hamster is a particularly simple case should be borne in mind. One mechanism is concerned with the locating of objects, at least insofar as orientation of the head and body toward a stimulus source is involved. The other mechanism is concerned with the specific identification of objects, and with actions directed toward or away from them.

References and Notes

1. G. E. Schneider, thesis, Massachusetts Institute of Technology (1966).
2. The term *visual cortex* is often used to mean only the striate cortex—that is, Brodmann's area 17. However, adjacent cortical areas may be included in this term: areas which receive visual input not only from area 17 but also from the dorsal thalamus. In the literature, ablation of visual cortex has frequently meant destruction of area 17 and considerable amounts of the surrounding visual areas.
3. P. Flourens, *Recherches Expérimentales sur les Propriétés et les Fonctions du Système Nerveux dans les Animaux Vertébrés* (Bailliere, Paris, 1842); W. Bechterew, *Pflügers Arch. Ges. Physiol.* **33**, 413 (1884).
4. M. Minkowski, *Pflügers Arch. Ges. Physiol.* **141**, 171 (1911); S. Polyak, *The Vertebrate Visual System* (Univ. of Chicago Press, Chicago, 1957).
5. K. S. Lashley, *J. Comp. Neurol.* **53**, 419 (1931); ——— and M. Frank, *J. Comp. Psychol.* **17**, 355 (1934); J. A. Horel, L. A. Bettinger, G. J. Royce, D. R. Meyer, *J. Comp. Physiol. Psychol.* **61**, 66 (1966).
6. H. Klüver, *Biol. Symp.* **7**, 253 (1942).
7. J. H. Bauer and R. M. Cooper, *J. Comp. Physiol. Psychol.* **58**, 84 (1964).
8. J. D. Layman, *J. Genet. Psychol.* **49**, 33 (1936); E. E. Ghiselli, *J. Comp. Neurol.* **67**, 451 (1937).
9. L. Blake, *J. Comp. Physiol. Psychol.* **52**, 272 (1959).
10. J. M. Sprague and T. H. Meikle, Jr., *Exp. Neurol.* **11**, 115 (1965).
11. R. W. Sperry, N. Miner, R. E. Myers, *J. Comp. Physiol. Psychol.* **48**, 50 (1955); R. E. Myers, *Arch. Neurol.* **11**, 73 (1964).
12. Response variation is also emphasized by R. A. McCleary [see, for example, *J. Comp. Physiol. Psychol.* **53**, 311 (1960)] and others investigating transfer of information from one brain half to the other, and by N. Geschwind [*Brain* **88**, 237 (1965); *ibid.*, p. 585] in analyzing effects of cortical lesions in man. My approach resulted also from H. L. Teuber's emphasis [*Ann. Rev. Psychol.* **6**, 267 (1955)] on the need for "double dissociation" as a minimum requirement for distinguishing effects of manipulating two brain regions: If lesion *A* leads to effect *a* and not *b*, while lesion *B* leads to effect *b* and not *a*, then a functional distinction between the two brain regions is indicated.
13. K. S. Lashley, *J. Comp. Neurol.* **59**, 341 (1934); R. Siminoff, H. O. Schwassmann, L. Kruger, *ibid.* **127**, 435 (1966).
14. G. E. Schneider, *Psychol. Forsch.* **31**, 52 (1967).
15. The degenerated areas contained many normal or nearly normal neurons, indicating that the lateral geniculate nucleus may project to cortex outside area 17. This finding is similar to results obtained for the hedgehog by W. C. Hall and I. T. Diamond [*Brain, Behav. Evolut.* **1**, 181 (1968)].
16. L. Weiskrantz, *Neuropsychologia* **1**, 145 (1963).
17. A warning to those who may wish to replicate this result is in order: it is of critical importance that the normal animals perform well in terms of either type of error recording. I have observed that, in apparatus of slightly different design, normal animals may fail in terms of "orienting errors."
18. W. J. H. Nauta and V. M. Bucher, *J. Comp. Neurol.* **100**, 257 (1954); L. J. Garey, *Nature* **207**, 1410 (1965); R. D. Lund, *J. Anat.* **100**, 51 (1966); R. A. Giolli and M. D. Guthrie, *Brain Res.* **6**, 388 (1967).
19. M. Mishkin, in *Frontiers in Physiological Psychology*, R. W. Russell, Ed. (Academic Press, New York, 1966), p. 93; G. Ettlinger, E. Iwai, M. Mishkin, H. E. Rosvold, *J. Comp. Physiol. Psychol.* **65**, 110 (1968).
20. M. Snyder, W. C. Hall, I. T. Diamond, *Psychonomic Sci.* **6**, 243 (1966); I. T. Diamond, in *Contributions to Sensory Physiology*, W. D. Neff, Ed. (Academic Press, New York, 1967), vol. 2, p. 51.
21. M. Snyder and I. T. Diamond, *Brain, Behav. Evolut.* **1**, 244 (1968).
22. P. Abplanalp, thesis, Massachusetts Institute of Technology (1968).
23. J. M. Sprague, *Science* **153**, 1544 (1966).
24. D. Denny-Brown and R. A. Chambers, *J. Nervous Mental Disease* **121**, 288 (1955); *Trans. Amer. Neurol. Ass.* **1958**, 37 (1958).
25. N. K. Humphrey and L. Weiskrantz, *Nature* **215**, 595 (1967).
26. G. Wald and H. M. Burian, *Amer. J. Ophthalmol.* **27**, 950 (1944).
27. D. Denny-Brown, *Proc. Roy. Soc. Med.* **55**, 527 (1962).
28. P. Pasik and T. Pasik, in *The Oculomotor System*, M. B. Bender, Ed. (Harper and Row, New York, 1964), p. 40; T. Pasik, P. Pasik, M. B. Bender, *Arch. Neurol.* **15**, 420 (1966).
29. H. E. Rosvold, M. Mishkin, M. K. Szwarcbart, *J. Comp. Physiol. Psychol.* **51**, 437 (1958).
30. Symposium at the Eastern Psychological Association meetings, 1967: see R. Held, D. Ingle, G. E. Schneider, C. B. Trevarthen, *Psychol. Forsch.* **31**, 42 (1967); D. Ingle *ibid.*, p. 44; G. E. Schneider (see *14*); C. B. Trevarthen, *Psychol. Forsch.* **31**, 299 (1968); R. Held, *ibid.*, p. 338.
31. The stain, for visualizing normal axons and cell nuclei, was a modified Nauta technique developed with the collaboration of Robert Fink at M.I.T. Unmounted sections 25 microns thick, cut frozen, are washed thoroughly and put overnight in a solution of 2.5-percent silver nitrate (8 parts) and pyridine (1 part); after washing, one follows steps 5 through 7 of procedure I of R. P. Fink and L. Heimer [*Brain Res.* **4**, 369 (1967)].
32. W. J. S. Krieg, *J. Comp. Neurol.* **84**, 221 (1946).

33. Aid and encouragement throughout this work came especially from Professors H. L. Teuber and W. J. H. Nauta, and from Patricia D. Schneider. The development of the interpretations was aided particularly by discussions with the workers cited in (*30*) and with Dr. W. A. Richards. Ann Graybiel helped with the microscopic analysis that led to the preparation of the cortical map of Fig. 2. Janet Stuart helped with some of the histology. Initial support for the work came from a Public Health Service predoctoral fellowship and a training grant in psychobiology to M.I.T. from the National Institute of General Medical Sciences. Subsequent support came from PHS grant NB 06542 to Dr. W. J. H. Nauta and from NASA grant NsG 496 to Dr. H. L. Teuber.

Science and the City: The Question of Authority

The research and development activities of the Department of Housing and Urban Development are analyzed.

