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SCIENCE IN NATIONAL POLICY
A PRELIMINARY INQUIRY

BY VINCENT P. ROCK

PROGRAM OF POLICY STUDIES IN SCIENCE AND TECHNOLOGY
THE GEORGE WASHINGTON UNIVERSITY

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SUMMARY

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To attain our goal of the "great society" we must have science in policy.

This involves large-scale support of fundamental research in the social as well as the physical sciences. Scientific knowledge must be organized and applied to the major problems of national and international life. New means are required for rapidly diffusing the scientific knowledge needed in daily life. Society needs better methods for making the strategic choices between present desires and future needs, between individual acquisition and social progress. Finally, scientific knowledge is essential to permit the sustained development of a viable sense of community.

Each of these elements of science in policy is examined with a view to suggesting new directions for action.

author

INTRODUCTION

Our founding fathers stood outside their eighteenth century society and asked: How should our political life be shaped? Their answer was the Federal Union, a structure of such strength and ambiguity that it has survived, as have the arguments about the proper relationships of the parts. Those were revolutionary times. Today, we require a substitute for the revolutionary perspective — to help us choose in an era of permanent change. Increasingly, we require scientific knowledge — sure knowledge — not conjecture or conventional opinions.

To attain our goal of the "great society" we must have science in policy. But science must be seen in the cultural as well as the laboratory sense. Whether there will be science in policy depends on the answers given to five subordinate questions. These are:

1. Will the "great society" find a way to support on a grand scale the expansion of fundamental new knowledge not only of nature but of man as a social being?
2. Will the "great society" find a way to organize and apply scientific knowledge to the major problems of national and international life?
3. In an age of swiftly advancing technology will the "great society" find the means of rapidly diffusing the scientific knowledge needed for many daily choices that determine the quality of existence?
4. Will the "great society" devise better ways for making strategic choices between present desires and future needs, between individual acquisition and social progress?
5. Will the "great society" not only find but use the scientific knowledge necessary to achieve integration — a viable sense of community — both at home and throughout the world?

In this preliminary exploration of these questions we will deal briefly with: the interplay of magic and science (the sacred and profane) in all societies; the knowledge requirements of a democratic society; some common and contrasting aspects of science and policy; finally, we will turn to five important research requirements for science in policy.

Washington has a great many individuals highly skilled in the art of the possible — experts in what can be done now and in the immediate future. My stress is on the desirable, in the belief that discussion of the desirable sometimes helps to make it possible. If bias is seen in these views, be assured the bias has not yet hardened into conviction. It is preliminary — open to dissent, to change.

MAGIC AND SCIENCE IN SOCIETY

We all know that at no time have the actions of society ever been based entirely on scientific knowledge. Even when scientific knowledge exists within a society, it may not be available in the place or shape which makes it useful to particular sets of decision makers. In the absence of sure knowledge, magic, myth or ritual have been relied on in the painful process of choice. After long use magic and myth imbedded in men's minds gain dynamism of their own. Throughout history scientific knowledge and magic have mingled in ever shifting proportions as the fate of men and nations has been decided.

The co-mingling is more apparent to us in the simpler societies. Malinowski writes of the Melanesians:

> . . . they rely mainly on gardening for their subsistence . . . . They have to select the soil and the seedlings . . . [and] fix the times for clearing and burning the scrub, for planting and weeding, for training the vines of the yam-plants. In all this they are guided

> by a clear knowledge of weather and seasons, plants and pests, soil and tubers, and by a conviction that this knowledge is true and reliable . . . .
>
> Yet mixed with all their activities there is to be found magic, a series of rites performed every year. . . . Magic is undoubtedly regarded by the native as absolutely indispensable to the welfare of the gardens. . . .
>
> There is, of course, no widespread thirst for knowledge in a savage community.... [Yet] there is . . . to be found the naturalist, patient and painstaking in his observations, capable of generalization and of connecting long chains of events in the life of animals, and in the marine world or in the jungle. . . . There is finally among the primitives, the sociologist, the ideal informant, capable with marvelous accuracy and insight to give the . . .function, and the organization of many a simpler institution in his tribe.[1]

Even when the scientific accomplishments of a society are far in advance of their time, the growth of new knowledge can remain largely in the possession of a small group. The science of the Hellenistic period, for example, was both the product and the private possession of a relatively small elite. During the three centuries following the death of Alexander the Great, the sciences of geometry, astronomy and anatomy were established. Yet, during that period there was no public education except the forum and the theater in the street. The overwhelming proportion of the population continued to rely on mythology, magic and simpler forms of certainty. The early men of science stood very much to themselves.[2]

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[1]Bronislaw Malinowski, "Rational Mastery of the Environment," Theories of Society, II, ed. Talcott Parsons, et al. (New York: The Free Press of Glencoe, Inc., 1964), pp. 1056-60.

[2]George Sarton, A History of Science (Cambridge: Harvard University Press, 1959), pp. VII-XVII, preface.

Not until nearly two millenia after Aristotle did science become a driving power in society — criticizing, renewing, constructing. Only in the West did it become a dynamic element of social change. In our time we believe we have discovered the means of consciously creating and expanding science. Science has given us the power to control nature and to modify society. Yet even in our world, we find, in different proportion, the two domains of primitive man. On the one hand there is the world of rational outlook, and on the other hand the world of magic, myth and ritual. These two domains — sure knowledge and magic — exist in the minds of individuals throughout our society, among the high as well as the low, among the educated as well as the ignorant.

The exponential growth of the creation of new knowledge of nature has, in our generation, acquired radical implications for society. Technology based on the new knowledge has given us nuclear weapons and nuclear energy, missile systems and space ships, automated data processing and mechanized production. The need for many forms of labor is declining, some forms of mental work are being taken over by machines, and man himself might disappear if all nuclear weapons are used. Society is growing more complex. As it does, the apportionment of magic and scientific knowledge we use in its regulation grows more critical. The creation of new knowledge goes on apace, but the resources devoted to its various parts do not always match the needs of society. Possibly the most critical of all, the diffusion and use of sure knowledge occur slowly and unevenly through society.

