might expect to find interaction between the effects of social environment and famine. None was evident in the data relating mental performance to social class and exposure to famine.

The results are positive in two respects. First, they point either to a high order of protection afforded the fetus in utero, or to great resilience of the fetus in the face of nutritional insult, or to both. Second, the results affirm the association of social environment and mental performance. Among these birth cohorts there are considerable variations, not reported here, on the matrices and in the frequency of mild mental retardation between large cities and small, between town and country, between religious groups, and between birth orders. These variations in mental performance point to effects of postnatal experience that are likely to be crucial and demand continued testing.

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Politicalization in Science

Joseph Haberer

In this article I elaborate on some of the profound impacts and consequences of three significant transformations of modern science that have occurred in the last century: first, the politicalization of science, then the shift from an international to a national orientation of the scientific enterprise, and finally, the professionalization of the community of science. Such an undertaking may help us to better understand (i) the emergence of social responsibility as an item of major concern among scientists and others; (ii) the pattern of "prudential acquiescence" that characterized science during most of its history; and (iii) the pervasive influence that the belief in a partnership between science and government has had upon the study of science and its relation to the political order.

Politicalization

For science, the age of innocence is over. That innocence to which J. Robert Oppenheimer alluded in his famous, if somewhat enigmatic, remark that "scientists have known sin" (*1*), began to disintegrate some decades before the blinding flash at Alamogordo brought to full consciousness the recognition that the knowledge produced by scientists contained within it the seeds of an awesome power. Implementation of the Baconian ideal of science was predicated on the notion that knowledge is power —power over nature that could be used for the improvement of the human condition. Ironically, the Baconian model reached its first full expression in the Manhattan Project, that massive team of scientists and engineers whose efforts culminated in the destruction of two cities. Yet the overweening optimism of the founders of modern science threatens to turn their dreams into nightmares.

The belief, based on a faith in science, that progress is inevitable and beneficial, began to turn to ashes when it became evident that science as power was also an agent of destruction and death. None of this surprises us today. Yet, notwithstanding the increased social consciousness among segments of the American scientific community, even before the outbreak of World War II, that innocence, that optimism, remained the dominant outlook among American scientists well into the 1950's. Indeed, it may be that most scientists are still wedded to the conviction that the solution to our social, political, and human problems lies in applying to them the instruments of modern science and technology.

In contrast, European scientists were much less likely to operate under a belief that the scientific fraternity was somehow sheltered from the vagaries of the surrounding social and political order. For them, the age of innocence ended soon after the first shots rang out at Sarajevo. The rallying of scientists to national banners and the utilization of scientists as a national resource created in the international community of science a schism that ex-

The author is associate professor of political science and director, Program in Science and Public Policy, Purdue University, Lafayette, Indiana 47907. This article is adapted from a paper presented at the AAAS annual meeting, Philadelphia, Pennsylvania, 29 December 1971.

isted until the late 1920's. Furthermore, divisiveness increased within national scientific communities. For example, the civil war in German science during the Weimar Republic produced conflicts that left indelible marks.

European leaders in science had stressed, since the end of the 19th century, that science was a national resource which needed to be nurtured. It had become difficult for any but the most obtuse to fail to see that the life of science was deeply affected by the sociopolitical milieu in which it existed. It is not that European scientists were, on the whole, imbued with a grave concern about the impact and long-range consequences of science and technology on society or with the kinds of questions about the social responsibility of science that engage us today—quite the contrary. But there was an earlier recognition that science had become an integral part of the modern industrial system and that the growth of science required considerable public support (that is, government funding), which would be forthcoming only if it could be justified in terms of science's usefulness to society. Such justification was not hard to produce, since the connections between scientific research, both basic and applied, and national power were even then becoming apparent. This meant that European science became more visibly politicalized several decades before the process began to assume major dimensions in American science.

In France, Germany, and the Soviet Union, the politicalization of science became quite pronounced in the interwar years; in Britain and the United States, on the other hand, struggles for influence and power remained muted. Vituperative attacks by scientists upon other scientists were eschewed, and both the American and the British scientific community remained relatively untouched by bitter internal conflicts, unlike the scientific communities of the other major powers. These differences suggest that the duration, intensity, and scope of politicalization in the sciences of particular countries are significantly conditioned by the cultures of those countries.

One may wonder whether the realm of science changes the realm of politics or vice versa. Actually, there is little indication that the outlook on and approach to scientific problem-solving have profoundly changed the practice of politics. Politics has not become more scientific—science has become more political. One need only think of the manner in which a nation's style of politics is invariably more deeply embedded in its policy-making mechanisms and methods for resolving conflicts than are the articulated norms of science. When the political climate becomes volatile, one may expect a pronounced spillover into the social system of science. The conflicts with which scientific communities have been faced in the 20th century become increasingly political rather than scientific. Scientific conflicts, of course, remain, but more and more of the scientific communities' energies are likely to be directed toward institutional (that is, social and political) rather than paradigmatic issues.

Science as a multifarious human activity is not only a body of knowledge or theory, it is also a methodology, a praxis, a network of habits and roles through which this knowledge is acquired, tested, and transmitted. Further, science is a philosophy, an ideology, even a mythology—in any case, an outlook that contains considerable connotative and symbolic potency. Finally, science is an institution rooted in society and as such inevitably becomes politicalized. Because of its social nature, science is infused with politics. Politics is that sphere of human activity which deals with public problems arising primarily from the aspirations, conflicts, and dilemmas of social existence. While science is inherently political, it has only become politicalized in the 20th century. By "politicalized" I mean that both in its internal affairs and in its relations to the rest of society science has become deeply immersed in political problems, issues, and processes.

The politicalization of science calls forth a new kind of leadership within science. Leadership has been most frequently paradigmatic in modern science (*2*). A paradigmatic leader is one whose preeminent achievements have been recognized and proportionately rewarded—by election to membership or office in a learned society of his peers, by the award of a Nobel or other prize, or possibly by the attachment of his name to a theory or discovery. This kind of leadership is for the most part honorific, and few responsibilities are attached to it other than protecting the integrity of science (for example, ensuring that its methodological ethic is maintained). Paradigmatic leadership is co-optive, elitist, and nondemocratic; in some respects it resembles the college of cardinals.

In the Cartesian model of the community of science, scientists were considered peers whose relationships to each other were nonhierarchical and without complex functional differentiation. Questions about the responsibility of paradigmatic leaders to their constituency did not really arise until the question, "Who speaks for science?" came to the fore. However, as modern science changed increasingly into a Baconian form, a different kind of leadership emerged—that is, institutional leadership. Today, institutional leadership is becoming as important as paradigmatic leadership in the affairs of science.

Institutional leadership is needed to deal with organizational and political imperatives; its priorities are defined primarily in terms of the needs and demands of a given enterprise. Moreover, the hierarchical structure of Baconian science, its complex pattern of relationships, its large-scale institutions and mass membership, creates varying constituencies, interest groups, and organized sources of support and opposition, both within and outside of the scientific community. This transformation from a predominantly Cartesian to Baconian pattern invariably leads to the politicalization of science, at which point institutional leadership takes precedence over paradigmatic leadership. As science conforms more and more to the Baconian image, institutional leaders will become more and more important and influential. This is precisely what has been occurring in American science in the last two decades.

Just as there has been a shift in the leadership pattern, so there has been a change in the conflict pattern in the scientific community. Paradigmatic conflicts involve strictly scientific issues and take place on the terrain of knowledge and theory. Institutional conflicts involve policy issues. Interests, relationships, and goals emanating from the social nature of science are involved here. Institutional leaders in modern science, however, have viewed their responsibilities largely in instrumental terms. Science has been used as a tool, with scientists giving scant attention to the ends to which their energies have been directed. The institutional ethic of science has remained weak because a pervasive methodological ethic has dominated the value system of science to such an extent that consideration of other normative issues has almost been excluded, at least until these issues were forced upon science.