James D. Carroll

In his speech (*1*) accepting the first Mellon Institute Award, delivered at the Carnegie-Mellon University on 10 May 1968, D. F. Hornig asked, "Is there a crisis in science?" He answered this question with the observation that, in an immediate sense, there is a crisis in financial support. In a long-term sense, however, he argued that there is a crisis rooted in the fact that members of Congress and of the public see "a scientific community which, insisting on its purity, will not deign to communicate with the public and justify itself, but prefers to believe that its virtues are so self-evident that a right-minded society must necessarily support it on its own terms." He concluded that the scientific community through its pride and aloofness "has done much to alienate itself from the society which supports it."

Authority and Relevance of Science to Society

As Hornig's remarks indicate, the social authority and social relevance of public science and technology today are in question. While there are many reasons for this, one basic reason is that science and technology only partially meet and relate to the expectations and values of metropolitan America, particularly the expectation that some form of decent urban life can be maintained in the United States and that progress can be made in resolving the inextricable

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mix of urban and racial questions confronting the United States.

Among the basic social questions facing science and science-based technology today are questions of the extent to which science and technology are relevant to the definition and resolution of the mix of urban and racial problems of the United States, of the extent to which the priorities of what is loosely termed federal "science policy" can be restructured to express a commitment to the restoration of decent urban life in the United States, and of the extent to which academic and other scientists can transcend the limitations of their disciplines and the abstractions with which they work and inform their inquiries with a concern for metropolitan-rural development as they have done in agricultural development, national security, public health, atomic energy, space, and other areas of public concern.

The questions of authority and relevance apply not only to public science and technology but in part to the entire American system of politics and government. In its *Ninth Annual Report* (*2*), the Advisory Commission on Intergovernmental Relations outlined the severe strains in the authority of the American system of politics and government. The commission asserted, "In 1967, the American political system—and in turn, federalism and the federal system—was on trial as never before in the Nation's history with the sole exception of the Civil War. The major crisis threatening the political system and, indeed, the whole fabric of American society, was in the Nation's cities. The crisis was characterized by serious rioting, the breakdown of law and order, and in a number of areas, the disappearance of any meaningful sense of community among the residents of blighted neighborhoods" (*2*, p. 1).

National Survival and Democracy

The issue is not the survival of the system per se, but the survival of the system in a form consistent with essential democratic and constitutional values —individual liberty and opportunity, numerous centers of political power, effective constraints on centralized control, local initiative, and local freedom of choice within broad constitutional restrictions. As stated by the advisory commission, the issue is whether "we must sacrifice political diversity as the price of the authoritative action required for the Nation's survival" (*2*, p. 14).

As Bailey (*3*), Price (*4*), Kotler (*5*), and others have argued, the change in the authority of government that is occurring is characterized by a devolution of authority from public agencies and organizations to quasi-public and private organizations and groups (*6*). Law and the structures and procedures of administrative organizations based explicitly upon law express compromises and perceptions of events that are defined and codified at particular times in the context of particular social and political conditions. The rapidity and complexity of social and technological change, from a historical perspective, continuously threaten to render obsolete the perceptions and social and political conditions and compromises on which law and administrative structures and action are based. As a result, there is an increasing and persistent tendency for knowledge and authority to devolve from the most general levels of politics and government, where knowledge and authority of the common interest are expressed in law and legally based administrative action, to particular organizations of government that can operate in response to changing conditions beyond strict legal control, to quasi-public and private organizations not rigorously bound by law and tradition, and to individuals and groups systematically involved in developing and controlling processes of social and technological change. These various parties become the respositories of authority by default. In their areas of operation their perceptions, knowledge, will, and judgments become a substitute for, and in some ways the equivalent of law.

There is little question of the ability of governments to impose some form of order in urban areas by force. The widespread use of force, however, is not generally regarded as a satisfactory substitute for social order based upon voluntary assent to the authority of law. The question is how to effectively relate the authority of law and the common interest to the authority and knowledge and processes of social and technological change (*7*).

In this article I describe and analyze the movement in the federal government to design and undertake a comprehensive set of urban research and development activities. I interpret this movement as the beginning of a belated national effort to relate legal and administrative structures and processes to processes of scientific inquiry and social and technological change for purposes of urban development. I argue that the success of this movement will depend on significant changes in social and political attitudes and organizations, on significant changes in federal research and development policies and procedures, and on at least marginal changes in dominant attitudes concerning the nature and purposes of science and technology.

Background

The idea of using science and technology in a controlled, systematic way to plan, build, and administer humane cities is as old as the idea of modern science. Since Bacon (*8*) advanced an elementary form of the idea in the 16th century, generations of latter-day technocrats have tried to give it practical force (*9*). Yet, the exercise of effective public control over and effective public use of science and technology for urban development remains elusive. The possibility of the development of a meaningful science of urbanism remains remote (*10*). Technology still shapes cities far more than the public needs of cities shape technology (*11*). Intermixed with racial and economic factors, laissez-faire technology long has been and continues to be a primary determinant of urban as well as other forms of life in the United States.

To the technocrat the cure for laissez-faire technology is more technology, particularly public technology based on scientific understanding designed to extend the range of control and choice in areas of public responsibility such as planning, land use, environmental control, transportation, public housing, and public safety. But as a generation of political scientists (*12*) has observed, the exercise of meaningful control and choice in urban areas may require strong, well-structured political and fiscal systems and governmental jurisdictions that are coextensive with social and technological opportunities and needs. In most metropolitan areas these do not exist. The scientific and technological promise in metropolitan areas, like the promise of effective local government, seems to be the victim of tradition and vested interests —overt and covert racism (*13*), jurisdictional politics (*14*), industrial and labor policies and practices (*15*), inadequate fiscal policies (*16*), limited markets (*17*), fragmented governments (*18*), outdated building codes (*19*), state

constitutional restrictions upon local governments (*20*), the frequent indifference of governments to needs of central cities because of the general rural and suburban orientation of many state governments (*21*), and general disparities between public needs and private resources (*22*).

Saving the Cities

Many of the problems of effectively developing and using science and technology for urban development are coincident with problems of reconstructing fiscal and governmental systems, and of restructuring markets and other incentives to labor, industrial, academic, and other interests to induce them to cooperate in urban development. The problem is to define objectives through political processes, to obtain enough money for public programs, to limit or eliminate disincentives to cooperation, to mold science and technology into instruments for urban development, and to change perceptions of private and public good. The immediate policy question is not whether the United States should save its central cities or abandon them for an alternative such as the development of new cities. The question is whether something can be done to make existing central cities more suitable for the millions of people who in fact now live and work in them, and whether adequate steps can be taken now to plan for new cities and orderly metropolitan and rural development and the resolution of racial problems in the future (*23*).

But this policy question also poses the question of who is to define "the good" when meaningful political-jurisdictional units for this purpose do not exist in metropolitan areas. In the political language of today, public technologies should be participatory technologies (*24*)—technologies which in the processes of their development, products produced, and manner in which they are used express the choice of those who must live with them. Public housing is an example. The problem of participatory technology is that the logic of science and technology is not necessarily the logic of democracy (*25*), and it is often hard to reconcile the two. It is easier to build high-rise public housing on the basis of technological considerations and cost than to find out what people want within a cost range, to harmonize conflicting desires, and to use technology insofar as possible to obtain for people what they want.

The imperatives of technology and organizational rationality often require long-term planning and standardized processes and procedures, requirements which conflict with mercurial shifts in political expectations and demands. The impulse of the manager of large-scale processes is to insulate the "rationality" of his procedures from shifting expectations and demands, and to control these demands if he can. However, in what is regarded as a democratic system, the alternative to a reconciliation of scientific and technological values with democratic participatory values presumably is unacceptable—the emergence in urban affairs of a shadow image of the technical, military, industrial complex of which President Eisenhower (*26*) spoke, a complex that could unilaterally exercise its own will in urban development for its own purposes (*27*).

