn. Science and, even more so, technology are not "value free" and are, in fact, subject to a variety of external influences, many of them political and economic. Furthermore, the view that scientists and technologists are self-governing is also not born out by the facts: a wide variety of interests must give their consent to policies regarding the pattern and direction of research and development in the United States.

One of those interests consists of the group of people who pay the taxes that fund research and development and who both benefit from and suffer from the harms and social dislocations of scientific and technical progress. Yet in the absence of an active interest in public affairs on the part of members of the public, the responsibility for directing those affairs is likely to be devolved to a small clique of those with a vested interest in the scientific or technical activity. This, we are told by theorists like Gaetano Mosca and Robert Michels, is a central tendency in advanced, western democracies. These tendencies towards oligarchy shape the type and degree of accountability one can come to expect.

If examples of "pure" or "objective" science are hard to find in the modern world, so are examples of "pure" democracy. Like most other states that call themselves democracies, the United States is a mixture of democracy and oligarchy, falling
somewhere between what James Madison described in Federalist No. 10 as "a society consisting of a small number of citizens, who assemble and administer the government in person" and what the elite theorist, Joseph Schumpeter, has called "the institutional arrangement for arriving at political decisions in which individuals acquire power to decide by means of competitive struggle for the people's vote".

Hence, when thinking about the democratic governance of science and technology, a variety of direct and indirect modes of participation are possible. Evidence from case studies shows that legitimate forms or modes of political participation for citizens in public policy with high science and technology content—what James Carroll calls "participatory technology"—range from picketing, class action suits, and civil disobedience, to lobbying, technology assessment, testifying at public hearings, and periodic voting in elections (a minimum requirement of full citizenship). That the legal system guarantees citizens the right of intervention does not, however, guarantee the wisdom of that intervention. The textbook controversies in Texas and the creationist flap in Arkansas are cases in point.

That scientific expertise and democracy need to be reconciled has been eloquently stated by Duncan MacCrae, Jr.

In so far as public choices depend on expert information, science requires that this information be judged by experts rather than the electorate. Democracy, however, requires that the electorate have the ultimate power.
Those who value democracy, or fear its erosion, sometimes see scientists as an elite serving special interests, or see applied science as simply unplanned and uncontrolled.

This tension between democracy and expertise is a recurring theme in much of the discussion of the public governance of science and technology. In the concluding paragraphs of this paper, I will examine individual- or group-level impediments to the democratic governance of science and technology and suggest a set of preconditions that ought to precede the development of a more specific governing scheme--one that attempts to reconcile democracy with science and technology.

IMPEDEMENTS TO DEMOCRATIC GOVERNANCE

The points have already been made that science and technology are not completely separate, value-neutral social activities; scientists and technologists are neither autonomous nor apolitical; and policies for science and technology--the mechanisms, institutions, and operating principles that are used to allocate resources for scientific and technological activities--are the product of myriad forces, some of which are scientific and technical but many of which are economic, social, or political.

There is even some question as to whether or not there is a national policy for science and for technology at all. According to Henry Lambright, *de facto* legitimation comes from below, but
the driving force is the executive branch of government.

There is certainly no general overarching, long-range course-setting for the federal government-as-a-whole in R & D affairs... What constitutes the reality of policy is more a combination of initiatives, mostly from the agencies but occasionally from central political authorities.

In spite of an "iron triangle" of relations among interest groups, federal agencies, and Congressional committees and subcommittees that tends to produce a convergence of interests, the unique characteristics of the U.S. system of government have encouraged a divergent, uncoordinated, directionless, and, at times, contradictory "non-policy" for science and technology. Furthermore, although much U.S. science and technology policy making is conducted within the legislative and executive branches in Washington, power is not centralized but is widely shared between national and subnational governments and between governments and subgovernments, especially corporations, professional associations, the military, public interest groups, and universities. Organized into groups for the purpose of exerting pressure on the system for favorable treatment, these actors are part of a network who see their interests affected by public choices, for example, about how scientific research is to be conducted, along what specific hard or soft paths technologies are directed, or what kinds of science- and technology-driven health, defense, or environmental protection systems are adopted
for society.

