Social Control of Science and Technology

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Science and technology increasingly work changes in the complex matrix of society. These changes pervade our ecological systems and our physical and psychic health. Less perceptibly, they pervade our culture, values, and value-based institutions, such as the law. In turn, our values and institutions shape the progress and utilization of science and technology.

Science and technology have provided society with enormous material benefits and a higher standard of living and health. Yet these benefits have been accompanied by alarming rates of resource consumption and new hazards to ecological systems and health. Social response to these unexpected problems has been of a remedial nature—that is, how to diminish pollution through regulation and technology. However, since our values and institutions shape the progress and use of science and technology, the fundamental social response must come from change in these values and institutions. To the extent possible, this change should yield preventive or a priori controls.

This important task can be described as the need to formulate coherent and humane social controls on science and technology.

Of course science and technology are not discrete activities: They describe a process that ranges from basic research through applied research and development technology to application and use technologies. Most social change occurs during the latter stages, in which technology is manifested either in specific acts, such as organ transplantation techniques, or as part of a major public or private system, such as nuclear energy or computer applications.

Events throughout this process have become highly dependent on federal funds since World War II. In 1969, approximately 65 percent of the funds spent in the United States on basic and applied research and development technology were provided by federal agencies. This reliance on federal support provides even further justification for public interest in the social control of science and technology.

The most substantial expenditures and investments occur during the development technology stage, after a number of important decisions have been made about prototypes, production, application, and use. Of the approximately $17 billion of federal support for research and development in 1969, it is estimated that $5 billion went for research and $12 billion for development. Production and application activities undoubtedly involved billions more. Similar ratios prevail in the private sector.

These investments must be considered in human as well as economic terms, for it is during the development and subsequent stages that large numbers of engineers, administrators, managers, production and shop personnel, salesmen, and subcontractors commit their careers, personal values, and families—and ultimately their communities—to the specific technological activity or system. Therefore, all subsequent social controls must consider the political, economic, and human factors that have been developed.

Numerous social controls on institutions and individuals generating or utilizing science and technology have been developed over the years. Table 1 suggests, in general terms, what these controls are and where they function in the various stages of science and technology. The legal doctrines in the table all operate during the advanced technology stages—after decisions committing economic and human resources have been made and, normally, after injury has occurred. By this time, fully developed systems and practices are in use, without coherent controls.

This has led to condemnation of law as a modern system of control. As Jacques Ellul has said (*1*):

> The judicial regime is simply not adapted to technical civilization, and this is one of the causes of its inefficiency and of the ever greater contempt felt toward it.
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> Law is conceived as a function of a traditional society. It has not registered the essential transformation of the times. Its content is exactly what it was three centuries ago. It has experienced only a few fragmentary transformations (such as the corporation)—no other attempts at modernization have been made. Nor have form and methods varied any more than content. Judicial technique has been little affected by the techniques that surround us today; had it been, it might have gained much in speed and flexibility.
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> Faced with this importance of the law, society passes to the opposite extreme and burdens administration with everything that is the product of the times in the judicial sphere. Administration, because it is better adapted from the technical point of view, continually enlarges its sphere at the expense of the judicial, which remains centered on vanishing problems such as codicils, community reversions, and the like. These last, and all similar problems that are the exclusive concern of our law, are problems that relate to an individualistic society of private property, political stability, and judicial subtlety.

In specific terms, the legal system has not been responsive to new social conditions. For example, it has not functioned as an effective control on science and technology because it does not operate early enough in the process. Harold Green, in discussing this issue, has said (*2*):

> The basic question is whether our legal system is capable of imposing effective social control over new technologies before they inflict very substantial, or even irreparable injury upon society. It seems clear that we cannot rely on the courts alone to protect society against fast-moving technological developments. Judge-made rules of law always come after, and usually long after, the potential for injury has been demonstrated. . . .