Whatever the merits of these observations, an alternative perspective on the nature of the relation of social to technological change also is useful. As Hooper (*28*) of the President's Office of Science and Technology has observed,

> The two-culture theory, technocrat vs. urbanist, . . . tends to inhibit a deeper understanding of the process of societal change. To be sure, there are engineers advancing single-minded solutions to narrowly conceived problems but they are not the critical actors. Change is generated when specific opportunities come into view which promise greater benefits than costs to all of the primary decision-makers. Therefore it is unreasonable to expect local government to "clean up the mess" of fiscal policies, government organization, etc., as a precondition to the rational exploitation of opportunities. I believe that only when the technologies of urban services and facilities are attractive enough, will the heavy cost of institutional change be voluntarily incurred at the local level.

The urban science and technology movement is directed both to the improvement of the operations of governments themselves in planning, budgeting, and line administration (*29*), and improvements in carrying out public functions in both new (*30*) and old cities. Various attempts are being made to identify relevant scientific principles and technologies. Harris (*31*), for example, suggested that five broad areas of scientific and technological understanding are particularly relevant —power sources, microprocessing, communication and control, biological control, and societal self-control.

The movement is widely dispersed throughout both the public and private sectors, as is evident in the scope of the activities which have been and are being undertaken, such as the State of California–aerospace industry systems studies (*32*); the Experimental City activities (*33*); the New York City–RAND contract (*34*); the IBM–New Haven information system and many other urban information system activities (*35*); the joint effort of the Department of Justice and the Institute for Defense Analyses (*36*) to design a research and development program for public safety; and other activities (*37*). However, the focal point of the movement at the federal level is the Department of Housing and Urban Development (HUD).

Research and Development at HUD

The effort within HUD to undertake a set of comprehensive urban research and development (R & D) activities with the support of the President's Office of Science and Technology is the result of the convergence of several political and economic trends in the 1960's at the policy-making levels of the federal government. These include the systematic application of science to technology in this century, with the result that basic inquiries often have become a significant source of useful new products and processes (*38*); the nationalization of the economy and the domination of the income tax by the federal government (*39*), which have placed the federal government in a commanding financial position over state and local governments and have given the federal government the means to undertake and support R & D activities concerning almost every phase of contemporary life (*40*); the nationalization of R & D since the 1940's, a factor which generated a pluralistic (*41*), national legal and administrative system for the wholesale, conscious direction of scientific and technological activity toward national objectives; the increasing emphasis on transferring technology from one sector of the economy to another, and from use in one public function to others (*42*); the slight but distinct increase in federal support of social science research in the 1960's (*43*); the continuing demands for "equity" in the geographical distribution of research funds (*44*) and a more effective application of R & D to social needs (*45*); and the extension of the involvement of the federal government in urban development (*46*).

The federal commitment in the late 19th and early 20th centuries to public health and housing in urban areas has been extended in various forms since the 1940's to almost every aspect of urban public life: fire and other disaster protection and insurance; education; refuse collection and disposal; libraries; police protection; health; urban renewal; housing; parks and recreation; public welfare and employment; hospitals and medical care facilities; transportation; planning; water supply and sewage disposal; pollution control; poverty and economic development; and the effectiveness of metropolitan governments.

The scope of this list indicates the tendency of the concept of urban development in a predominately urban society to become coextensive with the idea of social well-being. It also indicates that public financial power is concentrated in the federal government, and not in state and local governments. The federal commitment varies substantially from function to function, but rarely extends to the direct provision of services to the public. The primary responsibility for service remains with state and local governments and with private groups (*47*).

The convergence of these trends is an expression of a belated national realization that America has become an urban nation, and that the authority of law and government must be extended to encompass new and rapidly evolving social patterns and needs on a national basis because the relevant social patterns such as the migration of population are national in nature. This convergence also expresses a belated and still tentative commitment to the application of a significant share of the nation's fiscal resources and managerial, scientific, and technical capability to such critical areas of common concern as housing and public safety.

Laws Authorize Urban R & D

In the 1960's these trends have come into sharp policy and programmatic focus in the effort of the Department of Housing and Urban Development to create a comprehensive urban research and development program. There are over 20 distinct statutory authorizations for HUD to conduct and support urban research and related activities, some of which date from the late 1940's (*48*). Title III of the Housing Act of 1948 (*49*) authorized HUD's predecessors to study housing codes and the standardization of code requirements. The Housing Act of 1949 (*50*) extended the authorization to housing technology and economics. From 1948 to 1954, Congress appropriated over $5 million to carry out these authorizations. The money was used to support 89 studies such as *Local Development and Enforcement of Housing Codes (51), How to Make and Use Local Housing Surveys (52), Housing Market Analysis (53),* and *Material and Labor Analysis: Housing Framing Systems (54).* In 1953, Congress terminated this research program with the following provision in the Independent Offices Appropriations Act of 1954: "Not to exceed $125,000 shall be available for liquidation of the housing research program not later than April 30, 1954" (*55*). Various segments of the housing industry opposed the program as a threat to the industry's autonomy, while many congressmen regarded it as a form of socialistic experimentation and an unwarranted intrusion by government into the domains of private enterprise. The demise of this program coincided with the rise of research empires in the Department of Defense, the National Institutes of Health, the National Science Foundation, the Atomic Energy Commission, and, a few years later, in the National Aeronautics and Space Administration. These and other departments and agencies incidentally funded research related to urban development, but none of these departments and agencies concentrated on this area of inquiry. In a survey conducted in 1963, the Bureau of the Budget found that 12 federal agencies were administering 400 urban research projects at a cost of $40 million (*56*).

Table 1. Appropriations for urban studies and housing research received by the Housing and Home Finance Agency and the Department of Housing and Urban Development, 1948–1968.*

Fiscal year or years	Appropriation	Statutory authority
1948–1953	$4,876,526	Housing Act of 1948, Housing Act of 1949
1954	$125,000 (Appropriated to liquidate the housing research program)	Independent Offices Appropriation Act of 1954
1955	0 (no request)	
1956	0 (no request)	
1957	0 ($175,000 request for census study of housing denied)	
1958	0 ($920,000 request for "housing studies" denied)	
1959	0 (no request)	
1960	0 (no request)	
1961	0 ($600,000 request for "housing studies" denied)	
1962	$375,000 ($900,000 requested)	Housing Act of 1948,
1963	$375,000 ($1,450,000 requested)	Housing Act of 1949
1964	$387,400 ($2,500,000 requested)	
1965	$387,400 ($1,5000,000 requested)	
1966	$750,000 ($1,500,000 requested)	
1967	$500,000 ($750,000 requested)	
1968	$10,000,000 ($20,000,000 requested)	Housing and Urban Development Act of 1966

* Does not include funds for demonstration activities and statistical studies. Source, Department of Housing and Urban Development and Independent Offices Appropriations Acts, 1948–1968.

The predecessor of HUD, the Housing and Home Finance Agency (HHFA), received appropriations for data collection and demonstration activities in the 1950's and early 1960's, but did not receive explicit appropriations for general research until fiscal year 1962. In response to HHFA's budgetary request for that year, the House and Senate Appropriations Conference Committee requested from HHFA a priority list of proposed research projects, picked the projects of which it approved, and appropriated $375,000 for their support. As is indicated in Table 1, the level of appropriations for general urban research did not materially change until 1968, when the figure jumped from $500,000 for fiscal year 1967 to $10,000,000 for fiscal year 1968.