In particular, the question of the social responsibility of scientists was ignored in favor of the expediency I have termed prudential acquiescence. Before Hiroshima, scientists believed that there was a natural conjunction between their intellectual product and the betterment of humanity. Such a belief did not require them to consider the ambiguous consequences or moral choices entailed in the utilization of their work. For three centuries this optimism made it possible to evade, repress, and ignore the question of social responsibility in all but its narrowest forms.

Modern science has been singularly devoid of any serious concern with fundamental questions—for example, those involving the relations between ends and means. Its overriding instrumentalism has been expressed in its desire to control and dominate nature, almost as an end unto itself. Not an intrinsic love of knowledge, but a Faustian hubris characterized modern scientific temperament. Bacon's vision of the social function of science reflects the new tone (*3*, pp. 372–373):

> [The scientific venture is not] a trumpet which summons and excites men to cut each other to pieces with mutual contradictions, or to quarrel and fight with one another; but rather to make peace between themselves, and turning with united forces against the Nature of Things, to storm and occupy her castles and strongholds, and extend the bounds of human empire, as far as God Almighty in his goodness may permit.

Concerned with "the enlarging of the bounds of Human Empire, to the effecting of all things possible" (*4*, p. 156), Bacon's concrete proposals reflect an externalization of values: the prolongation of life, the restoration of youth in some degree, the retardation of age, and the curing of diseases considered incurable head the list of 33 projects that his research institutes would work on (*5*). There is no need to quarrel with these goals as such, but they are surely not ends in themselves. It is precisely here that a hiatus is most noticeable. Neither Bacon nor Descartes was thinking about the possible long-range consequences for society in any but instrumental terms. Borkenau has pointed out that Bacon's *Essays* were "the only psychological writing of his time which did not once raise fundamental questions about the purpose and value of human existence nor the inseparately connected questions of the essential nature of man" (*6*). The same holds for Descartes, who developed no political theory, who put the area of ethics into abeyance, and whose outlook is also permeated by instrumentalism. Obsessed by death, Descartes seeks to conquer death, on the one hand, and on the other to become, through the method of his deductive science, a surrogate god (*7*).

These attitudes suggest that the power drive defines modern science and its practitioners far more accurately than does the belief that basic science is a disinterested search for knowledge and for the betterment of man's estate (*8*). It seems to me to be of the utmost significance that Bacon and Descartes, the institutional founders of modern science, placed the entire question of social responsibility into a limbo where it remained for the next 300 years. More than that, their advocacy of prudential acquiescence set the stance that modern science subsequently adopted in its relations with ruling powers. Their theories and their conduct posited retreat or an apparent acquiescence as the appropriate response to any serious confrontation with state or church.

The history of modern science reflects the tremendous influence that the doctrine of prudential acquiescence exerted on scientists. The responses of German scientists to National Socialism and of American scientists to the Oppenheimer affair are characteristic. The fact that this doctrine was formulated by two such leading institutional founders as Bacon and Descartes is therefore not irrelevant. While no causal relation can be established between their advocacy and subsequent responses, the fact remains that their message and example were influential (*9*).

The tactic of prudential acquiescence remained dormant after the rise of modern science because the fears of the founders did not materialize—there was no serious conflict between state and science. Not until the early decades of the 20th century did science, institutionally considered, become crisis-ridden. Science had remained a relatively small enterprise well into the 19th century, and its members were essentially soloists, men who happened to do some work in science or natural philosophy. Moreover, the interests of science and the emerging nation-state were viewed by leaders of both as mutually beneficial and in no sense fundamentally at odds with each other. Science remained relatively free of political conflict—particularly war. Only in the latter part of the 19th century, when science became a profession, did the possibility of a collision begin to appear. At that time, science was transformed from a predominantly Cartesian structure to a Baconian structure. From an enterprise with a small membership, rudimentary and relatively simple institutional networks, and laissez-faire relationships, science metamorphosed into a leading social institution with a massive constituency, an elaborate division of labor, and complex institutional structures; scientists began to work in teams similar to those Bacon envisages in *New Atlantis*. This profound institutional change signaled the movement of science from its former peripheral to its present central position in the social and political order.

Nationalism and Internationalism

It is generally held that science has been able, with considerable success, to ward off the divisiveness of parochial and nationalist political considerations. Most scientists believe science to be a predominantly open and international endeavor. Experience increasingly shows this belief to be misleading. The balance between nationalism and internationalism has fluctuated somewhat. The scientific community espouses a strong commitment to the international and universal nature of science; however, its practice reflects a preponderantly national and parochial orientation.

The internationalism of science tends to be shallow. Rather than being a strong commitment to universalism, it is much more akin to Olympic Games, with each country vying for prizes and the tangible or intangible advantages for national sciences that accrue from participation (*10*).

Beginning with the French Revolution, the tensions between nationalism and internationalism became pronounced (*11*). The professionalization of science that began with the Industrial Revolution further intensified this tension. While international organizations, congresses, journals, and the like mushroomed, the major institutional components of science became oriented toward national rather than international interests and goals. Most of the tangible supports of science in terms of the allocations of social resources, public funds, manpower, and training facilities, as well as policy directions,

derive from the needs of the nation-state. Science harnessed to modern warfare frequently contravenes the international values and institutions of science. In peacetime, science is increasingly viewed as a national resource or as the force driving modernization and industrialization. National sentiments powerfully condition scientific communities, particularly those that are organized along national lines.

National scientific establishments vary in their degree of development, traditional orientation, involvement with other vocational communities (such as industry and government), and in other important ways. Each discipline, each national scientific community forms a unit within the nation-state in which it functions and begins to develop its own vital interests. Each becomes concerned with strengthening itself, attracting to itself the most talented potential scientists and maximizing available resources in a situation of relative scarcity.

Institutional imperatives compel leaders in each field of science to protect, if not expand, their present position, and the resources available to them, from the incursions of those outside science (for example, legislative bodies intent upon greater economy and budget cutting), as well as from other leaders within science who seek to increase their own influence and resource allocation at the expense of others in science. The tension produced by this situation undercuts the idealized and widely accepted perception of science as a disinterested, fraternal community in which goals and the means of achieving them are in essential harmony. At the same time, the scientific ethos commits members to an international, nonpolitical conception of the enterprise. Behavior based on this ethos, however, is likely to contravene the practical workings of the scientific enterprise, thus creating further tension within the community of science. Viewed within a social context, the institutional makeup of science is intrinsically conflict-producing.

The imperatives of national defense and military policy derive logically from the nature of nation-states and the interactions among them, as well as from the technological-scientific developments that have made the modern power state possible. It may be that no fundamental change in the relation between science and government will occur until the nation-state system itself is transformed.

Although scientists and their institutional leaders have generally had a very narrow conception of their social responsibility, there is one area in which their sense of social responsibility has been very strong and persistent—patriotism. Institutional leaders of science have identified the locus of their social responsibilities in terms of the national interest. One can see this in all of the highly industrialized nation-states. In Germany, the founding of the Kaiser Wilhelm Gesellschaft and the part that Planck, Haber, and others played in it is indicative of the form such patriotism takes (*12*). These scientists took the lead in persuading the German government to support the establishment of this research institution on the grounds that it would strengthen the contribution of science to Germany. Dupree has shown that a similar pattern existed in the United States before World War II (*13*). This pattern is evident in every nation-state, where nationalism is a powerful magnet. It continues to be for scientists the most decisive source of commitment in their institutional life.

In the 20th century, nationalism created a tremendous rift in international science. In order to demonstrate the force of this nationalism, I focus in some detail on the first great rupture in international science—namely, that caused by the outbreak of World War I and the boycott of German science after the war. This example shows convincingly that, in any profound conflict between national and international objectives, the former tend to prevail. That first crisis showed more clearly than anything else since that the societal aspect of science has really always been national rather than international. This remains true, but recognition of the fact has been buried in the collective unconscious of scientists—for it is too painful for members of scientific enterprises to admit that their primary loyalties are to a state rather than to humanity.