Argument and action continue to rest on magic as well as scientific knowledge. The level of discourse between protagonists in the recent campaign, if it reflects an accurate assessment of the diffusion of scientific knowledge in society, is the strongest criticism which could be mounted against our present condition.

THE KNOWLEDGE REQUIREMENTS OF DEMOCRACY IN THE AGE OF SCIENCE AND TECHNOLOGY

In a democracy decisions affecting the future may be made throughout the land. We have a mixed economy of knowledge as well as material things. University professors and businessmen, as well as government officials, participate in decisions which affect the future of the nation and the individual.

Indeed a majority of the entire citizenry participates in shaping our future, whether by action or inaction. Only wide diffusion of scientific knowledge can provide an adequate basis from which citizens can judge the decision makers. Achievement of a better diffusion of knowledge represents a primary challenge in the United States today.

Many believe that democracy is not possible in an underdeveloped nation until a minimum level of literacy is acquired by a substantial portion of the population. One may be equally sure that in our highly complex society a much higher level of sure knowledge is required if the government is to remain responsive to the people. For example, we can hardly afford to expose less than ten per cent of the population to even the simplest concepts of modern economics. Nor can we forever rely so largely on ancient tribal rituals to maintain the internal unity of a people whose survival now depends partly on their understanding of their interdependence with all of mankind.

Moreover, facts alone are not sufficient. The knowledge of the people must be scientific in the sense that it has a rational conceptual framework. One objective of the democratic process is to increase the individual citizen's appreciation of what is possible and what is desirable. Planning in a modern society ought to be primarily concerned with the process of creation, diffusion and application of knowledge which contributes to that appreciation. Democratic planning can contribute to policy making by helping to develop and order the information from which both society and its decision makers may pursue their future course. Since action is continuous, planning also must be a continuous process.

Developing adequate information for democratic action is not easy. In the past, new scientific knowledge has been resisted by individuals in labor or business who have acquired a kind of proprietary right in earlier accumulations of knowledge. Yet independent institutions are essential for the maintenance of freedom in the search for knowledge.

The impediments to the spread of sure knowledge have sometimes been breached by war or migration. Other kinds of crises like the Great Depression often seem to have had a mixed effect. Large scale efforts at exploration have helped to stimulate the diffusion of knowledge. The rise of a leader with a special interest in a certain area of knowledge and his timely arrival on the stage of history have sometimes provided the opportunity for a breakthrough. Among our own presidents, Thomas Jefferson and Theodore Roosevelt are outstanding examples. We must take advantage of both men and events if modern democracy is to continue to acquire, organize and diffuse the sure knowledge needed to govern itself.

THE SCIENTIFIC PROCESS

In the rapidly changing scientific and technical society now opening before us, scientific knowledge seems to be increasingly the source of power. Since power may be used to frustrate or advance the public good, much depends on who has access to knowledge. In turn, access to knowledge rests both on the preparation of individuals to perceive it and upon how the information (knowledge) is organized. Scientific knowledge, even though it may originate in the laboratory, needs to be viewed as a growing element of our culture. Science, as culture, refers not only to the creation of new knowledge, but to its diffusion and application. It is in this sense that it is used here.

Three characteristics of science require comment. These are the element of uncertainty in all knowledge, the need for the diffusion of discovery in order for it to become knowledge, and, finally, the multiplying effect of knowledge.

The uncertainty in all knowledge arises from the fundamental nature of the interaction of man and his environment. What man understands about his environment depends not only upon the ultimate nature of that environment but upon his own nature as well. When we move from the natural sciences to the social sciences, a further element of uncertainty is introduced. The planets move in their ordained way whatever may be man's view of their movements. But man's knowledge of other men and of society depends upon the understanding of both the observer and the observed. Man has the power to modify his behavior. His ability to modify his behavior arises from his capacity and, indeed, compulsion to attach values to all his experiences. Yet, many of these modifications may occur according to knowable regularity.

Dr. Edwin Boring of Harvard University has noted that scientific knowledge involves both an abstract concept and the testing of this concept against both new and old information. It implies an audience through which the knowledge must be diffused and who must apply it, either to establish its "truth" or to put it to practical use. The distinction between pure and applied science, of course, rests not only on the purpose served, curiosity or utility, but frequently on the rigor with which it is verified. For both, diffusion of the knowledge from its originator is usually required.

A third characteristic peculiarly relevant to our acquisitive and democratic society is the multiplying effect of knowledge. Recognition of this effect is of crucial importance in considering the proper role of government in the creation, diffusion and application of scientific knowledge.

The description of the multiplying effect by John Wesley Powell, uttered nearly eighty years ago in the midst of the first great debate over a department of science in the federal government, is classic. Powell said:

> Possession of property is exclusive; possession of knowledge is not exclusive; for the knowledge which one man has may also be the possession of another . . . . Property may be divided into exclusive ownership for utilization and preservation, but knowledge is utilized and preserved by multiple ownership. That which one man gains by discovery is the gain of other men. And these multiple gains become invested capital, the interest on which is all paid to every owner, and the revenue of new discovery is boundless.[3]

Today, faced with the spread of nuclear weapons, we are more cautious in emphasizing the benign effects of knowledge. We have become more concerned with the purposes for which knowledge is used. Having the weapons first, we find it more difficult to perceive the value of others' acquiring the knowledge. The outcome of Powell's generalization, we feel, remains profoundly in doubt. Yet its operational implications are everywhere visible.

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[3]A. Hunter Dupree, Science in the Federal Government (Cambridge, Mass.: The Belknap Press of Harvard University Press, 1957), p. 227. The frequency with which this paragraph is quoted is a tribute to the power of the historian.

THE POLICY PROCESS

The central task of policy-making is to gain an appreciation of the problem and hopefully to gain the appreciation in time to act or to refrain from action. Appreciation is difficult because it involves men and organizations whose perceptions differ and change from time to time. Thus the problem to be appreciated changes through time. The dilemma is met in part when there is widespread commitment to scientific knowledge in all walks of life. The commitment and the undertakings which it generates provide a more rational environment within which all policy-making takes place. The need to argue about the nature of a problem is not obviated, but as the problem is identified, the acquisition and organization of sure knowledge is accelerated. Then action which can be characterized as peaceful change rather than revolution will be more likely.