In the early 1960's, HHFA pressed for substantial increases in general research funds in its budgetary requests and publicly laid the foundation for an expanded research program through the support of a series of conferences and reports. These included a conference on the rationalization of research on housing and urban problems conducted in November 1960; a study of housing programs and research policies undertaken by E. M. Fisher (*57*) of Columbia University in the same year; and the design of a comprehensive program of

urban research by H. S. Perloff of Resources For the Future, Inc., in 1960 and 1961 (*58*). A number of individuals, government agencies, and other organizations have carried the movement forward in the 1960's (*59*).

Research Policies of HUD

Robert Wood has become the principal architect of the HUD research program. Wood combined long-standing interests in urban development and in science and public policy as a professor of political science at Massachussetts Institute of Technology in the early 1960's. When HUD was established in 1965, Wood was named undersecretary. This position has enabled him to combine and express his interests in urban development and science policy in the form of the department's research policies, subject to the limitations imposed by the traditions of America's disregard of its central cities, congressional and industrial and labor distrust of urban research, and various administrative and other constraints. The support of the President's Office of Science and Technology (OST), particularly the role of Hornig and Hooper of that office in mediating among various parties in interest in the Executive Branch, has been an important factor in the translation of the idea of a comprehensive urban research program into authorizing legislation, appropriations, and administrative action. In the case of HUD's research program, OST departed from its usual role as an overviewer and critic of research activities of federal departments and agencies and became an advocate of and participant in development of this program (*60*).

President Johnson signed the law establishing HUD on 9 September 1965 (*61*). The next year Congress, in Section 1010 of the Demonstration Cities and Metropolitan Development Act (*62*), directed this department to

> . . . conduct research and studies to test and demonstrate new and improved techniques and methods of applying advances in technology to housing construction, rehabilitation, and maintenance, and to urban development activities; and to encourage and promote the acceptance and application of new and improved techniques and methods of constructing, rehabilitating, and maintaining housing, and the application of advances in technology to urban development activities, by all segments of the housing industry, communities, industries engaged in urban development activities, and the general public.

Section 1011 of the act authorizes HUD to undertake

> a comprehensive program of research, studies, surveys, and analyses to improve understanding of the environmental conditions necessary for the well-being of an urban society. . . .

Although similar authorizations exist in earlier statutes, Sections 1010 and 1011 express renewed congressional interest in urban R & D.

In an example of the use of processes of inquiry to generate support for an evolving policy, HUD and OST invited representatives of universities, governmental agencies, and various other organizations to examine "Science and the city" at Woods Hole from 5 to 25 June 1966 (*63*). The Woods Hole conference was an attempt by HUD to publicize and to generate support for its planned research activities (*64*) as well as an attempt to obtain advice from knowledgeable people. It was also an attempt to create an image of itself as a department attuned to the forward-looking politics of knowledge and science rather than the traditional politics of middle-class ideology and vested economic interests with which its predecessors generally were associated.

On 14 March 1967 President Johnson (*65*) recommended three measures to lay the foundations of a federal urban R & D program:

> First, I recommend legislation to authorize a new Assistant Secretary in the Department of Housing and Urban Development for research, technology, and engineering.
>
> Second, I am asking the Secretary of Housing and Urban Development to encourage the establishment of an Institute of Urban Development, as a separate and distinct organization.
>
> Third, I recommend: twenty million dollars in fiscal 1968 funds appropriated to the Department of Housing and Urban Development for general research. . . .

On 2 May 1967, 11 months after the Woods Hole conference, Secretary Weaver (*66*) announced the creation of HUD's Office of Urban Technology and Research. The office was assigned staff responsibilities for coordinating existing demonstration, data-gathering, and research activities within the department, and designing a comprehensive budget for an urban R & D program. The office also was assigned line responsibilities for the administration of several existing grant and contract programs (*67*). These include the Urban Planning Research and Demonstration Program, which has supported such projects as a study of metropolitan area fiscal disparities by the Advisory Commission on Intergovernmental Relations ($60,000), and the development of a program to demonstrate the use of systems analysis techniques in urban planning by the International City Manager's Association ($80,000); the Low-Income Housing Demonstration Program, which has supported such projects as the development of cost-saving techniques in the construction of low-income, multilevel housing (Illinois Institute of Technology Research Institute, $239,000), and the development of housing for families of migratory farm laborers (Department of Finance of the State of California, $243,000); and the Urban Renewal Demonstration Program, which has supported such projects as the development of a system for storing and retrieving bibliographical references to material used by urban renewal and planning technicians (City University of New York, New York, $186,442), and a report on experiences of selected communities in residential rehabilitation programs (Urban America, Inc., Washington, D.C., $45,230).

T. F. Rogers, then Deputy Director for Electronics and Information Systems, Defense Research and Engineering, Office of the Secretary of the Department of Defense, was appointed director of the Office of Urban Technology and Research by HUD Secretary Robert Weaver in May 1967. The migration of defense-research administrators to civilian agencies—HUD, Interior, Post Office—has become a pattern in the 1960's, as it was to a greater degree in the 1940's and early 1950's.

In the spring of 1967 HUD recruited a "treeful of owls" on a not-for-pay, loan basis from think tanks such as MITRE Corporation and the Institute for Defense Analyses for advice on the design of a research program budget for fiscal year 1968 for presentation to the Bureau of the Budget and Congress in 1967. This research program budget, which encompassed all research-related activities within HUD, followed the five major programming, planning, and budgetary categories used throughout this department: (i) housing, (ii) land use and community development, (iii) public facilities and services, (iv) assistance to local governments in efficient administration, and (v) management of urban programs and resources. With the Department of Transportation, HUD also sponsored two 1967 summer studies of the potentials of urban research and

development conducted by the RAND Corporation (*68*), and independently contracted for sustained inquiries into the physical and social science potentials of urban R & D with the National Academy of Sciences and the National Academy of Engineering (*69*). In late 1967 and early 1968, HUD also initiated a series of meetings with representatives of other federal departments and agencies in an attempt to lay a foundation for informal coordination of all federal urban-directed R & D activities. It did so under cover of a letter sent by Hornig on 11 October 1967, to the heads of all major federal departments and agencies. The letter outlined HUD's responsibilities for developing a comprehensive federal urban R & D program, and requested the cooperation of other departments and agencies.

Appropriations for HUD

On 6 April 1967, Under Secretary Wood (*70*) explained HUD's request for $20 million for general urban research and technology to the Independent Offices and Department of Housing and Urban Development Subcommittee of the House Appropriations Committee. He justified the request on the following grounds.

> First, the past 20 years of large scale defense contracting have made it clear that government and industry *can* work together on major undertakings. Moreover, this experience, together with that of the AEC [Atomic Energy Commission] and NASA [National Aeronautics and Space Administration], has clarified the optimum roles for government, for industry, and for the universities.
>
> Secondly, both the public and private sectors have increasingly recognized the benefits of government-sponsored research in non-defense areas, and this research has grown accordingly.
>
> Third, the spirit of innovation and problem solving is now clearly a national characteristic. The drive, the vigor, and the enthusiasm that have been generated by past accomplishments create an atmosphere which encourages the seeking of new challenges. The unsatisfactory condition of our cities and towns is one such challenge. It is not possible to attend a meeting of a professional society anywhere in the country without sensing a growing concern about urban problems—and a conviction that new approaches and new techniques can help solve them.