In an article written a quarter-century ago, Wallace Sayre made the following observation about the nature of democratic governance in the United States:

In a democratic order all policies of significance must secure a wide range of consent, not merely from the general public but also from 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.

As Sayre and others make clear, lay members of the public have a legitimate claim to shape the course and conduct of basic and applied research and technological development, yet there is little evidence that the content of science and technology policy has been much influenced by lay members of the public. In reality, there are several major psychological and sociological obstacles to the public governance of science and technology, the most important of which are: (1) a mass public that has little
power because the vast majority of its members are apathetic, unorganized, and scientifically and technically illiterate; (2) a powerful, organized, politically active community of experts that can mobilize its members, many of whom believe that science should live not by democratic but by elite criteria; (3) corporate capital, in the form of major science-based industries, that is resource-rich and has major incentives for wanting to maintain the current "two-tiered" system for governing science and technology; and (4) a university that is, to use Ralph Nader's words, fast becoming "a vanguard of mercantilism", but one that is vulnerable because of its heavy dependence for its future not only on the genius of its faculty, but also upon government and industrial largesse.

Apathy

That most Americans are not actively involved in science and technology issue resolution is well documented. Yet this same evidence supports the theory that power in America is shared, not concentrated— that a different minority of interests governs each public policy domain. And there is no reason to believe that science and technology would be an exception to this "rule by minorities" principle of governance. One explanation for low levels of citizen participation in the making of public policy for science and technology is that alienation breeds distrust. In blaming the victim for his or her lack of participation, however, this explanation points to psychological barriers as conditioning, if not determining, political behavior. For example, the "cult of expertise," so goes this argument, conditions many members of the public to behave as spectators,
thus allowing elected representatives to be the gladiators in the arena of Congress, a passive behavior on the part of the public that is learned and internalized as part of the socialization process.

There is no strong sense of civic responsibility among the vast mass of the community and this an obstacle to widespread public participation. Due to the representative for of the United States brand of democracy there is, however, a widespread belief that the job of governing public affairs lies not with the people but with their elected representatives. This belief in the "invisible hand" that results from competition among elites that Don Price contends is part of the "unwritten Constitution" is an ideological barrier to more direct social control of science and technology. Of course, Price's solution—to give more power to the President—would make it even more difficult for ordinary citizens to have access to governing institutions.

Another, more sinister explanation for low levels of citizen participation is that those in society who specialize use a variety of structural devices to protect their privileged positions: those with special education and knowledge mystify science and technology (with aid and comfort from the masses), rely heavily on technical jargon in communications, form exclusive professional associations, and use professional, specialized journals that are not widely circulated in order to communicate their research results. Via university and professional reward systems, those with expert knowledge and training are rewarded for these types of professional behaviors.
and discouraged from other, more public ones. The end result is a fairly narrow set of activities directed at a very limited audience. And this mystification process discourages public understanding of science and technology.

Experts as Political Actors

Although the ultimate power to determine research priorities rests with members of the public, they either consciously or by default delegate much of this responsibility to scientists and technologists. And whereas the Constitution designates Congress as the law making branch of government, on many scientific and technical matters much of the responsibility for making policy has been delegated to non-elected officials in the executive agencies. Through this two-stage process of deferral to expert opinion, those with specialized knowledge gain considerable power. When it suits them, members of this group of scientists and technologists—and their non-credentialed allies in industry and the university—can use their power to discourage public participation, or at least neutralize its effects.