With the outbreak of World War I, the internationalism of science received a shattering blow. Like the socialist international, the scientific international simply collapsed under the siren song of patriotic obligation. Deep-seated, although somewhat muted, animosities between German and French scientists were quickly mobilized by both German and French governments in the service of the propaganda war. Like most of their compatriots, German scientists were engulfed in a wave of nationalist fervor. Planck's speech as rector of the University of Berlin on 15 October 1914 is characteristic of the spirit (*14*):

> The German people had once again found itself, and with such greatness that it surprised friend and foe alike. Students jubilantly left the universities by the thousands to heed the call to arms. . . . Many an academic society sent its members, down to the last man, out to do battle for their country. . . . The fields of battle have already been reddened by the blood of our brave men. Those of us who remain behind are overcome by envy that it should be denied us to sacrifice our very best, our own lives, for the highest of all earthly ideals.

Similarly, in France, the distinguished mathematician Duhem welcomed the war, saw in it a coalescing of national solidarity and an opportunity to get even for the humiliating defeat of 1870 (*15*).

The first and most famous case of scientists lending their name to a propaganda campaign on behalf of the war effort was in Germany. On 4 October 1914, a document entitled *Aufruf an die Kulturwelt* (*To the Civilized World: A Manifesto of German University Professors and Men of Science*) was published (*16*). It was subsequently translated into ten languages and widely disseminated. Ninety-three signatures were attached to the manifesto—all of distinguished scholars, scientists, and artists. Twenty of the names were of leading scientists, including Haber, Haeckel, Nernst, Ostwald, Planck, Roentgen, and Wien, who were or became Nobel laureates. The manifesto stated in part (*16*, pp. 74–76):

> As representatives of German Science and Art, we hereby protest to the civilized world against the lies and calumnies with which our enemies are endeavoring to stain the honour of Germany in her hard struggle for existence—in a struggle which has been forced upon her. . . .
>
> *It is not true* that Germany is guilty of having caused this war. . . .
>
> *It is not true* that we trespassed in neutral Belgium. . . .
>
> *It is not true* that the life and property of a single Belgian citizen was injured by our soldiers without the bitterest self-defense having made it necessary. . . .
>
> *It is not true* that our troops treated Louvain brutally. . . .
>
> *It is not true* that our warfare pays no respect to international laws. It knows no undisciplined cruelty. But in the east, the earth is saturated with the blood of women and children unmercifully butchered by the wild Russian troops, and in the west, dumdum bullets mutilate the breasts of our soldiers. Those who have allied themselves with the Russians and Serbians, and present such a shame-

ful scene to the world as that of inciting Mongolians and Negroes against the white race, have no right whatever to call themselves the upholders of civilization.

It is not true that the combat against our so-called militarism is not a combat against our civilization, as our enemies hypocritically pretend it is. Were it not for German militarism, German civilization would long since have been extirpated. For its protection it arose in a land which for centuries had been plagued by bands of robbers, as no other land had been. The German army and the German people are one, and today this consciousness fraternizes 70 millions of Germans, all ranks, positions, and parties being one.

The manifesto was a defense of German militarism. It argued that the invasion of Belgium had been a justified preemptive measure because Britain and France had planned to invade that country; that the war had been forced upon Germany by England and France; that the enemy was engaging in a systematic campaign of lies intended to blacken the name of Germany. In short, Germany was the righteous and honorable participant in the war and a true defender of culture. At issue here was not that these scholars and scientists came to the defense of their country, but that they lent their names to a blatant piece of propaganda which contained serious distortions and lies (*17*). The apparent alacrity with which German scientists fired this verbal volley shocked Allied scientists. The memory of the manifesto lingered on; it helped, in fact, to strengthen the position of the forces who after the war imposed the boycott against German science.

Duhem's lectures on German science were published in France in 1915. German science, he argued, was imbued with a "geometric spirit"; its outward strength belied its internal weakness. It was, he concluded, inferior and auxiliary to French science (*15*, p. 143):

> The geometric spirit which inspires German science gives it the strength of perfect discipline; but this strictly disciplined method can only end in disastrous results if it continues to submit to the laws of an abstract and senseless algebraic imperialism; the laws it obeys, it must accept if it wishes to produce beautiful and useful work; such is the case with French science, which is throughout the world the principal depository of common sense. *Scientia germanica ancilla scientia gallicae.*

Les Allemands et la Science appeared in 1916 and contained essays written by 27 luminaries of French science and scholarship, including Duhem and Picard (*18*). These essays constituted a sustained attack on German science and had a common theme: French contributions to science were superior to German contributions; German achievements had been overrated; these achievements were, on the whole, the result of a national propensity for collective hard work and discipline. Lacking, for the most part, great scientific minds, Germany's science was strong because of the notable thoroughness, organizational ability, and scientific imperialism German scientists had practiced in the prewar years. German science and its leaders had worked hard to bring about its hegemony over all of science, and this in support of a pan-German policy of cultural domination.

One manifestation of the latent hostility among members of the international scientific community was the rapidity with which a campaign of mutual defamation began. In France, Germany, and England, and later in the United States, there arose a literature, a great deal of it written by well-known scientists, which claimed that the enemy's scientific culture was inferior, derivative, aligned with reactionary forces, and the like. Diels, at a meeting of the Prussian Academy of Sciences on 27 January 1916, informed his colleagues that the superiority of German sciences could be demonstrated by comparing the number of German scientists who had received Nobel prizes and membership in foreign scientific academies with the corresponding number of British and French scientists (*19*). Lenard, himself a Nobel Laureate, wrote a book in which he claimed English physics was little more than plagiarism of German physics (*20*).

On the whole, though, very few eminent German scientists took part publicly in this type of denigration. The same cannot be said for leading French scientists, who contributed to works whose main purpose was to demonstrate that German science was inferior in quality, creativity, imagination, and fruitfulness. On 3 November 1914, the Academie des Sciences officially stated that "the Latin and Anglo-Saxon civilizations have over the last three centuries produced most of the important discoveries in the mathematical, physical, and natural sciences" (*18*, p. v; *21*).

In Great Britain, the attack was less vitriolic, but similar themes were expressed. Two months after the war had begun, *Nature*, Britain's leading scientific journal, editorialized (*22*):

> The originality of science of the Germans has decreased during the past generation in spite of their enormous output of literature; this is to be attributed, no doubt, to the restraining influence of a military despotism, which has pervaded all aspects of their life. But in the design and manufacture of their war material they have worked increasingly for years in their usual methodical manner, trusting rather to myriads of experiments than to the utilization of original thought, which is for them in great measure lacking.

Before the year was over, *Nature* reported the following (*23*):

> In a letter to *The Times* of December 26, and in an article of the *Strand Magazine* for January 1915, Sir E. Ray Lankester disputes the idea that Germans are entitled to special pre-eminence in the domain of physical sciences. On the contrary, with the exception of the work in spectrum analysis, in the middle portion of the last century, their claims to original discoveries of importance, more especially during the reign of the present Kaiser, are comparatively insignificant. Their real line of success lies in their capacity for adopting and developing the discoveries made in other countries for their own interest and benefit, more especially when large profits are to be made. . . . In their voluminous treatises on the history of science published during the last forty years they have in many instances deliberately ignored the claims of investigators in other countries to discoveries and ideas upon which their own work is based.

British scientists were less grudging in paying tribute to the achievements of German scientists, but their view was that German scientists had failed to dissociate themselves from the spirit of Prussian militarism. Fleming put it this way in a letter to the London *Times* which was later quoted in *Nature* (*24*):

> No one familiar with the achievements of scientific thought would refuse to admit the indebtedness of the world to such thinkers and workers as Jacobi, Gauss, Bessel, Riemann, H. F. Weber, von Helmholtz, Kirchoff, Hertz, and Röntgen, but the fact is quite astonishing as it is painful that a nation which has made such contributions to the upbuilding of natural philosophy should have permitted itself also to be dominated by an immoral militarism by whose votaries sheer brute force is worshipped as the highest virtue and the only source of national advancement. Side by side with an immense ability in creating and applying scientific knowledge we have an almost complete failure to recognize truth, honour, faith-keeping, and justice as the foundations of national greatness.