Congress subsequently appropriated $10 million for HUD general research for fiscal year 1968. In its first year, the Office of Urban Technology and Research entered into several research and development contracts, including (i) a $75,000 contract with the National Academy of Engineering for a study of future developments in communications technology which could affect urban life and urban development; (ii) a $250,000 contract funded jointly by HUD ($200,000) and the Department of Defense ($50,000) with the Institute of Defense Analysis to determine if production costs for low-income housing can be reduced through large-volume production to meet unified public, private, and military housing markets in selected urban areas; (iii) initial study-phase contracts for a multimillion dollar national "in-city" experimental low-cost housing project designed to identify constraints on the use of new products as well as innovations in design, financing, and construction and rehabilitation of low-cost housing. Two sets of first phase contractors were selected. One included Abt Associates, Inc., Cambridge, Massachusetts, and Daniel Mann, Johnson and Mendenhall, Los Angeles, California; and the other included Building Systems Development, Inc., San Francisco, California, and Westinghouse Electric Corporation, Pittsburgh, Pennsylvania. (iv) A series of 1968 summer conferences in universities was also supported by HUD at various funding levels, on a range of urban problems, with an emphasis upon problems involving the department's programs. The universities were University of California, Berkeley; University of Chicago; University of Colorado; Columbia University; University of Illinois, Chicago; Massachusetts Institute of Technology; University of Miami at Miami; New York University; and Texas A&M.

In 1967–1968 HUD also made several decisions that will have major effects upon the nature of its future research and development activities.

Six priority R & D areas were identified: volume production of low-cost housing; the study of social and behavioral problems related to the provision of housing for low-income families; the development of the Model Cities Program as an experimental program; the use of the federal surplus urban land program (*71*) for urban R & D; the improvement of urban planning and administrative processes; and the establishment of an effective network for exchange of urban R & D information. The administration of R & D activities were modeled (*72*) roughly on the procurement and bid pattern of the Department of Defense and the National Aeronautics and Space Administration, rather than on the unsolicited proposal peer group review, grant pattern of the National Science Foundation and the National Institutes of Health.

Requests for proposals directed to qualified commercial, industrial, academic, and other organizations are now being issued, and for the most part contractors are being selected on the basis of open competitive bidding. This procedure is more suitable for directed than undirected research and is generally consistent with the intention (*73*) to support research closely related to HUD's operational responsibilities and programs.

At the request of the Executive Office of the President, substantial funds are being earmarked to support the Institute for Urban Development, the not-for-profit federal think tank for the cities established by President Johnson (*74*) in late 1967. The work of the institute will consist of basic research, sensitive policy questions, the independent evaluation of federal and other governmental urban activities, and problems that transcend departmental and agency lines. The institute may become in time the nucleus of a number of satellite research organizations located in metropolitan areas. In its first years, the institute may further fragment urban R & D efforts. In time, however, it should become a multidisciplinary center for the planning and conduct of a national program of coherent urban R & D activities.

Prospects and Problems

In recent years there has been much speculation concerning the potentials of science and technology for urban development. Research and development activities at HUD are designed to determine what the real potentials are.

These activities may have their most useful and immediate effects in the development of social and managerial technology as distinguished from hardware technology. By social technology I mean a method of organizing fiscal, legal, architectural, planning, managerial, and technological expertise for such purposes as rehabilitating housing in a ghetto area. The fact that HUD has supported the development of participatory social technology in the early 1970's could prove to be the counterpart of support of the development of

"systems analysis" and "systems engineering" on the part of the National Aeronautics and Space Administration in the 1960's.

The development of social technology is of pressing importance because of the movement in most large central city ghettos toward community self-determination and control under such labels as "black power." Community self-determination groups generally reject the political and economic "imperialism" of the community at large. They claim the right to make their own decisions concerning education, housing, and other activities. In the words of one of several community-development bills introduced in the 90th Congress,

> [T]here exists today a nation within a nation composed of millions of Americans in urban slums. . . . [P]rograms. . . . should aim to restore to the people of local communities the power to participate directly and meaningfully in the making of public policy decisions on issues which affect their everyday lives. Such programs should aim to free local communities from excessive interference and control by centralized governments. . . . [T]he role of government at all levels should be to reinforce, guarantee, and support individual and mutual self-help efforts to make their maximum contribution to the strength and welfare of the Nation.

While groups in favor of community self-determination reject the political and economic "imperialism" of the larger community, many of these groups are increasingly aware that technological capability is essential to effective action in housing, economic development, and other activities. The kind of social technology that HUD and other organizations such as the Office of Economic Opportunity may be able to organize for use in central cities may become an important instrument for relating self-determination groups to the larger community. In a practical and ideological sense, technology may be one of the few remaining ways of relating the authority of law and government to the authority of self-determination groups.

Obstacles to HUD Program of R&D

Despite these and other possibilities, HUD's research and development activities face obstacles. Many of these are political in nature and involve industrial, labor, and congressional wariness of urban R & D, and political entanglements inherent in working through the American system of over 90,000 state and local governments.

Industrial opposition to federally supported, large-scale R & D efforts in housing construction may be substantial. Various segments of the housing industry have long opposed federal involvement in housing R & D. In the 1960's this opposition was expressed in response to the Department of Commerce's proposal to establish a civilian industrial technology program.

In August 1962, the Department of Commerce requested from Congress an appropriation of $7,400,000 to stimulate research and innovation in the textile and construction industries, with an emphasis on the housing segment of the construction industry. This request was supported by reports of the Building Research Advisory Board, a unit of the National Academy of Sciences, and the White House Panel on Civilian Technology, which stressed the need for research on housing. The prevalent industrial response to the Commerce Department's proposals was expressed in a 1963 report (*75*) by the Construction and Community Development Committee of the Chamber of Commerce of the United States.

> The construction industry leaders of business firms and associations have not been asked if they want a centralization of responsibility for research and development vested in the federal government. . . . The Construction Civilization Industrial Technology Program makes no contribution to the private enterprise system. The private enterprise system requires limited government. The Construction Civilian Industrial Technology Program adds more government intervention and more government spending at a time when less government intervention and lower levels of federal spending are most needed by the construction industry.

At a conference (*76*) convened by the Construction and Community Development Committee in 1963, the proposed R & D program was vigorously denounced by 14 representatives of several of the major building and housing trade and professional associations and corporations in the United States. Only one speaker supported the proposed program. The program never received approval from Congress.

In an effort to induce and coordinate industrial cooperation in urban development, HUD established an Office of Business Participation on 26 February 1968 (*77*). There has been a significant shift in business ideology toward urban development since 1963 (*78*), and various corporations and trade and professional groups are making significant contributions to urban development in a variety of ways (*79*). However, it remains to be seen whether federally supported urban development activities —including but not limited to the provision of housing—will prove financially attractive enough to induce large-scale industrial cooperation and participation. The pressing need is effectively to couple the profit incentive with social welfare objectives. Even if this can be done, it may be extremely difficult to insulate industrial and business operations and their particular forms of rationality and efficiency from political demands. In effect, business in some ways is being asked to exercise the powers of government. It may have to assume the responsibilities as well, particularly the responsibility of being responsive to social and political demands. Business may encounter the complex entanglements encountered by local governments in urban affairs, as business has encountered the entanglements of international politics in international operations. Some form of corporate entity may prove necessary to mediate between business and political groups.

Industrial opposition to innovation in housing and various other aspects of urban development has been reinforced by organized labor's opposition (*80*) based upon fears of jurisdictional and other possible changes. It will be necessary to restructure the incentives to labor as well as to business.

Scientific and technological innovations affecting urban development must, to some degree, be carried out by the 90,000 local governments in the United States. Many of these governments do not have the financial, technical, and political capabilities to make effective use of technical innovation in carrying out their functions. Jurisdictional conflicts and political fears long have been barriers to change and innovation, and may be so in the future.

HUD Needs Unified Program of Research, Education, and Application

It also is politically significant that HUD so far has not moved to establish a decentralized, integrated program of research, education, and application similar to the agricultural research and extension pattern (*81*). Although this exact pattern may not be appropriate to an urban society, the politically significant point is that the agricultural program has supporters in communities in every state in the United States, and this support is expressed in congres-

sional action. The R & D program of HUD does not at present command similar support.