This characteristic of retroactivity limits the ability of the legal system to respond to a number of modern social problems, in particular the harmful effects of science and technology and the problem of environmental deterioration. Retroactivity is inherent in a legal system based on the values and conflicts of the private sector of society. The courts have not been designed to serve as oracles or social planners, but to

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Table 1. Where social controls occur in science and technology.

Sources of control	Basic science	Applied science	Development technology	Production, application, and use technology
Scientific peer groups	×	×		
Professional associations				×
Federal government				×
Executive action		×	×	×
Agency programs	×	×	×	×
Agency regulation	×	×	×	×
Agency security classification	×	×	×	×
Congressional hearings		×	×	×
Congressional legislation and funding	×	×	×	×
Industry-consumer markets			×	×
Industrial associations and labor unions			×	×
Insurance				×
Crusaders and citizens' groups			×	×
Law				
Patents, copyrights, trade secrets			×	×
Torts				×
Constitutional rights				×
Land use			×	×
Consumer protection				×
Experimentation		×	×	
Education-ethics	×	×	×	×

grapple with actual conflict manifested in specific acts or injuries. They lack the technical, astrological, or other expertise needed for the diffiult task of evaluating the present, diffuse effects or the future effects of science and technology. Consequently, the courts are reluctant to impose controls and have rarely intruded on the substantive aspects of decisions of public agencies, which presumably are technically expert.

Judicial procedures that have reinforced concepts of justice and due process, such as statutes of limitations and rules of evidence and standing, have also brought an immobility to the law to the extent that it cannot respond easily to such issues as deleterious damage or public health.

Recent developments in environmental litigation have ameliorated some of these procedural obstacles, particularly the issue of standing for citizens' groups alleging other than economic injuries. But some feel that this brief honeymoon is already over. In Sierra Club *v.* Hickel (*3*), the Ninth Circuit Court of Appeals denied that the Sierra Club had standing, since it had not alleged that its members would be affected, beyond displeasure, by the scheduled action of the Department of the Interior. (This action was the approval of a commercial and recreational development, in the heart of Yosemite National Park, to be carried out by the Walt Disney Corporation.) This may indicate that the bounds of procedural flexibility have been reached.

The list of problems is incomplete, but sufficient to justify the conclusion of a recent law review note: "The passive nature of the courts and the difficulties encountered in their use make it clear that they cannot serve as society's primary instrument for technology assessment" (*4*).

To return to Table 1, the controls of the private sector are similarly clustered in the advanced technology and use stages. For obvious reasons, industrial decisions and insurance controls are implemented without full consideration for the public interest. Decisions are made on market or profit considerations, based on what the consumer wants or can be manipulated to want, and do not consider larger public interests in the preservation of natural resources or public health, for example. Advertisements boost the sales of items that are attractive to individual consumers, but that collectively erode environmental quality, other public interests, and, ultimately, private interests. Sales of snowmobiles to the new breed of armchair sportsmen have climbed to 500,000 annually and provide a noisome case in point.

The automobile represents the ultimate absurdity. The automobile birthrate is now treble the human birthrate in the United States: 10 million automobiles are produced for every 3 million human beings. Death rates occur in a similar ratio. Automobiles produce most of our air pollution, are dangerously designed, and are not economically recycled. How much longer can these absurd ratios and harmful effects be tolerated, despite the importance of the industry to the economy? Obviously, many of our problems labeled technology-induced or environmental are, in reality, the behavioral problems of a materialistic society. As such, we cannot expect effective private sector controls to emerge, nor can we expect courts to alter such "normal" behavior.

Crusaders and citizens' groups have recently proven somewhat effective as technology-curbers, but they have not provided coherent, a priori controls. Crusaders are in short supply, and citizens' groups lack funds, technical expertise, and national political strength. They can only attack discrete problems, often on a local scale, and must ultimately resort to the legal system with its shortcomings. Their task is made extremely difficult by the fact that, once again, substantial economic and human commitments have already been made in support of harmful developments, on a scale far larger than the immediate interests represented by such groups. Without substantial evidence of harm to public health, such groups appear to represent merely their own esthetic or otherwise elitist values, or a Luddite revival. This is not said to disparage such activities: They have served to educate and involve citizens, and they represent an exciting and valuable development.