No doubt the manifesto had deeply hurt the signatories' British colleagues. That the most prominent German men of science should have approved and

supported the German government, "in spite of the fact that it uses methods of warfare which we regard as outside the pale of humanity and common civilization" (*24*, p. 94), was painful to accept. Such support would not have been possible in Britain, for there a citizen's duty was not only to obey the government but also to protest its unjust actions. German scientists were different then—conditioned to follow orders, supporters of a blind nationalism (*25*).

> If the British military authorities had transgressed against the written and unwritten laws of humanity as Germany has done, we feel sure that our men of science would have found a voice in condemnation of the Government. In this country it is no unusual thing for men of science to find a voice in condemnation of the Government, both for what it does and what it leaves undone. Such condemnation used, in fact, to be in peacetime a stable article of scientific public speaking, the like of which one did not find in Germany. One never heard there even in private conversation the kind of criticism of Government action or inaction which in this country is reiterated, commonplace.

Ramsay showed that Germany (together with Austria) had attained only 17 out of the 58 Nobel prizes awarded between 1901 and 1912. Moreover, in 1912 only 28 percent of foreign members in the world's learned societies were German. While these figures should not be ignored, they reflect Germany's organizational ability. Britain lacked a national organization of scientific effort, yet in the roster of brilliant scientists and inventors—in its overall scientific accomplishments—Ramsay argued, Britain and France had far surpassed Germany in each of the two preceding centuries (*26*).

Scientists rallied en masse to their respective countries' defense. Britain is a good example of the response to the crisis of the war, because its intellectuals were probably less under the influence of a strident nationalism than those of France and Germany (*27*). Britain's scientific leaders were determined from the start to make their contributions in several ways. First, it was necessary to present a united front to the rest of the world: impress upon the enemy that the scientists of Great Britain and the Commonwealth were solidly behind their government and believed that German militarism was indeed guilty of the crimes charged against it. An early indication of this line was the response to the German manifesto. A letter printed in the London *Times* of 21 October 1914 and signed by 150 well-known scholars stated (*28*):

> The German Professors appear to think that Germans have in this matter some considerable body of sympathizers in the universities of Great Britain. They are gravely mistaken. Never within our lifetime has this country been so united on any great political issue. We ourselves have a real and deep admiration for German scholarship and science. We have many ties with Germany, ties of comradeship, of respect, and of affection. We grieve profoundly that under the baleful influence of a military system, and its lawless dreams of conquest, she whom we once honoured now stands revealed as the common enemy of Europe and of all peoples with respect to the Law of Nations. We must carry on the war in which we have entered. For us, for Belgium, it is a war of defense, waged for peace and liberty.

Among the signers were 40 scientists, including such luminaries as Lodge, Cavendish, Thompson, Haldane, Crooke (president of the Royal Society), Ramsay, and Sheridan.

Almost from the day the war started, scientific leaders in Britain pressed the government to utilize scientists more effectively. They argued that Germany had been able to wage war so successfully because it had harnessed its scientific manpower much more efficiently. They were convinced that the government was simply not aware of how crucial scientific research and development were to the successful conduct of modern war. As early as 29 October 1914, *Nature* editorialized (*29*):

> There is a class of our fellow subjects which as yet, so far as we are aware, has not been organized. That is the Fellows of the Royal, the Physical, the Chemical, and the Engineering Societies. In their own provinces they are the pick of the brains of the country. This war, in contradistinction to all previous wars, is a war in which pure and applied science play a conspicuous part. Has any effort been made to coordinate the efforts of the devotees of physical, chemical, and engineering science, so that they may work together at what for us is the supreme problem of all—how to conquer the Germans? For if we fail, civilization as we know it will disappear. Democratic rule will have to yield to military oligarchy.

Almost a year later, after numerous letters and editorials on this theme, *Nature* could still assert (*30*, pp. 419–420; *31*):

> When a man of science of such distinguished eminence as Prof. J. A. Fleming can say, as he does in *The Times* of June 15, that after 10 months of scientific warfare he has never been asked to cooperate in any experimental work or place any of his expert knowledge at the disposal of the forces of the Crown, though he is anxious to give such assistance, it is evident that the people in authority cannot understand the value of the scientific forces which it cheerfully neglects. Not a day passes but we are asked by men of science how they can devote their knowledge to national needs; and there is no ready answer. The organization of the scientific intellect of the country is essential, yet almost nothing has yet been done towards its accomplishment.

As leaders of British science saw it, science was a national resource. It was a key to the military as well as to the economic strength of the country. German scientific preeminence in fields such as chemistry was dangerous to the future of England's economic position, for in many fields of science new knowledge promised important technological and economic benefits. Until his death in 1916, Ramsay was the most forceful proponent of this view. In a series of articles in *Nature*, he stressed that Britain must catch up with Germany in its utilization of science if it were to compete successfully in the world market after the war. To achieve this, Britain needed to overhaul its haphazard scientific organization and bring into existence a true partnership between science and government. For a start, a more systematic advisory process was essential (*32*).

> Behind the Government, whether in association with a special Minister or not, there must be a powerful advisory committee with facilities for initiation as well as discrimination, a sort of Privy Council for Science with public responsibilities, to whom the public as well as the Government can appeal.

The pressure to put science to use in the war effort was initiated and maintained by the scientists, whose leaders saw much earlier than did the politicians that this war would be one in which scientific research and development would play a decisive part. To mobilize the country's scientific manpower, scientists recognized that they would have to persuade the political leadership that the coordination and support of scientific resources was essential to survival. By 1916, with the emergence of Lloyd George's government, they had succeeded to some degree (*33*).

International scientific meetings virtually ceased during the war. National scientific meetings were greatly curtailed. Communication between scientists of warring nations stopped. This course of events was not imposed from

the outside, but was entered upon voluntarily by scientists. Members of academies from enemy countries were not, with one or two exceptions, stricken off the roll, but hostile feelings toward them ran high, as revealed, for instance, in an October 1914 editorial in *Nature* (*34*, p. 206).

> It is to be hoped . . . that if meetings go on as hitherto, any German or Austrian members of the societies will absent themselves for the time being, as objection might be taken to their presence under existing conditions.

In a secret meeting of representatives from all German universities in July 1915, a motion to sever all connections with foreign universities and academies, which was supported very strongly by the University of Berlin, was narrowly defeated because of the opposition of universities in southern Germany (*35, 36*).

On 3 September 1915, Picard, as president of the French Academy of Sciences, told the members that any personal contacts between scientists of countries at war with each other was out of the question (*36*). Two years later he was to state publicly that he opposed any future meetings with German scientists; such meetings would be too painful to French scientists, for "too much blood and too many crimes have come between us" (*35*, p. 162). Moreover, he argued that German-speaking scientists should be excluded from international scientific meetings after the war. "We believe that a nation which has put itself outside the pale of humanity should be excluded, at least for a time, from scientific meetings between peoples of human culture" (*37*).

There is no way of ascertaining the extent to which the attitudes and arguments expressed by scientists in the warring countries were based on honest conviction. I assume that the anger was genuine, as was the patriotic support of the war effort. Did leading scientists quite believe the attacks on the integrity and achievements of scientists in the enemy's country? Perhaps. At any rate, scientific leaders saw their role as one of mobilizing the scientific potential of their country and of contributing to the morale of scientists and the public, even if this meant attacking scientists elsewhere. It is significant that, throughout the war, a pejorative posture was adopted by scientific leaders on both sides. The seeds sown in the early years of the war would yield fruits of divisiveness in the peace to follow.

Table 1. Relocation of headquarters of international organizations and institutes (*39*, p. 116; *62*).