Geoffrey Vickers, in a recent issue of the British Journal of Psychiatry, has dealt at length with the "appreciative" element of policy-making. Let us follow his reasoning. The precarious balance of an organization fluctuates constantly. Total resources may be reduced or increased relative to current demand. Decisions as to where cuts will be made or growth permitted must constantly be taken. At the same time the standards by which the variety of services provided by the organization are judged may change, subsequently increasing or reducing the claim of one service relative to the others. This, too, will require redistribution of resources throughout the system.[4]

In deciding on a course of action, policy-makers confront and resolve conflicts, which are normally described as arising from the pressures of various interest groups. The

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[4]Geoffrey Vickers, "The Psychology of Policy Making and Social Change," British Journal of Psychiatry, May 1964.

selection of what is to be noticed and how it shall be classified is often decisive in determining whether a problem is really a problem. A government will find it very difficult to notice issues to which it is not organized to attend. Since, for example, some executive departments are primarily designed for action, their appreciative capacity will be limited and distorted by the nature of the organization. This is one of the reasons independent research or planning organizations have become more common.

As a government seeks to make policy, one of the most important consequences is a change in the setting in which future policy-making takes place — a change which may far outweigh the immediate results of a particular decision. The change in setting, appreciation of the situation, may modify a whole array of future choices of what is to be noticed and how it will be classified and valued.

Improvements in the quality of policy-making are likely to be heavily correlated with both the advance of scientific knowledge and the organization of knowledge which advances our appreciation of the problems of society. Policy-making involves the readjustment of relationships within a whole system. This system may be defined as a unit of local government, a functional problem area, the nation as a whole, or, indeed, the entire international system. The object of the policy-maker is to achieve a continual readjustment of the relationships of the parts of the system within which he works. In a democratic system, the citizen's appreciation of what is possible and desirable as well as that of the decision-maker must be taken into account.

Policy-making is not determined but merely conditioned by the world of objects and events which form its physical milieu. Both the physical milieu and men's appreciation of their world are essential concerns of the policy-makers. Their view will be modified as new and sure information about its nature is made available. The policy-maker and citizen are linked in a continuing series of transactions — in a dialogue about what merits attention and how it should be regarded. The aim of science in policy is to increase the element of rationality in the dialogue.

Before turning to the kinds of research which will contribute to science in policy-making in a modern democratic society, may I summarize. All societies act on the basis of a mixture of sure knowledge and magic or myth. Ours is no exception. What is exceptional is that in our time, science — the systematic pursuit of sure knowledge — has become a dynamic, driving element in society. Society is making an increasing investment in rationality. Even in the most rigorous fields of science, an element of uncertainty will remain due to the transactional nature of knowledge. Policy-making can never be as exact as natural science, but science can never achieve absolute exactitude. The problem in policy is not so much to make the right decision as to achieve an appreciation of what the situation demands. Appreciation leading to action will profit from an increase in sure knowledge, from its proper organization and from its widespread diffusion among the citizens.

The object of research in support of policy-making is thus the development of a more scientific "appreciation" of the problem. Today some voices question whether Congress can act on the basis of certain knowledge in issues created by science and technology. Others are equally dubious about the organization of the executive branch in this respect. An examination of the range of knowledge required for rational decision-making in a modern democratic society may cast light on the adequacy of the present structure.

AN ARRAY OF KNOWLEDGE REQUIREMENTS FOR SCIENCE IN POLICY

Five categories of sure knowledge are important for national policy-making. Let us give each a name. For new knowledge which is created largely by basic research we will use the conventional term fundamental knowledge. To the basic and applied knowledge acquired and organized to cope with major tasks of society, e.g., defense or poverty, we will give the term problem knowledge. The knowledge required for the society to know what it knows, and what it is likely to know in the future we will designate information system knowledge. The concepts and data required for choosing among alternative future uses of our economic means, we will call our resource system knowledge. Finally, the knowledge required to maintain or create a sense of community, will be termed integration system knowledge. All can contribute to scientific management and modification of our "appreciative" world — the artifacts we call our neighborhood, local community, corporation, state and our emerging international system.

Fundamental Knowledge

Fundamental knowledge, it is widely believed, now stems primarily from explicitly organized basic research. Today, the federal government is by far the largest patron of basic research. In 1964, it provided more than $1.6 billion in support. This will increase to $1.8 billion in 1965. Five agencies account for more than 90% of the federal funds provided for basic research.

The National Aeronautics and Space Administration is said to provide nearly $700 million for this purpose. Defense and the Atomic Energy Commission together provide $455 million. The Department of Health, Education and Welfare provides $280 million. The National Science Foundation, the one agency of the federal government directly charged with the support of basic research, provides $200 million. The balance of the funds is divided among a dozen federal agencies. (See Table I.)

FEDERAL OBLIGATIONS FOR BASIC RESEARCH*
(in thousands of dollars)

TABLE I

Distribution by Agency

	1962	1963	1964
Agriculture	49,666	56,661	64,477
Commerce	16,290	22,424	28,147
Defense	177,919	186,732	207,688
Health, Education and Welfare	190,421	238,774	279,131
Interior	29,542	36,163	43,112
Labor	978	1,110	1,295
Treasury	142	167	317
Atomic Energy Commission	191,565	221,305	261,896
Civil Service Commission	14	17	20
Federal Trade Commission	153	247	327
National Aeronautics and Space Administration	316,241	480,904	677,934
National Science Foundation	105,491	143,308	209,081
Office of Emergency Planning	100	27	-----
Smithsonian Institution	3,314	4,133	4,756
Veterans Administration	3,399	3,400	4,102
TOTAL	1,085,235	1,395,372	1,782,283

*Statistics for Table I and Table II from Federal Funds for Research, Development, and Other Scientific Activities, Fiscal Years 1962, 1963, and 1964 (estimates for 1964) (Washington: U.S. Government Printing Office, 1964), pp. 137-143.