The public agencies have actual and potential social control functions that cover the complete spectrum of scientific and technological activities. But this role is inextricably wound up with their several other functions, which include the promotion of certain activities for national purposes such as defense or the balance of payments. Reasons for their failure to exert social control have often been cited and are true to varying degrees: bureaucracy and inertia, ignorance and lack of sensitivity to noneconomic interests, fragmentation of authority by congressional design or by subsequent developments.

Legislation has proven to be no guarantee of implementation. The Refuse Act section of the 1899 Rivers and Harbors Act is a potentially powerful source of authority for combating most forms of water pollution as they occur.

Yet for 70 years it had been ignored by the Corps of Engineers and the Department of Justice.

The idea of reorganizing the federal agencies or creating new administrative bodies to better control science and technology has been under discussion for some time. Under this rational measure, one or several new and prescient groups would function as long-range planners with coherent control authority. For example, a single agency could, perhaps, determine national and regional energy needs and then plan, license for construction, and regulate in the public interest more effectively than the present multiple-agency condition. Reliance on teams of technical experts and experts from such other fields as law, health, and economics could be built into reorganization plans of this kind.

These are certainly steps in the right direction. Of our present array of social controls, perhaps the public agencies, which support most research and development, could effectively perform assessment and control functions when they are most important—before large-scale development and the commitment of economic and human resources.

Hugh Folk, in considering present and future social control by public agencies, has already discerned some pragmatic problems (*5*). Experts will once again be drawn from the same pool. Many of them will actually have contributed, in industry or government, to the problems they will be called upon to solve. Few experts will be able to apply their disciplinary background to a wider range of social issues. And experts will need extraordinary courage to function in a truly critical sense, since their careers will still be rooted in the same industrial-governmental-university milieu. What will happen to the expert who tries to serve the public interest by calling for a halt to a particular line of research? A test case is now before us involving radiation safety standards. John Goffman and Arthur Tamplin have challenged the Atomic Energy Commission and its affiliates in industry and the universities.

Folk's central thesis must be repeated here: assessment and control are essentially policy-making processes and, as such, will be embroiled in political controversy. He fears the repetition of the nonrational policy-making that occurs in our present agency framework and that results in agency establishment of "standards at levels slightly below that at which people complain vigorously . . . thus keep[ing] the public sullen but not mutinous." Designs for central assessment and control authorities must meet these issues squarely if real change is to occur.

Finally, let us briefly consider peer groups, well positioned to assess and control early in the basic and applied science stages.

Based on personal observation, in part, I do not think scientific peer groups presently have the objectivity or capability to function as coherent and humane social controls. The members of a peer group share the narrow confines of their discipline, and individual success is measured by the degree to which one plunges more deeply into and more narrowly draws the bounds of his research. There are no peer group rewards for activities or perceptions that extend beyond the discipline or relate it to social problems. Members are therefore neither motivated nor trained to relate their peer group activity to broader social concerns. Probably because of their closeness and commitment to their work, they are unable to objectively assess implications and recommend controls.

Genetic research today provides us with a case in point. It is proceeding rapidly in the United States and England, and, periodically, significant breakthroughs are announced. Members of the peer group and others have frequently discussed the potential applications of their work, and it has become a fashionable topic. Despite the potential for genetic engineering and its misuse for political and social goals repugnant to our professed values, this work continues at an urgent pace. I would think that the historical evidence of the political misuse of science and technology in this century would at least bring about a slight pause or slowdown in activities until our legal and other control systems had time to prepare principles regarding experimentation, as well as other public and private safeguards.