So far, HUD has not moved to design a large-scale academic R & D program that could simultaneously meet three strong needs and demands and generate widespread political support for its R & D activities: the desperate financial need of many universities and colleges for educational and research funds (*82*); the related need or demand for a wider geographical and institutional distribution of R & D funds (*83*); and the apparent need for the direction of more of the nation's brainpower to urban affairs. Through a large scale system of institutional grants directed to urban education, research, and application, each of these various needs and demands could simultaneously be met. The existing proposals (*84*) for institutional grants could be redesigned to reflect an urban educational and research and development orientation.

The most serious substantive problem with this proposal is that the present compartmentalization of knowledge in universities in the form of academic disciplines is not coincident with social need (*85*). However useful this compartmentalization may be for the inner development of knowledge, it is only marginally useful for the resolution of social questions. For this reason urban R & D may ultimately be centered in think tanks and similar organizations rather than in the academic departments of universities because think tanks are committed to translating academic knowledge into socially useful forms.

However, this problem may be less an organizational one than a problem concerning the nature of the development of knowledge in the modern world. It is unclear whether the social and physical sciences can be melded into one science of metropolitan development. Some version of "systems analysis" and "systems engineering" (*86*) may in time prove appropriate to the need, but so far the promise has exceeded the performance (*87*).

There also are substantial administrative problems involved in HUD's attempt to undertake a comprehensive urban R & D program because many other federal agencies have jurisdiction over matters such as education and health that affect urban development. This fact poses a variation of the familiar problem of coordinating R & D activities of various agencies. In time a reorganization of federal agencies concerned with urban affairs may be necessary.

The most difficult question is whether existing or new knowledge and technological processes will be of much use if the objectives for which these should be used cannot be defined clearly through the American political system. For this reason, urban research should also be directed to political attitudes and processes—research designed to find ways consistent with constitutional values of removing the political and social obstacles that now impede effective action to resolve the mix of urban-racial problems facing the country, The question of adequate federal support of political science research and other forms of research on political problems has proven nearly intractable. The problem (*88*) is to support such research with adequate controls which will ensure relevancy without being so rigid as to destroy the integrity of such research, and which will not generate opposition from the forces of the status quo, whether represented in Congress or elsewhere. From its quasi-private position the urban institute may be able to undertake sensitive research that regular departments and agencies cannot or will not undertake or support.

Conclusions and Implications

Authority depends largely upon the capacity of an individual or an organization to satisfy expectations and values. It is only secondarily a matter of power or force.

There are many indications that the nature of authority in this century is undergoing profound changes perhaps comparable in magnitude to those that occurred in the Renaissance and Reformation. The change clearly is related to the increasingly important role of knowledge in society. The central social and economic role of land in a feudal society and of machinery in an industrial society is filled by organized knowledge in a science-based, noetic society. By necessity, government is increasingly involved in the development and management of organized knowledge for public purposes. At the same time governmental and political activity is measured in terms of the expectations and values generated by the development and communication of new knowledge at an increasing rate. The authority of knowledge undermines and often replaces the authority of tradition and the authority of law.

There are many indications that the rapidity and complexity of social and technological change have rendered obsolete many of the perceptions and compromises expressed in law and existing governmental structures and organizations. The effectiveness and relevance of existing political and governmental processes are in question. This is particularly true in urban areas, where the jurisdictions and structures of governments and political systems generally are regarded as obstacles to the satisfaction of public needs.

In many areas of governmental responsibility, science and technology have been used to increase the effectiveness of governmental action. For example, scientific research has been considered an integral part of agricultural development for almost a century. However, this has not been true in urban development, an extremely complex area of concern because it involves many intricate social, personal, and political aspects of life. As public concern over urban development has increased, the relevance of science and technology to the dominant domestic concerns of the nation has come into question because of the lack of research traditions relating to urban development and because of uncertainty over the meaning of "urban science and technology" and "urban research and development."

The HUD R & D effort is an attempt to relate processes of law and government to processes of science and technology for the purposes of urban development. It may be some time before this effort produces substantial results. If successful, it should increase the effectiveness of legal and governmental action in urban areas. It also should add a new dimension to public science and technology and strengthen the case for public support of research and development in the future.

This movement may require a greater involvement in political and social matters than some scientists may consider necessary or desirable. It is possible that the idea of science itself in time may change to reflect a greater idea of social relevance.

In the immediate future, HUD's R & D activities may help to build technological bridges between ghetto communities and the nation at large. In the more distant future, these activities may help to make law and government, and science and technology, more responsive to evolving urban conditions and needs.