Noting the institutional responsibilities and hardware orientation of the National Aeronautics and Space Administration, the Department of Defense and the Atomic Energy Commission, some have questioned whether the present distribution of funds among investigators of the unknown in nature and society results in an equal opportunity for all excellent scientists to tap these funds. Moreover, information on the "hardware" element in these figures is inadequate.[5] Certain disciplines are far more richly financed than others, which the average citizen, or even the average scientist might feel were equally worthy. (See Table II.) This is not to suggest that the present allocation is wrong. Indeed, it is sometimes said that the stage of development of a field or discipline is the primary factor in determining the availability of resources. Yet alternative institutional arrangements might provide a pattern significantly different from the present. A single department whose primary interest is not in particular missions or combination of missions might result in a dramatically different use of funds. It also might result in a drastic reduction of funds.

The state of the various disciplines is said to play a major role in the distribution of funds. The physical sciences, for a variety of reasons, are believed to be further advanced than the behavioral sciences. Should this be taken as an argument for emphasizing basic research in the social sciences? Apparently not, since only two per cent goes in that direction. On the other hand, the problems with which the behavioral sciences have to deal are at least as critical as those with which physical science deals. Must desirability give way to feasibility in the exploration of the unknown. It seems to.

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[5]While the distribution of funds by agency, discipline, and recipients is known, information on the character of the work actually being performed is not readily available. The amount of hardware or "instrumentation" involved in the $1.5 billion is uncertain. Each agency is the judge of what to place in the basic research category.

FEDERAL OBLIGATIONS FOR BASIC RESEARCH
(in thousands of dollars)

TABLE II

Distribution by Discipline

	1962	1963	1964
Life Sciences, total	316,985	403,211	487,974
Psychological Sciences	27,563	33,453	48,920
Physical Sciences, total	618,092	793,345	1,030,961
Mathematical Sciences	22,633	29,194	42,536
Engineering Sciences, total	80,353	111,237	138,416
Social Sciences, total	18,019	23,039	31,336 (2%)
Other Sciences	1,590	1,893	2,140
TOTAL	1,085,235	1,395,372	1,782,283

The Committee on Science and Public Policy of the National Academy of Sciences has dealt in broad terms with the need for support of fundamental research. They have emphasized the role of the project director in choosing wisely and the role of government with the advice of the academic community in choosing among proffered projects.

Dr. George Kistiakowsky, Chairman of the Committee on Science and Public Policy is now an advisor to the Daddario Committee of the House of Representatives. (Representative Emilio Q. Daddario is Chairman of the Sub-committee on Science, Research and Development of the House Committee on Science and Astronautics.) In his triple role at Harvard, the National Academy, and on the hill, Dr. Kistiakowsky is in an excellent position to provide the knowledge of basic research which will illuminate its present characteristics and point the way to its further balanced development.

Problem Oriented Knowledge

Since World War II, the government has emerged as a great user of science and a great supporter for many lines of problem-oriented research. Indeed the whole history of the federal government's involvement in science is a record of pragmatic response to particular problems. But no generation has been entirely satisfied that the pragmatic response of government was entirely adequate. There has been a continuing drive to arrange the piecemeal use of science into a more coherent pattern.

In the past when a problem was identified, a proposed program was developed and legislation sought. After a period of public controversy and legislative debate a new law was placed upon the books. The result was the creation of a new agency or institution to carry out a program. As the program was carried out it became clear that there were many questions on which new or better knowledge was required if the program was to succeed. Only at this point, and frequently after considerable delay, did the executives turn to research and development to help them carry out their duties more effectively.

An alternative approach is one which begins with a broad statement of a problem and moves directly to research and development which will help to clarify and restate the objectives and to devise a means for their achievement. This approach begins with the belief that scientific knowledge based on careful research is essential to effective action in the complex modern world. It has the advantage of keeping open the roles of institutions and individuals in handling the new problems of society until their nature can be clarified and the best means found for dealing with them.

Congress, the executive branch, and the public seem gradually more willing to accept the view that the federal government has a responsibility to conduct a search for sure knowledge on many of the problems confronting this generation. The limits on the government's role in helping society acquire new scientific knowledge are being worn away by the widening of research in those pragmatic areas in which it has gained congressional acceptance and executive support. Nevertheless, it is likely that authorization of research and development by the federal government will continue to be attached to particular pragmatic purposes for the foreseeable future.

Broadly, governmental action is concerned with two main problem areas: international stability, and domestic growth and welfare. The present research and development program is heavily weighted toward the former. The federal government is now spending between $9 and 12 billion in research and development aimed at international stability. Between $2 and 4 billion are being directed to the problem of domestic growth and welfare. The estimates vary depending on how one classifies miscellaneous expenditures of NASA, the National Science Foundation, and certain other agencies.

International Stability

Research and development aimed at maintaining international stability has three main elements: 1) the development of military strength; 2) the maintenance and improvement of the non-violent means of conflict management; and 3) international economic development. The following figures (Table III) show the estimated present distribution of research and development resources among the elements which are involved in the achievement of international stability.

TABLE III

RESEARCH AND DEVELOPMENT SUPPORT FOR UNITED STATES EFFORTS TO MAINTAIN INTERNATIONAL STABILITY[6]

(In millions of dollars)

Military Strength*	9,000
Conflict Management	90
Overseas Development	9

* Includes the 67 percent of AEC expenditures for production and weapons programs and the estimated $1 billion contribution of NASA space activities to potential military applications.

It is not unreasonable to question whether a ratio of 1,000 for military strength to 10 for conflict management to 1 for development represents the most rational application of research and development resources. No one can doubt that adequate military strength is essential to maintain the peace. But many do doubt that military strength alone will be sufficient to avoid war in our long nuclear future. The nations of the world must somehow acquire the

[6]U. S., The Budget of the United States, Fiscal Year ending June 30, 1965, Special Analysis (Washington: Government Printing Office, 1964)

knowledge and wisdom to live together peacefully.

The assumptions of our present research and development investment in military strength are two. First, the U.S. must maintain technological superiority in its weapons systems. Second, superior strength to meet any aggression of potential enemies will deter attack.