It is a disturbing experience to discuss these issues with biologists. Their responses avoid the central issue of slowing or suspending work to formulate controls and include the following:

► "If we don't do it, somebody else will";

► "Don't worry about secret and horrible developments—all work is done in large, expensive labs funded by the government";

► "Further work will improve the health of society and upgrade the gene pool";

► "Cloning of humans is at least 5 [or 10] years away";

► "Science is intrinsically valuable in its contribution to man's collective knowledge, and it must not be controlled for social purposes of any sort."

Self-enclosed peer groups cannot be entrusted with self-control, perhaps because of their narrow disciplinary backgrounds or self-interest, and perhaps because our educational system does not foster ethical and interdisciplinary values in professional training (*6*).

The social control of science and technology will be a troublesome and never wholly successful undertaking. It bears the potential to politicize and regiment intellectual activity, which has been realized in Russian genetics. Nor will the task lend itself to a specific solution—there are no administrative, legislative, or judicial panaceas.

Of course, it must also be recognized that future impact assessment and derivative control will always be limited, as man's intellectual and imaginative resources are limited. Even our measuring devices are still too crude to discern pernicious impacts in many cases. The earlier the assessment takes place in the process of science and technology, the more speculative it is. But the practice must begin, and develop, and pervade all the social control mechanisms we now have and may devise.

To begin, there are a number of reforms that can be introduced in our present array of social controls. Administrative agencies must be reorganized sensibly in light of new national objectives and available scientific and technological resources.

Legislation must be generated to provide guidelines for the administrative agencies similar to those provided by the National Environmental Policy Act (NEPA). Substantive and procedural duties are imposed by NEPA on all federal agencies to implement a broad policy of preventing and eliminating environmental damage. Section 102(2) of NEPA requires that the federal agencies, in their policies, recommendations, and other major federal actions affecting environmental quality, shall (*7*):

A) utilize a systematic, interdisciplinary approach . . . in decision making which may have an impact on man's environment;

B) . . . insure that presently unquantified environmental amenities and values . . . be given appropriate consideration in

decision making along with economic and technical considerations;

C) include in every major recommendation . . . and other major federal actions . . . [a] detailed statement . . . on (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, (iii) alternatives to the proposed action, (iv) the relationship between . . . short term uses . . . and long term productivity, (v) any irreversible and irretrievable commitments of resources which would be involved . . .

D) study, develop and describe appropriate alternatives. . . .

We can only speculate about what impact NEPA will have on environmental quality. Perhaps its primary significance will be to instill certain *habits* and *values* in federal officials and the experts they consult: the habits of interdisciplinary assessment and consideration of alternatives, and a value system that would include health and ecological considerations.

NEPA will probably slow down the agency decision-making process, and this will help matters. Finally, NEPA will bring about the generation of information by federal agencies. This information should become available in useful form to concerned citizens who invoke the Freedom of Information Act (*8*). The agencies' broad-based studies of harmful effects and alternatives will be helpful, either because of contents or omissions, to environmental action groups. Hopefully, executive privilege and other exceptions to the Freedom of Information Act will not be invoked to the detriment of congressional purpose as expressed in NEPA. Unfortunately, this has already occurred in Soucie *v.* DuBridge (*9*), where the Office of Science and Technology report to the President on the SST was successfully withheld from conservationists.

Obviously, NEPA will also bring about some assessment and agency control of science and technology when environmental effects are predicted. However, there is a need for legislation, similarly grounded in a multiple-value system and the habit of assessment, that will more directly confront the need for a priori control of science and technology. This legislation should be directed at the substantial agency sponsorship of research and development, thereby regulating federal procurement and government contractor activities.

Independent adversaries must be fostered. A tax-exempt status ruling by the Internal Revenue Service would be a helpful first step for citizens' groups pursuing activities in the public interest—for example, groups that have demonstrated their concern for public health. Multiple-year grants to interdisciplinary groups, perhaps based at universities, could foster independent adversaries by establishing new career patterns. Congress, through its committee structure and reference service, should assist in this process.