References and Notes

1. D. F. Hornig, *Science* **161**, 248 (1968).
2. Advisory Commission Intergovernmental Relations, *Ninth Annual Report* (U.S. Government Printing Office, Washington, D.C., 1968).
3. S. K. Bailey, personal communication.
4. D. K. Price, *The Scientific Estate* (Harvard Univ. Press, Cambridge, Mass., 1965).
5. M. Kotler, in "Urban America—goals and problems," *Report of the Subcommittee on Urban Affairs of the Joint Economic Committee, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967), pp. 170–191.
6. A. Pifer, "The quasi nongovernmental organization," *1967 Annual Report of the Carnegie Corporation of New York* (Carnegie Corp., New York, 1968), pp. 3–16.
7. J. D. Carroll, "Noetic authority," in preparation; see also V. A. Thompson, *Modern Organization* (Knopf, New York, 1961).
8. F. Bacon, *Essays and New Atlantis*, G. S. Haight, Ed. (Black, New York, 1942).
9. W. H. G. Armytage, *The Rise of the Technocrats* (Routledge, London, 1965). See also N. Eurich, *Science in Utopia* (Harvard Univ. Press, Cambridge, Mass., 1967).
10. C. Kimball, in "Urban America—goals and problems," *Report of the Subcommittee on Urban Affairs of the Joint Economic Committee, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967), pp. 87–92. See also L. F. Schnore and H. Fagin, Eds., *Urban Research and Policy Planning* (Sage Publications, Beverly Hills, Calif., 1967).
11. Corplan Associates, *Technological Change: Its Impact on Industry in Metropolitan Chicago* (Corplan Associates, Chicago, 1964); R. Vernon, *Metropolis 1985* (Doubleday, Garden City, N.Y., 1963); L. Mumford, *The City in History* (Harcourt, Brace and World, New York, 1961).
12. For example, D. R. Grant, "The metropolitan government approach," *Urban Affairs Quart.* **3**, 103 (March 1968); J. A. Rehfuss, "Metropolitan government: Four views," *ibid.*, pp. 91–111 (June 1968).
13. *Report of the National Advisory Commission on Civil Disorders* (U.S. Government Printing Office, Washington, D.C., 1968).
14. Advisory Commission on Intergovernmental Relations, *Factors Affecting Voter Reaction to Government Reorganization in Metropolitan Areas* (U.S. Government Printing Office, Washington, D.C., 1962).
15. *Hearings Before the National Commission on Urban Problems* (U.S. Government Printing Office, Washington, D.C., 1968), vols. 1 and 2; "Lowering the Cost of Housing," *Progr. Archit.* **49**, entire issue (June 1968).
16. A. K. Campbell and S. Sacks, *Metropolitan America* (Free Press, New York, 1967); "Revenue sharing and its alternatives: What future for fiscal federalism," *Report of the Subcommittee on Fiscal Policy, Joint Economic Committee, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967).
17. The restrictive effects of limited markets for public technologies is a recurrent theme in the literature on business, technology, and the city. For example, D. L. Birch, *The Businessman and the City* (Harvard Univ. Graduate School of Business, Cambridge, Mass., 1967).
18. There are over 90,000 governments in the United States. See Advisory Commission on Intergovernmental Relations, *Governmental Structure, Organization and Planning in Metropolitan Areas* (U.S. Government Printing Office, Washington, D.C., 1961).
19. Institute for Applied Technology, National Bureau of Standards, *The Performance Concept: A Study of Its Application to Housing* (U.S. Department of Commerce, Washington, D.C., 1968); Advisory Commission on Intergovernmental Relations, *Building Codes: A Program for Intergovernmental Reform* (U.S. Government Printing Office, Washington, D.C., 1966).
20. Advisory Commission on Intergovernmental Relations, *State Constitutional and Statutory Restrictions Upon the Structural, Functional, and Personnel Powers of Local Government* (U.S. Government Printing Office, Washington, D.C., 1962).
21. G. E. Baker, *Rural Versus Urban Political Power* (Doubleday, New York, 1955); P. T. David and R. Eisenberg, *Devaluation of the Urban and Suburban Vote* (Bureau of Public Administration, Univ. of Virginia, Charlottesville, 1961).
22. J. K. Galbraith, *The Affluent Society* (Houghton Mifflin, Boston, 1958).
23. The Housing and Urban Development Act of 1968 (Public Law 90–448, 1 August 1968) is the first urban development act to emphasize the importance of both new and old cities. Title IV authorizes the Department of Housing and Urban Development to guarantee financial obligations up to $50 million incurred in the development of a "new city."
24. See M. Kotler, *Self Government in the City: The Neighborhood Foundation* (Institute for Policy Studies, Washington, D.C., 1966). Public Law 89–754 (3 November 1966), which authorized the Model Cities Program, requires "widespread citizen participation in the program" [Sec. 103(a)(2)], as well as "maximum possible use of new and improved technology" [Sec. 103(b)(3)].
25. B. Harris, "The limits of science and humanism in planning," *J. Amer. Inst. Planners* **33**, 324 (1967).
26. President Dwight D. Eisenhower, *The Military–Industrial Complex* (Congressional Quarterly Service, Washington, D.C., 1968).
27. R. A. Cloward and F. F. Piven, "Corporate imperialism for the poor," *Nation* **205**, 367 (1967); see also M. Harrington, *Toward a New Democratic Left* (Macmillan, New York, 1968).
28. W. Hooper, personal communication.
29. *Governing Urban Society: New Scientific Approaches* (American Academy of Political and Social Science, Philadelphia, 1967).
30. Editorial, "The instant city," *Fortune* **75**, 135 (1967).
31. B. Harris, "The new technology and urban planning," in *Urban Research and Policy Planning*, L. F. Schnore and H. Fagin (Sage Publications, Beverly Hills, Calif., 1967), pp. 363–388.
32. H. R. Walt, "Technology and the American economy," *Report of the National Commission on Technology, Automation, and Economic Progress* (U.S. Government Printing Office, Washington, D.C., 1967), vol. 5, appendix, pp. 47–73.
33. A. Spilhaus, "The experimental city," *Science* **159**, 710 (1968).
34. "City hires RAND Corporation to study four agencies," New York *Times*, 9 January 1968, p. 31, column 2; "The think tank comes to the big city," *ibid.*, 14 January 1968, section 4, p. 2, column 4; *Comment*, 17 January 1968, p. 46, column 3; *ibid.*, 18 January, p. 42, column 5; *ibid.*, 19 January, p. 46, column 2.
35. Systems Development Corporation, *Urban and Regional Information Systems* (Systems Development Corp., Santa Monica, Calif., 1968).
36. Institute for Defense Analyses, "Science and technology," *A Report to the President's Commission on Law Enforcement and Administration of Justice* (U.S. Government Printing Office, Washington, D.C., 1967). See also "Department of Justice appropriations, fiscal year 1969," *Hearings before the Subcommittee on Departments of State, Justice, and Commerce, and Related Appropriations, House Committee on Appropriations, 90th Congress, 2nd Session, 1968* (U.S. Government Printing Office, Washington, D.C., 1968), pp. 362–389.
37. Editorial, "Los Angeles' plunge into technology," *Nation's Cities* **6**, 16 (June 1968).
38. For a recent survey see M. Kransberg, "The unity of science—technology," *Amer. Sci.* **55**, 48 (1967).
39. R. Lekachman, *The Age of Keynes* (Random House, New York, 1968).
40. "Science, technology, and public policy during the 90th Congress," *Report of the Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 90th Congress, 2nd Session* (U.S. Government Printing Office, Washington, D.C., 1968).
41. Organization for Economic Cooperation and Development, *Reviews of National Science Policies: United States* (Organization for Economic Cooperation and Development, Paris, 1968).
42. For example, U.S. Arms Control and Disarmament Agency, *Defense Systems Resources in the Civil Sector* (U.S. Government Printing Office, Washington, D.C., 1967); National Science Foundation, *Proceedings of a Conference on Technology Transfer and Innovation* (U.S. Government Printing Office, Washington, D.C., 1967).
43. Editorial, "Expenditures continue upward—R and D associated with social problems on increase." *Battelle Tech. Rev.* **17**, 2 (January 1968); "The use of social research in federal domestic programs", *Report of the Research and Technical Programs Subcommittee, House Committee on Government Operations, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967).
44. For example, Senator W. Proxmire, "Better distribution of federal research and development funds can help solve rural-urban problems," *Congressional Record*, 19 October 1967 (daily ed.), p. S15034.
45. D. S. Greenberg, *Science* **160**, 400 (1968).
46. No standard history has been written. See "Basic laws and authorities on housing and urban development," *Report of the House Committee on Banking and Currency, 90th Congress, 2nd Session* (U.S. Government Printing Office, Washington, D.C., 1968).
47. For an analysis of the significance of this point see the testimony of A. K. Campbell, in Creative federalism," *Hearings before the Subcommittee on Intergovernmental Relations, Senate Committee on Government Operations, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967), part 2-B, pp. 846–872.
48. The idea of a federal urban research and development program was advanced in 1940 by R. H. Denton, in "Toward more productive housing," *Senate Temporary National Economic Committee, 76th Congress, 3rd Session* (U.S. Government Printing Office, 1940), pp. 123–194.
49. Public Law 901, 80th Congress (1948).
50. Public Law 171, 81st Congress (1949).
51. G. R. Barnhart, *Local Development and Enforcement of Housing Codes* (U.S. Government Printing Office, Washington, D.C., 1953).
52. Bureau of Business and Social Research, University of Denver, Colorado, *How to Make and Use Local Housing Surveys* (U.S. Government Printing Office, Washington, D.C., 1954).
53. C. Rapkin, L. Winnick, D. Blank, *Housing Market Analysis*, report of the Institute for Urban Land Use and Housing Studies, Columbia University, City of New York (U.S. Government Printing Office, Washington, D.C., 1953).
54. J. T. Lendrum, *Material and labor analysis: Housing framing systems*, report of the University of Illinois Small Homes Council, Chicago, Illinois (U.S. Government Printing Office, Washington, D.C., 1954).
55. Chapter 302, Public Law 176, 83rd Congress (1954).
56. Bureau of the Budget for the Subcommittee on Intergovernmental Relations, Senate Committee on Government Operations, 88th Congress, 2nd Session, *Urban Research Under Federal Auspices* (U.S. Government Printing Office, Washington, D.C., 1964).
57. E. M. Fisher, *A Study of Housing Programs and Policies* (Housing and Home Finance Agency, Washington, D.C., 1960).
58. H. S. Perloff, *A National Program of Research in Housing and Urban Development* (Resources for the Future, Inc., Washington, D.C., 1961).
59. For example, National Research Council, Highway Research Board, "Urban research," *A Report Presented at the 39th Annual Meeting, 11–15 January 1960*; "Environmental health problems," *A Report to the Surgeon General, Department of Health, Education, and Welfare* (U.S. Government Printing Office, Washington, D.C., 1962); "Space, science, and urban life," *A Report of a Conference Supported by the National Aeronautics and Space Administration and the Ford Foundation in Cooperation with the University of California and the City of Oakland, California* (U.S. Government Printing Office, Washington, D.C., 1963); "Information problems related to urban research," *Proceedings of a Conference on 11 October 1965 Sponsored by the Advisory Commission on Intergovernmental Relations, the Department of Housing and Urban Development, and the Science Information Exchange* (Advisory Commission on Intergovernmental Relations, Washington, D.C., 1965); "Applying technology to unmet needs,"

A Study Prepared for the National Commission on Technology, Automation, and Economic Progress (U.S. Government Printing Office, Washington, D.C., 1966); Harvard Program on Technology and Society, *Conference on Science and the City, 20–21 October, 1966* (unpublished transcript); Institute for Defense Analyses, "Science and technology," *A Report to the President's Commission on Law Enforcement and Administration of Justice* (U.S. Government Printing Office, Washington, D.C., 1967); J. B. Eberhard, "Technology for the city," *Int. Sci. Technol.* (September 1966), p. 18. See also "Federal role in urban affairs," *Hearings before the Subcommittee on Executive Reorganization, Senate Committee on Government Operations, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967), No. 16.