Development of Military Strength

Military strength has a number of dimensions.[7] Our strategic nuclear forces must have the ability to destroy the society of a potential attacker under any conceivable conditions. Our military power must also be sufficiently mobile to convince a potential aggressor that it can and will be used to prevent gains by piecemeal aggression in third areas. Our military strength, it is said, must contribute to the cohesiveness of our alliances. Our allies must be sure that we can come to their assistance in event of an attack. Military strength is also needed to contribute to the local defenses of scores of nations throughout the world. Military strength provides an instrument by which we may impress neutrals with our power.[8] Together these capabilities are intended to prevent the expansion of the Communist domain. They are also intended to contain violence in contingencies which are not directly related to the East-West struggle.

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[7]See David W. Tarr, "American Military Presence Abroad," a paper delivered at American Political Science Association Meeting, September 9-12, 1964, for a more complete discussion of the external dimensions of American military power.

[8]Some believe that military strength should also be designed to permit the United States to intervene at will to maintain governments in power.

Development of Non-violent Means of Conflict Management

Many who support the need for military strength question whether it provides a sufficient basis for stability. Beneath the umbrella of nuclear power, many nations have sought to reassert their independence of action. In the East the Sino-Soviet split has become obvious to all. The European satellites are asserting their freedom to act independently not only in developing their separate roads to socialism but in expanding their relations with the West.

In the West the once Grand Alliance has fallen on troubled days — as a result, in part, of a perceived reduction in the threat from the Soviet Union and, in part, from a desire to assert policies different from those of the United States. As the bipolar character of the world has declined, both the Soviet Union and the United States have become more concerned about the non-violent management of conflicts.

New knowledge of conflict management which would permit us to reduce our reliance on force seems to be urgently required. The new knowledge which is needed may not be so much new discoveries in natural science as the advance of social science and the application of technology to positive purposes.

The estimate of ninety million dollars for research now being devoted to conflict management is a generous one. It includes \$5 million for State Department intelligence and research activities, an estimated \$25 million in the budget of the Central Intelligence Agency, \$5 million for activities of United States Information Agency and \$5 million for the work of the Arms Control and Disarmament Agency. An additional \$50 million has been included to cover the activities of all other public and private institutions which may be making contributions which would be useful for this purpose.

The cold fact is that non-violent conflict management has not been identified as a problem area open to progress by research and development. Most of what is being done in the field represents an extension of past practices. For example, the Arms Control and Disarmament Agency assumes, in programming most of its research, that it already knows how to control conflict. The general assumption of the vast majority of those now acting in the field is that a series of specific tasks are involved to which research and development may make only a modest contribution.

Yet, conflict has been endemic since the beginning of recorded history. Our century has seen the two most devastating wars of all time. We may again find ourselves poised on the brink of the third and most catastrophic of all. In such circumstances one might reason that a rational government would be spending as much for research and development to understand the nature of human conflicts and to devise techniques for managing and controlling them as it did on new weapons. History suggests that, while weapons have been found useful in war, they have been unable of themselves to prevent war.

We do not yet know how to maintain an alliance. We have but the cloudiest notions of how to build the bridges which turn enemies into friends. Nor are we much more knowledgeable on how to create and strengthen the international organizations judged essential to the maintenance of peace and the development of mankind. In the face of such colossal ignorance one would think that the systematic search for new knowledge would be proceeding apace and on a broad scale. Yet because the subject is man, men in all walks of life seem inclined to believe that basic and applied research can only play a marginal role. This state of mind, if it continues to persist within the executive branch, in the Department of State, in the Central Intelligence Agency and in Congress, exposes the society to risks which might well be avoided if there were an adequate commitment to a search for scientific knowledge of conflict.

International Economic Development

Economic and social development, in the decades immediately ahead, has a dual role to play in maintaining international order. First, economic development within the underdeveloped countries which contain two-thirds of the world's population is essential to meet the rising expectations of their peoples. Second, development of common enterprise among the more developed nations — and the rest of the world as well — can help to provide and strengthen common interests in maintaining the peace.

The total gross national product of all the underdeveloped countries is about three-eighths that of the United States. Average per capita income is less than one-tenth that of the United States. Population continues to increase. Social disorganization is widespread. International divisions are intensified by the predominance of the white population in the wealthy nations.

Since World War II the United States government has extended over $90 billion in assistance in one form or another. Approximately one-third has been military assistance and two-thirds economic. In the early years, of course, a substantial amount was directed to the recovery of Europe and Japan. Now the objective is largely the underdeveloped lands of Asia, Africa, and South America. In 1962 the net United States government assistance to developing lands was just over four and a half billion dollars.

Private capital outflows have gone largely to the advanced industrial nations since World War II. The developing nations received only seventeen per cent of the total in 1962. During the decade of the 1950's the volume of exports and imports of the developing nations grew more slowly than the world total. Their share of world trade fell from thirty per cent to twenty per cent. A United Nations projection has estimated a gap of twenty billion dollars a year by 1970 in the international accounts of developing countries as they seek to realize a two per cent per year per capita income rise.

Meanwhile, in the United States there is serious popular disenchantment with a foreign aid program which can show no dramatic results. Doubts are raised about its contribution to stability. Objections are raised to the United States' contributing to the public sector in underdeveloped lands. Some believe that other industrial nations are not bearing their full share of the burden. The government is concerned with the impact on the United States balance of payments. Private foreign investment is reluctant to move to the developing land because of limited markets, inflation, nationalism and instability — because the lands are underdeveloped.

Yet the alternative to United States aid or investment is thought to be industrialization on the pattern of China today or the Soviet Union in the Stalin period — in short, accumulation of capital by enforced savings under regimented control.

The implications for domestic institutions of effective United States involvement in the developing nations are substantial. The educational system will increasingly require an international dimension focused on Africa, Asia and Latin America — a dimension largely missing at the present time. Teachers, researchers, engineers, businessmen and administrators in increasing numbers will be needed to adapt and export American technology for developing nations. New institutions and arrangements on a grand scale will be required.