Citizens should continue to press for responses from the legal system. Environmental litigation to date has been marked by ingenuity, but it lacks a coherent rationale. If Sierra Club *v.* Hickel is an omen of anything, it may be that the mere displeasure or the aggravation of elitist values of a citizens' group will not be sufficient to challenge agency and industrial actions that serve economic or public recreational interests, even though on a crass and commercial basis. Perhaps this is as it should be. Litigation to control environmental quality and science and technology should seek a coherent and important *raison d'être*—public health.

Public health—in both physical and psychic terms—includes esthetic and recreational values and the importance of ecosystems. It can therefore provide the nexus between citizen group social action or litigation and the public interest. The federal agencies, under NEPA, must now consider health effects. Establishing public health as the nexus does not simplify decision-making, but it can reduce subjective value clashes and will cause science and technology to be used in a self-evaluative and beneficial manner.

Finally, the most important social control must be discussed—education. The training and values of our professionals in law, engineering, and other fields must be responsive to the problems that beset society. The intense specialization that marks graduate education fosters narrow professionalism. Peer groups have not rewarded members who apply their training to problems that extend beyond disciplinary confines.

Our graduate schools and departments represent artificial divisions of knowledge and experience, and they deprive students of important opportunities and professional qualities. Substantive specialization and procedural barriers prevent students from working with colleagues in other disciplines and, often, from doing clinical work that is related to social issues. As a result, they are unfamiliar with the values, attitudes, and methods of other disciplines and unable to synthesize and apply them to social issues. These limitations in training are then reflected in careers and social problems.

No new degree programs will provide us with the answers. Rather, every degree program we now have must be enriched with interdisciplinary, clinical, and, preferably, problem-oriented components. Many exciting educational experiments, such as Cornell's "Science, Technology, and Society" program, are being conducted in institutions across the country.

Several innovative developments are taking place in the Boston area. At M.I.T., the school of engineering is moving to confront problems of biomedical engineering, public systems, and environmental quality. The civil engineering department has brought into its faculty and academic structure an interdisciplinary team made up of a political scientist, a lawyer, and an economist to work with the engineering faculty on water resources, transportation systems, systems engineering, and environmental quality. Engineering students can now enrich their academic programs with courses and research that relate their engineering disciplines to the full complexity of the social context in which they will eventually work. A number of engineering students have joined members of the Harvard and Boston University law schools' environmental law societies on projects confronting local and national environmental issues.

Professor Jerrold Zacharias is now working on adapting M.I.T.'s advanced degree programs to specifically train students for college teaching careers in science and engineering. The mastery of a discipline, educational methods and technology, ethical and legal materials, and interdisciplinary research are now considered to be important features of this development. Graduates will be expected to bring breadth and innovative qualities to their teaching careers and relate their discipline to the social context.

Finally, at Boston University Law School, the new Center for Law and the Health Sciences has established a program that enables law students to work with graduate students from other disciplines on health-related social problems. Student and faculty participants are drawn from different disciplines and institutions, and students receive academic credit through ad hoc institutional arrangements.

David Bazelon, chief judge of the Washington, D.C., Federal Court of Appeals, has played a major role in this undertaking, as chairman of the center. In a summer pilot program, 15 graduate students from Boston University, Brandeis, Harvard, and M.I.T. were divided into four interdisciplinary teams. Each team confronted a complex health problem: genetic counseling, health insurance reform, multiple-service health centers, and the training of mental health professionals. Each team contained a law student, medical student, economist, or urban planner and a student from a discipline particularly relevant to the problem—for example, bioengineering. Twelve faculty members, representing a number of disciplines, served as a general resource to the students at scheduled meetings and informal sessions.

Interdisciplinary education presents a number of organizational problems and a number of unique educational benefits. Much was learned from the summer pilot program, and the academic year program is now being implemented. Problem orientation has proven to be an important aspect of the interdisciplinary program, in that it forces students to learn, synthesize, and then apply their knowledge. At the same time, students are able to exercise considerable initiative in defining and working on problems in a context of competing values. The center hopes thereby to enrich the graduate education of a number of students and enable them to function effectively in health-related careers.