Country	Headquarters or institutes (No.)	
	1914	1923
Germany	14	6
Austria	3	3
Italy	3	4
France	18	37
Belgium	13	21
England	9	14

The ensuing boycott can be attributed, in part at least, to the determination of institutional leaders in science in the Allied countries to prevent German science from regaining the kind of influence that it had exerted before the war. If science was indeed a national resource, then attainment of the national objectives of countries such as France, England, and Belgium—science policy becoming an adjunct of national policy—depended on weakening and isolating German science.

With the war over, international science was confronted by the same kind of task that the political order faced: to make the peace, to resolve differences, to heal wounds, to resume communications, and to create those conditions which made fruitful cooperation possible. Mutual distrust, anger, and fear of a "scientific imperialism" had left their mark. The international scientific community did not, and very likely could not, resume where it had left off in 1914. The war had left a legacy of bitterness that resulted in the boycott. In science, as in politics, the peace would be dictated by the victorious powers.

Until recently, little was known about the boycott. Memory of it seemed almost to have vanished. Schröeder-Gudehus' study *Deutsche Wissenschaft und internationale Zusammenarbeit: 1914–1928* is the only extensive examination of the phenomenon (*38*).

Under the vigorous advocacy of French and Belgian scientific leaders, but with the active support of British and American scientific leaders, a policy was initiated before the end of the war to exclude German scientists and scientific organizations from international scientific life. The policy was adopted in 1919 and was not officially terminated until the late 1920's.

The boycott took several forms. German scientists and scientific organizations were excluded from participation in international scientific, scholarly, and technical congresses that were sponsored by international organizations under the control of scientific leaders from the Allied countries. Of the 275 international meetings that took place between 1919 and 1925, about 165 excluded any kind of German participation. In 1923, Germans were absent from 60 percent, in 1925 from over 40 percent, and as late as 1927 from about 15 percent of the international meetings held. Until 1925, German scientists were effectively kept out of the majority of international meetings that were called by scientific associations of the Allied powers or that took place under the auspices of newly created international organizations. Between 1922 and 1924, for example, German-speaking and neutral powers were invited to 21 of the 106 such meetings held. Thirteen of these were boycotted by French and Belgian scientists because they objected to the inclusion of German scientists.

A boycott of the German language, both in congresses and in the literature, was initiated. French and English were to be the preferred international languages of science. This boycott reflected the feeling among many Allied scientists that the German language's monopoly of the literature in many fields in the prewar period had to be broken (*39*, pp. 408–409).

> [N]umberless Archives, Jahrbücher, Zeitschriften, Zentralblätter, and so on . . . have gradually monopolized the whole of the scientific production of the world. . . . Thus were apparently built up international scientific organs, but in reality German instruments of control and monopoly of science.

Headquarters or international organizations and institutes that had been located in Germany before the war were relocated. If that was impossible, new organizations were formed. As a result, there was a considerable shift in location (see Table 1). New international scientific organizations, such as the International Research Council (IRC), the Association International Geographique, and the Union Astronomique, were formed expressly to exclude German science from representation and German scientists from positions of leadership. Strong pressures were also exerted in forming the IRC to keep out neutral powers that were lukewarm about denying membership to Germany (*38*, pp. 99–101, 108–110).

By 1925, the boycott had reached its apogee. Only then were efforts made to bring Germany back into the international scientific community. Even so,

IRC leaders, who were mainly French and Belgian, resisted. Under pressure from their respective governments, IRC leaders initiated negotiations with German scientists for a resumption of "normal" relations. However, German scientific leaders were embittered and had to be pressured by their government to cooperate. Part of this reluctance stemmed from the conservative-nationalist political outlook of men like Planck, who remained cool toward the Weimar Republic because they saw it as the manifestation of the hated Treaty of Versailles.

Officially, the boycott was over by the late 1920's, yet the breach in international science continued to exist throughout the interwar years. As Schröder-Gudehus has demonstrated, the political leaders of the Allies and of Germany moved far more rapidly and willingly toward reestablishing amicable relations between their countries than did their scientific counterparts. And as she suggests, all this "stands in flat contradiction to currently widely held theories that science is a unifying, while politics is a divisive, principle among nations" (*38*, pp. 224–225).

During the interwar period, political conflict also intensified within national scientific communities, particularly those in Europe. And among these, internal conflict was sharpest in Germany, where during the period of the Weimar Republic (1919 to 1933) some scientists engaged in bitter ideological clashes. The virulent political attacks on the work and person of Einstein symbolize the state of affairs. For example, in 1922 the debate on his theory of relativity was marred by the overt anti-Semitism of some of the scientists who participated (*40*). Even in the early 1920's there was in Germany a visible minority of scientists who sympathized with the National Socialist movement (*7*, pp. 107–112).

The takeover of power by the National Socialist regime in 1933 created further stresses within German science. The new regime encountered practically no resistance in its attack upon the traditional practices and institutions of science. What occurred was more than a political assault from without on the autonomy and integrity of science; it was also an attack from within; for many scientists cooperated with, indeed strongly supported, the National Socialist movement's policy of ideological coordination. Moreover, in contrast to noteworthy instances of open and determined resistance to National Socialism in other vocational communities, whether religious, military, political, or literary, among scientists there was none. In essence, the attack was met with near total acquiescence on the part of the German scientific community (*41*). What becomes evident is that scientific leaders, when faced with a choice between the imperatives of conscience and power, nationalism and internationalism, and justice and patriotism, invariably gravitated toward power, nationalism, and patriotism and followed a policy of prudential acquiescence (*42*).

It should also be noted that scientific leaders in Germany continued to view their enterprise as a national resource. With very few exceptions, scientists rallied to the support of their country in time of war. There is no evidence that German scientists worked any less hard than their Allied counterparts did during the years 1939 to 1945 to assist their government in the war effort. The claim by Jungk and Heisenberg that German physicists deliberately sabotaged or at the very least slowed down their work on the military applications of atomic energy is a myth (*43*). German scientists in late 1938 brought the military potentialities of atomic energy to the attention of the German government and the military. German scientists were engaged in projects exploring potential military applications of atomic energy (*44*).

Finally, it should be noted that World War II did not see the kind of attacks of scientists upon each other that World War I did. With the end of hostilities in 1945, there was no repetition of the recriminations that followed World War I. Indeed, international scientific relations became, on the whole, smoother. The question of why communications and intercourse between scientists resumed so rapidly and with no apparent bitterness remains unanswered. Certainly the Allied governments sought out German scientists in order to benefit from their knowledge —they even kidnapped some of them. In any case, perhaps scientific leaders, like political leaders, had learned that a harsh peace brought few long-range benefits to the victors.

Professionalization

The professionalization of science within the last century has resulted in stronger ties between science and society, for that professionalization depended on large-scale societal investments and public support of scientific institutions. Years of training in universities, the establishment of postdoctoral and other research facilities, and manpower development programs all depend on resources allocated through public policies that foster professional objectives.

A special relationship exists between a profession and society. A profession is a socially rooted and supported vocational enterprise of full-time practitioners who earn their living by providing a vital social service through the utilization of expert and esoteric skills (*45*). They are granted substantial autonomy in conducting professional affairs—in setting standards, training new specialists, invoking disciplinary powers, and establishing and enforcing professional codes. This autonomy is based on the recognition that a profession operates in a realm of expertise which those outside of it can make no claim to and which they, at best, understand only very generally. For nonprofessionals, therefore, this requires a considerable degree of dependency and trust—if the professional is to perform his work satisfactorily. A reciprocal obligation, however, is placed upon a profession: namely, to fulfill those responsibilities which it has either explicitly or implicitly assumed. This relative absence of legal constraints and externally imposed controls is predicated on the belief that the special knowledge and unique skills of professionals render them the best judges in matters affecting the application of their expertise.