One of the best examples of the power of the scientific lobby is the concerted effort by scientists in 1977 to block legislation that would have institutionalized a public voice in making national policy for scientific research. In 1977, at the height of the rDNA debate, and in response to considerable public pressure, Senator Edward Kennedy introduced legislation in the Senate to establish a "balanced" committee to oversee gene splicing research. But as a result of organized lobbying on the part of scientists and technologists, his proposal was withdrawn. Writing of the "victory" in The New Republic, James Watson
believed that the bill's defeat would have occurred sooner if "all scientists had said in public what we were endlessly boring ourselves with in private". He continued,

This proposal naturally depresses me since it opens up the prospects of people with no scientific qualifications deciding what scientific work we should not do. Naturally, we have called on everyone we know in the White House to alert them to the new folly at HEW...that only we scientists can judge unquantifiable conceptual risks.

The Role of Corporate Capital

The story of what happened to the Kennedy proposal for a "balanced" recombinant DNA Committee is typical of "interest groups liberalism", a vulgarized form of pluralist theories of power in America. Interest group liberalism grants special interests the right to make public policy, which is then ratified by the state. In this theory of the state, the government protects the right of special interest groups to make policy decisions, and the regulatory powers that are granted to the state are used primarily for maintenance of existing power arrangements rather than for protecting the public or for reforming or changing the structure of the system. Another example of the influence of interest groups in the formation and implementation of technology policy is what happened in the early years of the funding and development of the totally implantable
artificial heart; Mary Lasker and her associates, and Dr. Michael DeBakey, were very influential in shaping the path of that medical device's research and development.

CONCLUSION

If both the systemic and individual- and group-level impediments to the democratic governance of science and technology that have been identified in this paper are accepted as valid explanations for low levels of citizen participation in making policy for science and technology, one question remains: How can a political solution be found that provides for meaningful, active participation on the part of the public yet protects scientists' and technologists' autonomy of inquiry? Clearly, voting in elections, and leaving matters scientific and technological to elected representatives or to specialists between elections, is an insufficient to Hunter Dupree's "unsolved dilemma" of all attempts at adopting a national policy for science and for technology.

No solution to Dupree's dilemma is possible unless positive steps are taken to overcome these psychological, ideological, and structural barriers to public participation in the governing of science and technology. By taking several practical steps in order to overcome these deep-seated obstacles to democratic governance, it is possible to establish the preconditions for a science and technology that will be governed more democratically in the future. Adopting these reforms assumes that existing institutions (some more representative than others) for governing
science and technology in a democracy are inadequate, as are the assumptions upon which they are predicated. Given this generally negative assessment of existing institutions, there are at least three ways in which credibility can be restored. The strategies outlined below are directed towards building a "democratic character" and towards improving the quality and quantity of public participation in making and implementing public policy for science and technology.

First, lay members of the public have to improve their understanding—of science and technology and of the requirements of citizenship. Aristotle, in making the distinction between the legal framework of constitutional government and actual behavior in the polity, makes the point that a crucial component of political stability is learned, supportive behavior, not merely book-learning. In Book V, Aristotle wrote:

The education of a citizen in the spirit of his constitution does not consist in his doing the actions which the partisans of oligarchy or the adherents of democracy delight. It consists in his doing the actions by which oligarchy or a democracy will be enabled to survive.

Second, members of various publics must recognize that in order for any political solution to work, they will have to respect the autonomy of others with legitimate, competing claims. Politics requires mutual respect and a recognition that political solutions are constructed on compromise. This requires that lay
members of the public have an equal right to a place—and not just token representation—in the institutions that make decisions about priorities in science and technology. One way to guarantee parity with experts is to either educate public members of decision making bodies or give them access to scientific and technical advice upon which to make sound judgments.

Third, steps must be taken to encourage public discourse, or discussion, including public hearings and referenda, on scientific and technical controversies. This requires improved access to policy formulation and adoption institutions and processes. Improved access necessitates a variety of participatory mechanisms, from more town meetings and community forums to intervenor funding to the demystification of science and technology. The critical aspect of public discourse is not only what is discussed, but where and when. In this regard, the anti-war movement is an appropriate model—local discussion in small groups with the supposition that fundamental assumptions can be assessed at any point in the policy process. Broadly speaking, rather than driven by the nostalgia of the Greek polis or the town meeting, what is required is old wine in new bottles—a restoration of some of the communitarian institutions of earlier times, but in a form that is consistent with modern life. Invigorating the democratic character of citizens will require opening up many social institutions—factories, universities, and families, for example—to democratic governance. In this manner, science and technology can be reconciled with democracy.
Notes


3. Aristotle, Politics 7,8; 1328 a 36.

4. The following differentiation is based on Dennis F. Thompson, The Democratic Citizen (Cambridge: Cambridge University Press, 1970).