In the face of the intractable problems of the developing nations — to which the United States has and is contributing billions; in the face of potentially great changes in American society required if it is to work effectively with the underdeveloped two-thirds of the world; in the face of the major role the government may be forced to play; and in the face of the equally important task of finding out how to bring about the conditions under which private enterprise and universities could play a much larger role — the United States is now spending a mere eight to nine million dollars through Agency for International Development for research. How many billions would be saved, how many billions in increased effectiveness could be achieved by adequate research, we have no way of knowing. Indeed, we have no certainty about what the past has taught us since there has been little support for analysis of our historical experience. Action is often required in the absence of scientific knowledge. But the failure to seek sure knowledge on a scale commensurate with the scope of the problem, seems the surest folly.

Progress is, of course, being made. Four years ago there were no research funds for overseas development. But, however wisely the few million dollars are utilized, it appears to be very inadequate — inadequate for finding a way in which private industry can do an increasing part of the job as they are for the prudent use of government funds.

Now let us turn to the second potential contribution of economic development to international stability — the creation of common enterprises among the industrial nations. A distinction needs to be drawn between enterprises in established industries and enterprises created to attain the benefits of new, world-circling scientific and technical advances.

Private capital has played a substantial role in developing common enterprises with the industrialized nations in the past decade. Half of the net outflow of $2 billion a year in U.S. private capital has gone to Europe and Canada over the past ten years. Two-thirds of the $38 billion private direct investment abroad in 1962 was in other than the developing countries. Doing business in Europe, Japan, as well as Canada, has become an accepted practice for a growing number of U.S. business executives. While these investments have inevitably created some sources of conflict, the major effect seems to have been to strengthen the common interests of the nations involved. As economic interdependence grows, however, there will be an increasing need to examine and anticipate its consequences, both in its own terms and in terms of the possible requirement for stronger political and administrative arrangements to support growth and to resolve conflicts. We must avoid a repetition of the pre-World War I environment in which the growing European economic and social interaction was not accompanied by new regulative and integrative actions on the part of governmental and political leaders. Here, again, is an area requiring a steadily expanding research and analysis capability — not alone to examine current problems but also to enable us to work consciously to shape the long term trends.

In addition to the ongoing trends, major new areas of government and mixed government-private enterprise will be opened by the rapid advances of science and technology during the coming decades. Space exploration is in its Lindbergh phase. Meteorology as a world undertaking is before us. Accurate prediction and ultimate control of the weather is in prospect. Oceanography as an international effort is now a fact. Exploitation of the oceans for a variety of purposes is in its infancy. Satellite communications will expand and intensify the links among all peoples. Further advances in the technology and economy of world-circling transportation are in prospect.

These remarkable advances are compelling a new view of ourselves, our boundaries, and our roles as part of mankind — as they are of others, including the Soviet Union. In several of these areas the United States and the Soviet Union possess the most advanced capability, followed at some distance by the larger European nations and Japan.

In the recent past, U S — U S S R common action in these fields has been encouraging but extremely limited. In regard to space exploration, there are limited agreements, but our cooperation with the United Kingdom, Canada and even Italy is much further advanced. Common interest in survival may be insufficient in the face of endemic conflict. Great positive common enterprises are required which create new careers for large numbers of trained men on both sides.

These enterprises will not be easy to devise. Nor will they be possible without investments in research and development both in the natural and social sciences which run into the hundreds of millions of dollars. The United States is a world leader both in space and in international cooperation in space. Physicists and engineers, Soviet area experts and behavioral scientists could now be brought together to devise a program so attractive to the Soviet Union and so threatening in terms of long range political influence that it might be compelled to participate. The participation sought is not merely the arm's length cooperation of the moment but engagement of government and scientific community alike in a major common effort.

Domestic Growth and Welfare

We now turn to the question of the research and development required to deal with the problems of domestic growth and welfare. The major complex of issues illustrating the range of requirements involves the American city.

Today we are a nation of urban dwellers. In 1900 only forty per cent of the United States population lived in urban areas. By 1960, this proportion had grown to seventy per cent. Most of the population increase in the future is expected to take place in urban areas, mainly in the suburbs. As the population spreads into the suburbs, city centers decay and city boundaries merge to form new social and economic units. The largest of these is the megalopolis. In the future the five hundred mile stretch from northern Virginia to southern New Hampshire will make up a megalopolis whose main outlines are already visible. Others may be expected to develop in the mid-West and far West. The growth of the megalopolis will intensify the need to develop new systems for a large number of services which cut across the boundaries of existing state and local governments.

Estimates of the total resources required for the development of urban communities in which we can not only live but live happily vary widely. This reflects a wide divergence in the appreciation of the problem. The estimates range from a few billion dollars a year through the $125 billion a year estimate of the National Planning Association. It is safe to say that no one knows because the nature of the problem is not generally appreciated. Not many would disagree that the urban growth problem requires resources at least comparable with our investment in defense.

A recent compilation of urban research prepared for the Subcommittee on Intergovernmental Relations, headed by Edmond S. Muskie of Maine, found that all federal urban research activities amounted to less than $40 million. Senator Muskie's Committee pointed out that

> . . . implications of the Report are disquieting. Despite the importance of better understanding the problem of urban growth and social and economic well-being, urban research, however defined, appears to constitute only a very small fraction of all research carried on under federal sponsorship.
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> . . . we have almost no current research directed to the identification of basic forces shaping our urban

areas and the effect of the urban environment on the behavior of its residents.[9]

The picture is no less irrational with respect to the major sub-systems and problems of urban life. For example, in the past century transportation technology has served as the strategic variable in determining the scale of urbanization. Urban transportation remains a critical element. The present system is both a health hazard and inadequate to meet future needs. Yet less than one million dollars a year has been expended on research to develop integrated and desirable mass transportation systems in the past decade.

Nor are the research resources to deal with the problems of the growing non-white population of the central cities any more adequate. Unemployment, low income, bad housing, juvenile delinquency, broken families and functional illiteracy among this group of our citizens are major problems for society.