When performance and conduct bring this trust into question, when the experience of enough members of a society suggests that a profession has not adequately lived up to those responsibilities, a social order is likely to make incursions into the autonomy of a profession's institutional modus operandi. A case in point is the medical profession in the United States. Until recently, it was widely held that physicians, true to their vocational ethos, would probably be the individuals most concerned with the formation of policies to assure adequate health care. However, in some important ways, the medical profession has obstructed the establishment of a first-rate, preventive program of health care—has, perhaps, done more than any other element in our society to bring about the crisis in health and medical care.

In a prescientific age, professions

were regarded as special callings, vocations that entailed service to human needs. That notion of a profession sounds rather hollow and archaic today. Modern professions, to the degree that they have become imbued with the scientific outlook and modeled after scientific practice, have become themselves more and more instrumental. In their concentration upon technique, professions tend to ignore human, social factors, which are not easily quantified. Not only in their outlook, but also in their embodiment as institutions, modern professions relegate normative questions to a secondary place and fasten upon science and technique as the keys to advancing human welfare. Education and training in the science-oriented professions stress, to the exclusion of nearly everything else, technique and methodology. Scant attention has been given to the social role of professionals or the social problems and issues with which a profession ought to be concerned. This situation has resulted from inverted priorities rather than from the prolonged training that specialization and the tremendous growth in knowledge and techniques have brought about.

As modern professions use the scientific approach, they become increasingly subject to inversion of priorities, instrumentalism, and detachment, even isolation, from humanity. Professions then tend to become increasingly schizophrenic in their conduct, as though the split between the realm of expertise and the social nexus in which it functions were nonexistent or, worse, unimportant.

A clue to the malaise of the professions may be found in these developments. One of the most significant factors in the crises in medical care, in the uses of science and technology, in the legal system, and indeed in every facet of contemporary life where professions operate, has been the failure of the professions to be sufficiently alive to their deeper commitments and to their common responsibilities. To be sure, professions have become more alert to problems of social responsibility in the last few years. However, only in cases of gross neglect (such as malnutrition and environmental destruction), serious malfunctioning of essential services (health and schools), or destructive or careless utilization of applied knowledge (defoliation and pharmaceuticals) have institutional leaders in the professions and the bulk of their members been roused from inertia and complacency. The pressures for change, the demands for action, and the insistence on revised priorities have largely been generated by groups outside the professions themselves, or else from among young professionals and graduate students (*46*).

Institutional life carries its own obligations and contradictions. Today, science consists of leaders and members who are interested in the survival and growth of their institutional network, irrespective of other considerations. These are vested professional interests. Policies in support of such interests are sure at some point either to collide with the interests of other vocational communities or to bring out into the open the question of whether such policies are in the public interest.

A profession is necessarily divided in its commitments. Investments in building and maintaining the enterprise, personal stakes in their careers and work, and a penchant for accruing influence and power move professionals in the direction of political activity to protect those interests. Such vested interests have been assiduously defended in American science in recent years. As science has attained its present magnitude, conflicts over the allocation of resources to its various sectors, over the determination of priorities, and over the accountability of leaders have become more visible and more frequent. The ensuing politicalization of science occurs not only within science, but also vis-à-vis the political order.

Institutional imperatives move men toward the pole of power, whereas vocational imperatives move them toward the pole of values. Professions pursue their goals in situations where their vested institutional interests are frequently at odds with the articulated value system that provides them their raison d'être. This tension is unavoidable. However, I believe that a heightened awareness of the incongruity can make professionals more sensitive to the human needs to which their professions minister. Their responsibility lies not in attempting the impossible—to do away with human suffering—but rather to eliminate needless suffering.

All of this is now becoming quite apparent. It is almost common knowledge that more scientists are living and working at this moment than the total of all scientists in history. The exponential growth of science from about 1600 until the 1960's has been well-documented (*47*). Science has become a national resource to be developed, nurtured, and used. In short, within the last three decades science, as well as its institutional leaders, remains no longer in the wings, as Vannevar Bush thought it was in 1945, but has moved to the center of the stage (*48*). In every advanced industrial society, science has become a leading institution.

In every major sphere of human activity, the consequences and implications of science and the technology it has made possible have become increasingly visible and problematic. And it is, of course, precisely the problematic quality of scientific progress that poses questions about the social responsibility of scientists. The present concern with social responsibility derives from the sense of crisis engendered by the knowledge that scientific achievements have jeopardized man's survival. An undertone of pessimism may be discerned in many of those who enter the dialogue on the social responsibility of science. It is a feeling exemplified by the cover of the *Bulletin of the Atomic Scientists*, which shows a clock with its hands a few minutes from noon (or is it midnight?), symbolizing the impending hour of doom—unless men can be shocked into realizing the lateness of the hour and the necessity for quick and drastic change in order to avert disaster. It would be foolish to deny that dire prognostications could indeed be fulfilled, but there are dangers in this negative approach. If our attitudes are infused more with fear than with hope, more with the foreboding of disaster than with a sense of opportunity, then man may not be able to respond appropriately to real dangers until it is too late. The shock treatment has its limitations: it may create a sense of powerlessness in the face of immense dangers or it may induce psychological defense mechanisms against an ominous reality. We are moving from a naive optimism to a pervasive pessimism, and both are deleterious. I do not minimize the dangers, but what seems to be missing is the recognition that modern science and technology also allow for immense possibilities. They can make possible the conditions necessary for building a social order in which human beings may have the opportunity to realize themselves far more fully than they have in the past (*49*)—not merely, as Lord Snow put it, by giving jam to those who haven't had it before, but by utilizing science and technology to create a qualitatively better society (*50*). If men are to transcend their present circumstances, fear,

perhaps in moderate doses, may be an inducement to action, but it seems to me that hope, nurtured by a compelling vision of ideals worthy of achievement, is a far more effective way to mobilize men to realize their potentialities, both individually and collectively.

Science and Policy: Partnership?

An increasing number of the assumptions that guided the study of science and public policy in the 1950's and 1960's have come to be challenged. We must consider the need for new frameworks, and we must ask whether this entails the application of more rigorously scientific, empirical approaches to problems that have already been set or an entirely new approach for perceiving, analyzing, and providing guidelines for coping with the problems and opportunities brought about by the rise of science. I want to suggest that we have not done very well in casting a net of inquiry—nor have we done very well in anticipating emerging trends and problems in terms of their political significance. Part of the explanation lies in the theoretical underpinnings of the field of science and public policy; the politicalization, nationalism, and professionalism that have transformed the scientific enterprise have also shaped the very study of the relation between science and the political order.

The field of science and public policy did not emerge until after 1950, when it became clear to scientific and political leaders that science had become a major social institution in the nation-state (*51*). Those in political science who have influenced the direction that the study of science and public policy has taken in the last two decades have shared most of the assumptions, expectations, and political outlooks of the institutional leaders of science. In short, there has been a shared interest between those in the physical sciences who are concerned with public policy and those in the social sciences who are concerned with science policy (*52*).

Most work has been predicated on the belief that the important task is to create, sustain, and cement the partnership of science and government. In support of this aim, the intellectual undertaking became one of analyzing the conditions, factors, institutional devices, and so on, that hindered or strengthened the partnership. Scientific leaders and their cohorts were, for the most part, indifferent to basic questions and simply accepted the conventional wisdom of a pluralistic political system. In the context of American politics, advocacy of a partnership became a claim for entrance into the strategic positions of access and influence. Such a position is one of the cardinal conditions for those who seek to wield power and to secure benefits in a pluralistic system (*53*). Not surprisingly, the partnership doctrine is based on an acceptance of pluralism as the most appropriate mode of political practice (*54*). Wary of party lines and condemning "ideological" commitments, the pluralistic political universe is one in which policy outcomes are grounded in interests (essentially relationships based on power), not in explicit political principles. The central concern in the study of the relation of science to the political order appears to have been twofold: delineating the conditions for the most effective utilization of science on behalf of national policy objectives and providing a rationale for protecting science's stake in the partnership of science and government.