5. See, for example, John Dewey, Freedom and Culture; C.D.H. Cole, Social Theory; and Harold Laski, Dangers of Obedience.


7. W. H. Morris-Jones, "In Defense of Apathy," Political Studies 2: 25-37. On the basis of a secondary analysis of The Civic Culture data, Giuseppe DiPalma concludes that instances of apathy in America are a result of modernization. See Giuseppe DiPalma, Apathy and Participation: Mass Politics in Western Societies (New York: The Free Press, 1970), 200-201. Another secondary analysis of the Almond data yield different results, for example, that economic development leads to higher levels of political participation. However, it may be the case that in western industrialized democracies up to a point, as a nation becomes more developed, levels of political participation rise. But once that point is reached, participation may begin to decline. This is an empirical question that bears further investigating. See Norman H. Nie, G. Bingham Powell, and Kenneth Prewitt, "Social Structure and Political Participation:


13. Mass society is a society in which masses are available for participation and elites are accessible. See William Kornhauser, *The Politics of Mass Society* (New York: Free Press, 1959). According to Kornhauser, a mass society tries to reconcile aristocratic and democratic traditions by creating intermediary groups such as political parties and interest groups—mediators between rulers and ruled.


15. Ibid., 17.


17. Mencius wrote of the division of labor in China more than 2000 years ago, but the modern formulation of oligarchy, even in democratic groups, comes from Gaetano Mosca's *Ruling Class* and


24. Edward Layton, "Mirror-Image Twins," Technology and


28. Ibid., 76.


30. From the New York Packet, Friday, November 23, 1787.

31. Schumpeter, Capitalism, Socialism, and Democracy, 264.


35. According to Don K. Price, this reluctance of political leaders to coordinate policy centrally constitutes America's "unwritten constitution". As a solution to the problem of what some political scientists have called "partisan mutual adjustment", Price advocates a parliamentary system in which the President, rather than Congressional committees and interest groups, dictates public policy. With this proposed reform, coherent, long-range plans for the nation could be established and implemented. See Don K. Price, America's Unwritten Constitution: Science, Religion, and Political Responsibility (Baton Rouge: Louisiana State University, 1983). For the contrasting view that policy can at times be centrally coordinated and at other times can be the product of


37. Ralph Nader, as quoted in Technology Review.

38. See Jon D. Miller, Robert W. Suchner, and Alan M. Voelker, Citizenship in an Age of Science: Changing Attitudes Among Young Adults (New York: Pergamon, 1980).

39. This does not negate the finding that socioeconomic class is positively related to involvement in political life. While access to the institutions of government may be equal, taking advantage of those opportunities is not distributed evenly across the social strata.


41. There are, of course, many exceptions to this rule. See, for example, the many case examples in James C. Petersen's excellent volume, Citizen Participation in Science Policy ed. James C. Petersen (Amherst, Ma.: The University of Massachusetts Press, 1984).


43. Price, America's Unwritten Constitution.


46. For a while, participatory democracy was very much in disfavor. But recent developments in politics at the national level have revitalized intellectual discourse on this subject. In one of the most coherent arguments for democratic governance to date, Benjamin Barber argues for "strong" democracy, where the ordinary citizen is very active in public affairs. His broad themes, which are consistent with our own recommendations, are citizenship, participation, and political activity. Benjamin R. Barber, Strong Democracy: Participatory Politics for a New Age (Berkeley: University of California Press, 1984).

47. Aristotle, Politics, Book V, 1310a.