The Economic Opportunity Act recently passed by the Congress is in large part directly pointed toward their problems. However, there is no general research provision in the Act. The Urban Community Action Programs title permits the "use of not to exceed 15 per cent of the appropriation under the title for the conduct of research, training and demonstrations pertaining to the purpose of the title." So far as can be determined, this provision is to be used largely for experimental action programs and evaluations. Those responsible for administration of the Act are under

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[9]U.S., Bureau of the Budget, Urban Research under Federal Auspices (a survey prepared for the Subcommittee on Intergovernmental Relations of the Committee on Government Operations, U.S. Senate, 88th Cong., 2nd sess., April 15, 1964) (Washington: Government Printing Office, 1964), pp. V-VI, foreword.

strong pressure to get going. There is little time for an appreciation of the amount of new knowledge needed and the extent to which existing knowledge must be "adapted" if the efforts to "eliminate poverty are to be successful." The Act is a fine testimonial to President Johnson's first year, but the ideas he injected into it from the depression years need to be supplemented by a systematic program of research and development.

One final example of the incongruity of the nation's problem oriented research should be mentioned.

Health research is by far the best financed of all domestic areas. Expenditures run more than a billion dollars a year. Yet, results of work in the health field may be seen in the dramatic shift in the leading causes of death during this century. Communicable diseases, including influenza, pneumonia, and tuberculosis have been replaced as the major causes of death by cancer, heart disease, and accidents. The very effectiveness of health services has brought about increased cost and heightened demand. Access, as a result, continues to be very unevenly distributed throughout the population.

In considering the best means of attaining a fully effective health program for the society, four distinct but interrelated steps are necessary: 1) basic research into the causes and prevention or cure of disease and illness; 2) adaptation of findings from basic research into health measures and medical care; 3) the organization of institutions to implement programs of action; and 4) the devising of a method or methods to pay for medical care, which, when it is most effective, is most expensive.

At each step we move from the natural to the social sciences, at each step the problems become more difficult to research, at each step the tasks increase as those of the previous step are accomplished. At each step there is a smaller proportion of funds devoted to research.

Moreover, some forms of death and disability remain so sacred that only the very bold tempt the fringes of the problem. Highway safety, for example, is a major national horror — 40,000 deaths a year, 4,500,000 injured, untold losses in man years and property. Yet research is extremely limited. There is some in the Bureau of Public Roads, and a bit in Health, Education and Welfare. Beyond that, there is very little.

The National Information System

Support for creation of new knowledge and for the application of knowledge to the major problems of society are two essentials of science in democratic policy-making. A third is an understanding of the state of the nation's information system — the knowledge production, diffusion and application system as a whole. The quality of a society is determined by what it knows — especially what it knows for sure. Some would say that the quality of society is determined by the values it holds, but the values it holds are shaped by its knowledge. What a modern society knows is a result of historical memory, current experience, research, and above all, the effectiveness with which knowledge is transmitted and diffused throughout all the people.

A recent report to the President termed the United States a research-oriented society. That is more an aspiration than a fact, but surely we are already a knowledge-oriented society. Increasingly our population and work force have been concerned with the production, distribution and consumption of knowledge — some would say information.

Looking at our changing society, Fritz Machlup calculated that between 1900 and 1959 the proportion of the economically active population engaged in what he broadly termed the knowledge-producing industries increased from 13.5 per cent to 42.8 per cent.[10] By the end of the decade over half the population will be occupied in these industries.

The knowledge industries include education, research and development, communications media, and information machines and services. As knowledge increases it holds out the promise of a great society. Insufficient awareness of our power over nature can be dangerous. An awareness on the part of the whole population may require a larger and more systematic educational effort than is being made at present. Similarly, a growing understanding of the nature of man may divide us unless that knowledge is widely shared. Media of communication such as radio and television may be more powerful instruments for shaping what we know—or believe we know—than a high school education.

There are major strategic and tactical choices in the development of the nation's information system. A vast increase in our knowledge of this system is essential if there is to be science in policy in this crucial field.

One or two illustrations will suffice. Estimates of the nation's requirements for education suggest that resources will have to be tripled in the coming decade if we are to continue to move ahead. The scope of the increase is suggested by a recent estimate that $28 billion additional resources will be required over the next decade simply to maintain present standards of education for a much larger population of scientists, mathematicians and engineers. According to the projections by a member of the staff of the National Science Foundation, the nation is expected to

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[10] Fritz Machlup, <u>The Production and Distribution of Knowledge in the United States</u> (Princeton, N.J.: Princeton University Press, 1962), pp. 384-85.

produce, in the decade 1966-75, approximately 2.5 million scientists, mathematicians and engineers holding B.S. degrees, 480,000 with master's degrees and another 130,000 with doctorates. To produce these numbers an increase of 100 per cent from current levels of college and university science and engineering manpower by 1975 will be needed. The increase of manpower will necessitate additional research and instructional facilities costing about $10 billion. Instruction associated with the creation of additional manpower will cost another $28 billion. Research directly associated with education will require $15 billion. Seven billion dollars will be needed for scholarships and fellowships, $3 billion for science information services, and a similar sum for the improvement of pre-college science and mathematics education. The total national effort in natural science and engineering is estimated conservatively to be about $65 billion over the next decade. This is required even before taking into account the rising cost of education, the increased sophistication of research, costs of big science and other rising trends.

The contributions from traditional sources of support — state and local government sources, tuition and related student fees, and private endowment earnings are optimistically estimated to be approximately $37 billion. The difference between the estimated cost and income anticipated from traditional sources it is suggested can come from only one other source of support, the federal government. Should these projections prove accurate, the federal contribution for scientific and technical education will have to rise from an estimated level of approximately $1 billion in the early 1960's to something in the order of $3 billion annually by the end of the decade.

The cost of scientific and technical education is only one element of the nation's educational bill, although a significant one. As has been suggested, the total outlay required seems likely to triple in the course of the decade.

The size of the educational industry alone, not to speak of the importance that the quality of education plays in the growth and development of society seems to warrant a substantial federal program of educational research. The only available figures suggest that the total national investment in educational research is now in the neighborhood of $75 million a year — a doubling of the research investment in education since 1960. Federal support for educational research appears to be running at a level of about $50 million a year, but this is minuscule in relation to recognized problems.

Economic, and social, and technical change require major innovations in the educational system, which should be based on knowledge flowing from sound research. The change is manifested in changing occupational patterns, changing curricula requirements, reduced working time, new uses of television, films and information machines. It is revealed no less in the new roles and relationships of schools and universities, business and government. Finally, it is demonstrated in the growing sense of occupational anxiety among our citizens.