60. W. Hooper, personal communication.
61. Public Law 174, 89th Congress (1965).
62. Public Law 754, 89th Congress (1966).
63. *Summary Report of Summer Study on Science and Urban Development* (Department of Housing and Urban Development and Office of Science and Technology, Washington, D.C., 10 July 1966).
64. R. C. Wood, personal communication.
65. President Lyndon Baines Johnson, "America's unfinished business: Urban and rural poverty," *Weekly Compilation of Presidential Documents* **3**, (No. 11) (20 March 1967). Each of these recommendations has been acted upon, as I note in the text. Although Congress has authorized a new assistant secretary the position is not required to be for research.
66. R. Weaver, "Responsibility for research and development activities of the department [of Housing and Urban Development]: Establishment of the Office of Urban Technology and Research," *Secretary's Organization Order No. 40* (Department of Housing and Urban Development, Washington, D.C., 1967).
67. However, it was not assigned responsibility for HUD's most substantial technological activity to date, the New Systems Study of urban transportation under the Urban Mass Transportation Act of 1964 (Public Law 265, 88th Congress). The results of this study are now becoming available. See, for example, Los Angeles Division, North American Rockwell Corporation, *Frontiers of Technology Study* (Department of Housing and Urban Development, 1968). The primary responsibility for urban transportation has been transferred to the Department of Transportation.
68. RAND Corporation, *Recommendations For Research In Support of Federal Urban Programs*, Ira S. Lowry, Ed. (RAND Corporation, Santa Monica, California, 1968).
69. Editorial, "Urban research committees named," *News Rep. Nat. Acad. Sci. Nat. Res. Council—Nat. Acad. Eng.* **17**, 8 (December 1967): For the background of this activity see "Science, engineering, and the city," *A Symposium sponsored jointly by the National Academy of Sciences and the National Academy of Engineering* (National Academy of Sciences, Washington, D.C., 1967).
70. R. Wood, *Independent Offices and Department of Housing and Urban Development Appropriations for 1968* (hearings before a Subcommittee of the House Appropriations Committee, 90th Congress, 1st Session) (U.S. Government Printing Office, Washington, D.C., 1967), p. 551.
71. Section 108 of the Housing and Urban Development Act of 1968 (Public Law 448, 90th Congress, 1 August 1968) authorizes HUD to support five major plans for new housing technologies to be used to develop housing for low-income people on surplus federal lands to be made available to HUD by other federal agencies at the request of the secretary of HUD for this purpose. The use of federal lands for R & D purposes avoids some of the difficulties inherent in the use of private land, such as obstacles posed by zoning regulations, housing codes, and inflated costs.
72. "Basic change in research and development procedures," *Department of Housing and Urban Development News* (17 April 1968). The announcement of this policy provoked opposition from various architects and engineers who argued that professional services should not be contracted for under competitive bidding. See *Housing Urban Affairs Daily* (7 June 1968), p. 1.
73. It is also consistent with the position of the Senate Committee on Banking and Currency, Subcommittee on Housing and Urban Development, that Section 1010 of the Housing Act of 1966 (Public Law 754, 89th Congress) under which many of HUD's R & D appropriations thus far have been made "does not involve basic research. Rather it is intended to encourage application of existing advances in technology created by private research and development efforts so as to assist industry in reducing the costs and improving the quality of housing construction" [report to accompany S. 3497, *Senate Committee on Banking and Currency, 90th Congress, 2nd Session* (U.S. Government Printing Office, Washington, D.C., 1968), p. 122].
74. "Johnson chooses 'think tank' panel on urban issues," New York *Times*, 7 December 1967, p. 1, column 6, and p. 39, column 1; " 'Think tank' for cities," *ibid.*, 11 December 1967, p. 30, column 2.
75. *Construction and Community Development Department*, "Federal subsidies for research and development in the construction industry under the Department of Commerce Civilian Industrial Technology Program," *Report of the Construction and Community Development Department* (Chamber of Commerce of the United States, Washington, D.C., 1963).
76. Editorial, "Builders attack federal subsidy plans," Washington *Post*, 19 October 1963, section D, p. 14, column 2.
77. "Office of business participation," *Secretary's Organizational Order No. 46* (Department of Housing and Urban Development, Washington, D.C., 26 February 1968). For an analysis of the background of this action see M. W. Karmin, "Great Society, Inc.: U.S. seeks to expand the role of industry in tackling urban ills," *Wall Street Journal*, 15 December 1967, section 1, p. 1.
78. U.S. Chamber of Commerce, *Forward America* (U.S. Chamber of Commerce, Washington, D.C., 1968); *National Conference on Corporate Urban Programs* (National Industrial Conference Board, New York, 1968); Editorial, "What business can do for the cities," *Fortune* **78**, 127 (January 1968).
79. The best reviews are J. M. Berry, "Private enterprise in city rebuilding," *Editorial Res. Rep.* **11**, 719–735 (1967); "Crisis in the cities: Does business hold the key," *Dun's Rev.* **90**, 31 (November 1967); "A special issue on business and the urban crisis," *Fortune* **77**, 1 (January 1968); "Tax incentives to encourage housing in urban poverty areas," *Report of the Senate Committee on Finance, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967).
80. Editorial, "Lowering the cost of housing: The labor union's view," *Progr. Archit.* **49**, 100 (June 1968).
81. Cooperative State Research Service, Department of Agriculture, *State Agricultural Experiment Stations: A History of Research Policy and Procedure* (U.S. Government Printing Office, Washington, D.C., 1962).
82. B. Nelson, *Science* **160**, 633 (1968).
83. J. D. Carroll, *Science* **158**, 1019 (1967); "Equitable distribution of research and development funds by government agencies," *Hearings before the Subcommittee on Government Research, Senate Committee on Government Operations, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967).
84. Subcommittee on Science, Research, and Development, House Committee on Science and Astronautics, 90th Congress, 2nd Session, *A National Program of Institutional Grants for Science and Science Education* (U.S. Government Printing Office, Washington, D.C., 1968).
85. A. M. Weinberg, *Reflections on Big Science* (M.I.T. Press, Cambridge, 1967).
86. For example, L. Lessing, "Systems engineering invades the city," *Fortune* **77**, 154 (January 1968).
87. J. R. Schlesinger, *Systems Analysis and the Political Process* (RAND Corporation, Santa Monica, Calif., 1967).
88. J. D. Carroll, in "The use of social research in federal domestic programs," *Report of the Research and Technical Programs Subcommittee, House Committee on Government Operations, 90th Congress, 1st Session* (U.S. Government Printing Office, Washington, D.C., 1967), vol. 4, pp. 81–105.

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