The social control of science and technology, through the training of new kinds of professionals, is one of the most important tasks at hand for law schools, schools of science and engineering, and other programs of higher education. This task must become an ongoing process, and it needs interdisciplinary cooperation and public support. Faculty in schools of professional training in medicine, law, and other fields, are needed to help build and implement these new programs of public service and must rejoin the university. In addition, these new programs must be related to the social system and values, for only through individual and collective wisdom and temperance, induced by an appreciation of the values of others, will we control science and technology in a coherent and humane fashion (*10*).

References and Notes

1. J. Ellul, *The Technological Society* (Random House, New York, 1964), p. 251.
2. H. Green, *The New Technological Era: A View From the Law* (Monograph 1, Program of Policy Studies, George Washington Univ., Washington, D.C., 1967).
3. Sierra Club *v.* Hickel, U.S. Court of Appeals, Ninth Circuit (1970).
4. B. Portnoy, "The Role of the Courts in Technology Assessment," *Cornell Law Rev.* **55**, 861 (1970).
5. H. Folk, "The role of technology assessment in public policy," paper given at the Boston meeting of the AAAS, 29 December 1969.
6. See H. Morgenthau, "Modern Science and Political Power," *Columbia Law Rev.* **64**, 1386 (1964).
7. 42 U.S.C. 4331 *et seq.* A full review of the National Environment Policy Act is presented in an article by R. C. Peterson of Yale Law School (*Title I of the National Environmental Policy Act of 1969*). It is available from the Environmental Law Institute, 1346 Connecticut Ave., NW, Washington, D.C.
8. 5 U.S.C. 552.
9. Soucie *v.* DuBridge, U.S. District Court, District of Columbia (1970).
10. Further information on the programs discussed above is available from the author, Room 1-376, M.I.T., Cambridge, Mass. 02139.

NEWS AND COMMENT

National Academy of Sciences: Awkward Moments at the Meeting

The *Government Organization Manual* classifies the National Academy of Sciences (NAS), along with the Red Cross, as a "quasi-official" agency. And it has been suggested that the Academy stresses whichever side of its split, public/private personality is more advantageous in a given situation. But at its annual meeting last week the Academy and particularly a few Academy members were much more open than usual about what happened in the organization's closed sessions.

The most significant piece of internal business transacted was the vote to raise the limits on the annual intake of new members so that total membership will rise from the present 900 to about 1200 over the next 5 years. The added increments above the prevailing limit of 50 members a year will be recruited from the clinical sciences and the social and behavioral sciences.

The strengthening of the Academy in these disciplines is regarded as a move to make the organization better able to discharge its congressionally chartered responsibilities to advise the government. Critics have charged that the membership has been weighted too heavily toward the classical disciplines to deal effectively with societal problems which require interdisciplinary efforts.

Expansion of the Academy was accepted gracefully; other events at the usually placid business session agitated the membership more.

● The Academy grappled again with the controversial subject of "behavioral genetics" and voted by a decisive margin not to encourage expanded federal research on the effects on intelligence of genetic differences. At the same time the members turned down a committee recommendation that the Academy form an internal working group to study the feasibility of long-term research on the subject. The Academy members did, however, approve a recommendation favoring cooperation to put research in behavioral genetics in a broader scientific context.

● The membership killed a motion designed to end Academy projects involving classified work for the military and then saw Richard C. Lewontin, professor of biological sciences at the University of Chicago, resign his membership in protest.

● A rare glimpse into the Academy's involuted election process was afforded when some members objected because the name of a scientist well known in the environmental movement was apparently cut from a list of nominees by the Academy's governing council.

● A petition from reporters who cover science affairs in Washington asking that more of the Academy's operations be opened to the press was received but not acted on by Academy officials.

Greater public ventilation of occurrences at the Academy's business ses-