The adaptation needed may not be possible within the framework of the formal educational system alone. We may need to develop a stronger appreciation of the possibilities of the media of communication and of the information machine and service industries. Perhaps we should consider a $10 billion subsidy to the communications industry to increase its contribution to national knowledge on the same scale as ten billion for increased educational facilities. The conclusion may be that we need both. The government has financed multi-million dollar assistance in the development of hydro-electric power and nuclear power, synthetic rubber, new metals and plastics, thereby creating new industries and enterprises. We need to look at the state of the information machine and service industries with an eye to enhancing their contribution to the quality as well as quantity of national knowledge.

To make these judgments, the nation, in its policy-making, requires systematic and comprehensive knowledge of the total information diffusion system — educational institutions, research and development, communications media and information machine and service industries.

National Resource System

Since the great depression of the 1930's the economy of the U.S. has been viewed as a single operating system by the top policy-makers of the federal government — Republican and Democratic alike. They have come to appreciate that their actions were important in affecting the performance of the total economic system. There is less consensus on whether they should seek to influence priorities of resources in goal achievement. Many believe these must be largely, if not wholly, determined in the market place.

The Employment Act of 1946 recognized the increasing degree of sure knowledge in the field of economics. It placed on the federal government a major responsibility for the overall economic performance of the system. The controversy which led up to the passage of the Act, the state of economics at the time, and the politico-economic environment in the intervening years have resulted in heavy reliance on fiscal and monetary policies for achieving the purpose of the Act.

In recent years the rapid march of technological progress, the desirability of developing new markets — both at home and overseas — and the identification of certain chronic socio-economic problems have suggested the need for additional devices to concert the activities of the many decision-makers in our plural economy.

As our ability to meet basic needs has increased, the question has been raised with increasing insistence: full employment for what? As business and program planning have acquired increasing sophistication, analysts have seen the advantage of authoritative overall economic projections which would be of assistance to them in their industry and enterprise planning. A recognition that our total resources are not unlimited has suggested to others the need for national priorities or goals. Industrial capacity has increased but certain basic resources have become more scarce. For example, water, long a free good, must now be thought of in terms of alternative uses.

The proper deployment of highly trained manpower has become a growing concern. Most important, there has been a recognition that a modern society must act within a longer time frame than a traditional one. Technological developments taking from eight to fifteen years in defense and space have played a major role in bringing about increased recognition of the time factor.

Thus a growing interest has developed in projections not only of the potential performance of the economy but of the achievements that could be possible in specific areas if resources were devoted to those purposes.[11] Projections of the future state of the economy must meet two criteria if they are to be widely useful. First, they must achieve an authoritative status in the sense that decision-makers

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[11]Gerhard Colm, Chief Economist of the National Planning Association, is playing a leading role in the development of concepts and procedures for planning in a democratic society. See his article, "National Goals and the American Economy," to be published in the Nov.-Dec. 1964 issue of <u>Financial Analyst's Journal</u>.

throughout the society use them as a rough frame of reference. Second, they must be based on the best sure knowledge available. They cannot be the product merely of specialists in economic projections.

The primary advantage of long range planning projections in a democratic society is that they will concert the actions of large numbers of decision-makers in determining the direction the economy will move. They bring out into the open the issues that exist with respect to the quantity and character of resources that will be required by alternative goals. They help to identify those undertakings which make it easier to achieve other objectives of the society. Projections cannot be made in isolation, however. They must be linked to the findings of basic and applied research. They must recognize the increasing numbers of the labor force who are devoting their lives to the production, distribution, and application of knowledge as compared to the production of physical products. They must in a word be sensitive to the quality of the development of the economy as well as the quantity of products which it turns out.

Political Integration

The ultimate task of government is to maintain and enlarge our sense of community. This is the most difficult area in which to introduce science in policy. At the same time it is the most urgent. Objective means of creating a sense of community are vitally needed on three levels. The first is at the level of the new giant urban complexes.[12] The unprecedented rate of urbanization has produced a log jam of complex human needs that are overtaxing established

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[12] Philip E. Jacob and James V. Toscano, eds., The Integration of Political Communities (Philadelphia and New York: J.B. Lippincott Co., 1964), pp. 1-2.

forms of local government.

The second great problem of community development involves the new nations. Traditional societies are seeking to become nations. The speed and scope of their needs must call forth a science for achieving them.

Third, at the level of the international system, nuclear weapons and the means of delivering them are increasingly locking the nations of the world in what could be an embrace of death. At the same time new means of communication, transportation and production are increasing the interrelationships among the peoples of the earth. Until now ultimate hopes and loyalties have been placed on the nation state. At present such instruments of international cooperation and political progress as have been created are so poorly supported that they cannot fulfill the needs of an interdependent world.

What seems to be required at each of these levels is a systematic and objective understanding and ability to use the processes by which integration in its non-parochial sense can be achieved. Sovereignty suggests complete integration within and complete disintegration without. As such, it is a fruitless concept. In fact, the scope and range of integration is very great. The smallest sovereign is hardly sovereign at all, and the largest sovereign is hardly sovereign in many dimensions.

Social science research is now, perhaps belatedly, turning again to the questions of how human beings can develop effective new political communities. The urgency for new insights into the bases of political community cries out for prompt and large scale research support for these efforts. For every dollar spent on such efforts ten thousand or one hundred thousand are spent on weapons whose integrative effect is very limited under present conditions.

CONCLUSION

Despite the great increase in the national research effort, its national importance is not yet clearly perceived. Its present state reflects the fragmentary character of its growth and the urgency which brought it into being. It is time to take a long hard look at our national research and development effort. As the nation examines its efforts in this field, it will find that many important purposes are poorly served with research resources. It will find vast areas in which scientific effort, though developing, is far too thin to serve the nation's interest. It may find the need for clarification of the concept of basic research and extension of support to that which is truly fundamental. It will find, no doubt, that the great increase in sure knowledge requires a much larger investment in its diffusion if the people are to continue to play an active role in the direction of the nation. In short, it will find that there are major tasks which must be undertaken if science is to replace magic in policy-making at every level of the political and economic system.

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