In the partnership doctrine, the relationship between government and science is viewed as one between equals: Science actively assists government, and in that sense it is a servant of the state; at the same time, however, science makes claims on government that are designed to further its autonomy and enhance its influence (*55*). Advocates of partnership seek an active role for science in government and seek the kind of influence that will give scientific leaders a determining role in the making of public policy, at least in those areas where science and public policy impinge upon each other in significant ways. "Those scientists who have undertaken the responsibility of carrying out research for the government and of administering the scientific business have not been backward in stating the special requirement that science *demands* of its partner, the government [italics added]" (*56*). At the same time, scientists want to retain the traditional independence and autonomy of science. The problem is the extent to which partnership and autonomy are compatible (*57*).

Partnership has its attractions. There is the promise of influence, even power, by decision-makers. It suggests an avenue for preferential treatment in procuring resources for professional activities. It lays the foundations for a network of privileges and status. To the extent that the scientific enterprise becomes enmeshed in this network, its critical distance is diminished. Independent, critical work is dampened and impeded where there exist obligations or close connections to those in power. What this means is that one cannot serve two masters—at least, not at the same time. A commitment to theorizing, for example, precludes involvement in the practical world of policy-making (*58*). Yet, in the field of science and public policy, there has been a notable absence of critical distance. Interest has been decidedly in the direction of influencing the outcome of policy, and not, for example, in examining the underlying structure of assumptions and values that shape policy. The point is that, in American politics, and increasingly in the politics of all modern, affluent societies, the theoretical imagination has atrophied. The consequences of this situation are now becoming evident, in our involvements in Southeast Asia and in the paradoxes of poverty amidst plenty and a sense of powerlessness in a world of immense man-made power. The consequences of our pragmatic, ahistorical orientation may become unbearable and too costly in human terms.

Almost all of the work done in the field of science and public policy in the last two decades reflects a preponderantly pragmatic orientation. The problems to which research appears to have been confined demonstrate the great influence of public administration in the development of the field (*59*). Decision-making patterns, allocation of resources, technological assesments—such is the stuff that research has largely been concerned with. It has dealt with the more specific issues of the formulation of policy, with problems revolving around the administration of science, and with the relationships between scientific and political leaders, their mutual and divergent interests. Not only has the scope of research been rather narrow, but most of it has been focused on the American experience as though it were representative of a universal relationship between science and politics. Moreover, most studies have dealt almost exclusively with the events of the period from 1940 to the present, and thus lack the kind of historical and cross-cultural perspective that is the sine qua non for a far-ranging theoretical approach to the study of the politics of science.

Comparative studies of the internal politics of science have been, at best, fragmentary. Nor have the political dimensions of the professionalization of science received systematic attention. Interdisciplinary, comparative, cross-cultural approaches and perspectives are the exception rather than the rule.

Very rarely have any fundamental questions even been raised, far less dealt with in a serious way. Yet such questions must now be raised in a sustained fashion. For example, what are the implications of the cybernetic revolution, of greatly expanded leisure, and of biomedical technology for political theory and practice? In what ways does the transformation of modern societies by science and technology bear upon the classical conceptions of citizenship and democracy? What kinds of changes are occurring in the political systems of the postindustrial world and what is their significance? Given the rapidity and far-reaching nature of changes induced by science and technology, how is government—indeed, decision-making in various kinds of organizations, professions, and communities—to be kept as responsive, effective, and democratic as possible? What factors further or hinder the utilization of science and technology in the interests of humanistic values? What patterns of governance are emerging within science and how do these derive from and affect the politicalization of science?

Basic scientific discoveries and key technological innovations are creating conditions that bring to the fore the fundamental questions raised by theorists from Plato to Marx and Weber. The problems of order and change, distributive justice, leadership and responsibility, the uses of power, the nature of the good society and the public interest, a consideration of size, density, and technological complexity as variables that affect or determine the structure (constitution) of political systems—these are some of the areas that must be explored.

The basic political questions are, I believe, theoretical and normative. They pertain more to a perception and vision of the political universe than to the details of practical solutions to technical problems. Such questions are not amenable to quantitative answers, nor are they essentially technical. Of course I am not suggesting that scientific knowledge and expertise are irrelevant, only that they are intrinsically instrumental.

The first theoretical task is to explore some of the crucial impacts and consequences of the interface of science and politics. Such work, however, is most valuable if it eschews a narrow professional orientation, if it recognizes that creativity is not a manufactured product, and if it encourages an immersion in those humanistic studies that enrich our understanding of the human condition. All of this suggests that there is a need to theorize not only about middle-range problems, but about the central questions and problems in the field as well (*60*). I am convinced that both the sociology of science and the field of science and public policy have made a profound mistake in focusing on the middle range of questions and that this, in part, explains the relative lack of vitality in both fields. Any framework that is to expand the boundaries of investigation must start with the recognition that science is central within the modern world. Such a framework must explore the profound and deep-seated symbiotic ties between science and the political order.

Events of recent years have increased awareness of the scientific enterprise as it impinges upon the social order, transforms it, and is itself transformed. The destructive impacts of specific technological innovations are becoming more visible. We are being forced to consider some of the negative and unforeseen consequences of a progress based on science—population problems, nuclear power, environmental pollution, ecological imbalances—in short, the dysfunctional impacts of technology. Our awareness, however, tends to be awakened only by impending or actual crises. In responding, we are inclined to concern ourselves only with the symptom rather than with the systemic causes of problems. Our frameworks are flawed because they do not deal with the normative dimension of political life (*61*). In any case, a better balance between the practical and the theoretical, between the empirical and the normative, and between the realm of means and the realm of ends is needed. We must begin by asking different kinds of questions.

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16. Reprinted in R. H. Lutz, *Fall of the German Empire: 1914–1918* (Stanford Univ. Press, Palo Alto, Calif., 1932), vol. 1, pp. 74–78.
17. H. Wehberg [*Wider den Aufruf der 93!* (Deutsche Verlagsgesellschaft für Politik und Geschichte, Charlottenburg, 1920)] documents these distortions. Some of the signers had not read the document at all; others had been misled as to its contents; a number regretted putting their names to the manifesto.
18. G. Petit and M. Leudet, Eds., *Les Allemands et la Science* (Alcan, Paris, 1916).
19. H. Diels, in *Sitzungsberichte* (Preussiche Akademie der Wissenschaften, Berlin, 1919), p. 95.
20. P. Lenard, *England und Deutschland zur Zeit des Grossen Krieges* (privately published, Heidelberg, 1914).
21. See also *Le Temps*, 4 November 1916, p. 2.
22. *Nature* **94**, 221 (1914).
23. *Ibid.*, p. 486.
24. *Ibid.*, p. 94.
25. *Ibid.*, **95**, 315 (1915).
26. W. Ramsay, in *Les Allemands et la Science*, G. Petit and M. Leudet, Eds. (Alcan, Paris, 1916), pp. 325–334; see also report in *Nature* **95**, 237 (1915).
27. See F. K. Ringer, *The Decline of the German Mandarins* (Harvard Univ. Press, Cambridge, Mass., 1969) and K. Schwabe, *Wissenschaft und Kriegsmoral* (Munsterschmidt, Göttingen, 1969) for the role of German scholars in the nationalist movement before and during World War I.
28. The London *Times*, 21 October 1914, p. 10.
29. *Nature* **94**, 221 (1914).
30. *Ibid.* **95**, 419 (1915).
31. See also: *ibid.* **95**, 57 (1915); *ibid.*, p. 295; *ibid.*, p. 295; *ibid.* **96**, 180 (1915); *ibid.*, p. 195; *ibid.*, 587 (1916); *ibid.*, p. 643; W. Ramsay, *Germany's Commercial War Machine* (reprinted from Manchester *Daily Dispatch*, Manchester, England, 1916).
32. *Nature* **95**, 317 (1915).
33. L. Varcoe, *Minerva* **8**, 192 (April 1970); N. Vig, *Science and Technology in British Politics* (Pergamon, Oxford, 1968), pp. 8–12.
34. *Nature* **94**, 206 (1914).
35. S. Grundmann, in *Relativitatstheorie und Weltanschauung* (Deutscher Verlag der Wissenschaften, Berlin, 1967), p. 162.
36. R. Rolland, *Das Gewissen Europas: Tagebuch der Kriegsjahre* (Rütten und Loenig, Berlin, 1963), p. 700.
37. E. Picard, quoted in B. Schröder-Gudehus, *Deutsche Wissenschaft und Internationale*

Zusammenarbeit, 1914–1928 (Dumaret & Golay, Geneva, These No. 172, 1966), pp. 106–107.
38. B. Schröder-Gudehus, *Deutsche Wissenschaft und Internationale Zusammenarbeit, 1914–1928* (Dumaret & Golay, Geneva, These No. 172, 1966).
39. E. Rignano, *Nature* **98**, 408 (1917).
40. R. W. Clark, *Einstein: The Life and Times* (World, New York, 1971), pp. 255–64.
41. For a more comprehensive discussion of the response of German science to National Socialism, see Haberer (7, pp. 103–181). Also see K. D. Bracher, W. Sauer, G. Schulz, *Die Nationalzozialistische Machtergreifung* (Westdeutscher, Köln, 1960), pp. 317–20.
42. See Haberer (7, pp. 179–181) for a summary of some of the factors that explain this pattern.
43. See Haberer (7, pp. 163–179) for a critique of the Jungk-Heisenberg thesis. See also R. Jungk, *Brighter than a Thousand Suns* (Harcourt Brace Jovanovich, New York, 1958); W. Heisenberg, *Universitaes* **8**, 337 (April 1953).
44. D. Irving, *The German Atomic Bomb: The History of Nuclear Research in Nazi Germany* (Simon & Schuster, New York, 1967), especially pp. 34–56.
45. For example, K. S. Lynn *et al.*, Eds. *The Professions in America* (Houghton Mifflin, Boston, 1965) (especially E. C. Hughes, pp. 1–14; J. H. Means, pp. 47–69; and J. J. Beer and W. D. Lewis, pp. 110–13). See also the perceptive study of C. L. Gilb, *Hidden Hierarchies: The Professions and Government* (Harper & Row, New York, 1966).
46. For the crisis in the medical profession and the attack upon the medical establishment, see the following: B. Ehrenreich and J. Ehrenreich, *N.Y. Rev. Books* **15**, 14 (12 December 1970); M. J. Michaelson, *Amer. Scholar* **39**, 694 (Autumn 1970); *N.Y. Rev. Books* **16**, 39 (25 February 1971). For a different view, see D. L. Farnsworth, *N. Engl. J. Med.* **282**, 1235 (28 May 1970).
47. D. J. de Solla Price, *Little Science, Big Science* (Columbia Univ. Press, New York, 1963), pp. 1–32.
48. V. Bush, *The Endless Frontier: A Report to the President on a Program for Post-war Scientific Research* (National Science Foundation Reprint, Washington, D.C., 1960), originally issued July 1945, pp. 11–12.
49. For a discussion of this point, see J. Haberer, "Technology and the emerging future: A framework for normative theory," (mimeographed) presented at the annual meeting of the American Political Science Association, Chicago, Ill., 11 September 1971, pp. 1–4.
50. C. P. Snow, *The Two Cultures and a Second Look* (Mentor, New York, 1964), p. 46.
51. Beginning with A. Comte, sociologists recognized this much earlier. M. Weber and K. Mannheim, among others, took this social reality very much into account in their theoretical work. See, for example, B. Barber, in *Sociology Today: Problems and Prospects*, R. K. Merton, L. Broom, L. S. Cottrell, Jr., Eds. (Harper & Row, New York, 1965), vol. 1, pp. 215–223.
52. The acceptance of the partnership doctrine appears to me to be a consistent one in the work of the leading people in the field—notably, in the work of D. K. Price, H. Brooks, A. Weinberg, E. Shils (as editor of *Minerva*).
53. Perhaps this explains the great interest in studying scientists' roles in decision-making, their influence in and access to the political process, particularly on the federal level.
54. D. K. Price, *The Scientific Estate* (Harvard Univ. Press, Cambridge, Mass., 1965), pp. 171, 174, 205–207.
55. V. Bush (*52*) provided the first full-blown expression of the partnership doctrine. However, the idea of partnership has permeated the thinking of the institutional leaders of American science for well over a century. See A. H. Dupree (*13*).
56. Committee on Science and Public Policy, *Federal Support of Basic Research in Institutions of Higher Learning* (National Academy of Sciences, Washington, D.C., 1964), p. 19.
57. Historically, the claim for the autonomy of science has meant the acceptance of a modus operandi in which the two communities refrained from interfering with each other's affairs. This did not preclude occasional government support of scientific activities; nor did it prevent scientists from giving advice or assistance to the state under certain conditions, in time of war for example. However, by and large, the community of science appeared to be an overtly apolitical community that considered affairs of state as an intrusion upon its more important work.
58. The tension between the two is brilliantly elaborated in M. Weber's classic essays "Politics as a vocation" and "Science as a vocation," in *From Max Weber*, H. H. Gerth and C. W. Mills, Eds. (Oxford Univ. Press, New York, 1958), pp. 77–156.
59. Public administration, government service, and science administration are part of the background of most of the leaders in the field.
60. For a defense of middle-range theorizing, see R. K. Merton, in *On Theoretical Sociology* (Free Press, New York, 1967), pp. 39–72; *Social Theory and Structure* (Free Press, New York, 1957), pp. 9–11, 85–117.
61. I have suggested a framework for such a normative theory elsewhere (*49*, pp. 4–12).
62. S. Grundmann, *Wiss. Z. Tech. Univ. Dresden* **14** (No. 3), 799 (1965).

NEWS AND COMMENT

Creationists and Evolutionists: Confrontation in California

A new biology textbook for elementary schools comes in two versions, a national edition and a California edition. The former, to illustrate an account of man's origins, pictures the paleoanthropologist L. S. B. Leakey. In the edition designed to meet the requirements of the California State Board of Education, Leakey is replaced with Michelangelo's Sistine Chapel fresco of the creation of man. The switch of Adam for Leakey accurately symbolizes the two sides of a controversy that has engulfed the teaching of science in California's elementary schools.

The publishers may correctly have inferred a desire on the part of the state board to substitute the Genesis account of man's origins for the version according to Darwin. In fact, the board is asking only for equal time; it wishes science teachers to present evolution and creation as equally plausible explanations of how man came to be. But unlike Solomon's equally even-handed decision to divide the disputed baby, the wisdom of this edict has not been universally apparent. Biology teachers and university scientists in California have belatedly mobilized against what they perceive as a threat to both academic and scientific freedom. The scene has been set for a head-on confrontation between science and religion, from which the reverberations may extend to the several other states in which similar tensions are latent.

Within the next month, the California board of education will adopt a science textbook for elementary schools. Whatever its choice, the matter seems likely to end in the courts, since the evolutionists have threatened to file suit if creation is mentioned and the creationists to sue if it is not. How did the board of education get itself into such a situation?

The story begins a decade ago in Orange County where two housewives, Jean E. Sumrall and Nell J. Segraves, became concerned about the conflict their children perceived between the Bible and the evolutionary account taught in school. They protested to the Orange County school board and were told that the board could teach only what was in the textbooks. With the help of a friend of Mrs. Segraves, Walter E. Lammerts, they set out to persuade the California State Board of Education to change the textbooks.

Lammerts, a fundamentalist with a Ph.D. in genetics from the University of California, is by trade a rose-breeder (the Charlotte Armstrong rose is one of his varieties). In 1963, he became the principal founder of the Creation Research Society, a body that has played an important role in the California textbook affair. The society has two requirements for membership—which, together, make it an unusual association. Applicants must hold master's or Ph.D. degrees in some field of natural science, and they must believe in the literal truth of the Bible. The society's credo states, for