Science and Human Survival

Unlimited war is self-defeating and an alternative must be found by a new science of human survival.

War is today a social problem of catastrophic force and overshadowing urgency. The basis of war is power, and power is a product of science. Science is therefore deeply involved in this problem, and scientists have a particular duty toward its solution. For the establishment of national policy on war—or peace—the public needs to learn the relevant facts and discuss their meaning. We believe that it is the obligation of scientists to make these facts known, to estimate the consequences of alternative policies, and, if need be, to seek new solutions (*1*).

War is a form of social action that is intended to conserve and protect the social order, or to extend it. It is one response to a basic social need for protection. Despite its inhumanity and wastefulness many societies have thus far been able to adapt to the increasingly stressful effects of war and to survive its growing violence. However, current war preparations involve new weapons—nuclear, chemical, and biological—that have not had a substantial trial in actual combat. There is therefore no historical evidence that adaptation and survival are possible in this type of warfare, or that these untried weapons can achieve the purpose for which they have been developed—the protection of nations or social orders.

Growing Destructive Power of War

The destructive power of modern weapons is increasing geometrically. The first nuclear bombs exploded in 1945 released energy equivalent to about 20 kilotons of TNT; in the test explosions of 1948 the maximum size was about 50 kilotons; by 1953 explosions of the order of 1000 to 10,000 kilotons had been achieved, and this year 30,000- and 50,000-kiloton bombs were exploded. In the 16 years since the first nuclear explosions the size of available weapons has about doubled every year.

The present arms race is the outcome of the widespread basic knowledge of nuclear forces, the essentially unlimited power of the resultant weapons, and the existence of several nations capable of building them. Because some of these nations regard each other as potential enemies, a rapidly accelerating process of competitive armaments has taken place. One nation arms to deter a possible attack from the other; fearing that these arms may be for aggression rather than defense, the second nation responds by an even greater armament; and the process continues. Defensive measures such as shelters follow the same pattern, for they too will tend to elicit a more powerful offense. The arms race is a typical self-accelerating process, and the destructive power of modern weapons is growing at a rate which becomes faster each year.

Modern technology is not only powerful but also complex and fast-acting. The development of rocket missiles has reduced the time for delivery of a nuclear weapon to about 20 to 30 minutes. In that brief time the target nation must discover that the attack has been launched, work out the missile's course, determine its national origin, decide on an appropriate response, and set in motion its own defensive and offensive measures. To achieve the necessary speed there have been developed elaborate networks of detectors, communication lines, and electronic computers. Modern systems of warfare have become so complex and swift that they can no longer be controlled consistently by human judgment alone.

Because of the complexity of modern war systems, considerable attention has been given to the problem of accidental war. Part of the elaborate instrumentation is designed to set up multiple controls and other devices to prevent mechanical or personal accidents, and, according to some observers, reduces the probability of an accidental war. However, Norbert Wiener has suggested that complex computer systems may sometimes respond to a situation in a way that is not anticipated by their human controllers, and do so at such speed as to produce a wrong decision before there is time for correction. He believes, for example, that a machine designed to solve war problems might sometimes operate in an unexpected way and "win the war" at a price that nobody wants to pay (*2*).

Regardless of which view of the effect of instrumentation on the probability of accidental or unwanted war one accepts, it is clear that the hazard is a real one. The Mershon report, which has surveyed the problem, concludes, "Taking together all the dangers, there is a significant chance that a major accidental war may occur sometime in the 60's" (*3*).

Immediate Effects of a Nuclear War

The immediate destruction expected from a full-scale nuclear war has been the subject of fairly detailed study, at least in the United States, and certain estimates are possible. The Joint Congressional Committee on Atomic Energy and the agencies cooperating with it have performed a valuable service in summarizing the relevant evidence on the effects of nuclear war (*4, 5*). These depend, of course, on what assumptions are made about the nature of an attack. In the congressional hearings, and in most subsequent discussions, it is assumed that the United States is attacked with 1- to 10-megaton weapons, totaling about 1500 to 3000 megatons, and that no adequate shelters have been provided. In these circumstances it is estimated that the attack would leave some 40 to 70 million dead within a few weeks; a lesser number would be injured and survive, depending on what medical facilities withstand the attack. According to a recent analysis of the effects of 20 megatons of nuclear explosive on the New York metropolitan area, total casualties of about 60 percent of that population would occur (*6*).

Any city struck in such an attack would be demolished by blast and fire storms. It is generally concluded that a massive nuclear attack on the United States could destroy most of the nation's major cities.

This scale of killing and destruction is so enormous that certain broad generalizations regarding its social consequences can be made. At the very least, all social and economic processes which depend on large cities would be massively disrupted: communications, transportation, finance, a considerable part of light and heavy manufacturing, major medical facilities, institutions of higher education, scientific laboratories, libraries, centers of government. If we add to this the widespread effects of fires and radiation outside the range of direct hits, it becomes apparent that such an attack would largely destroy our present social structure. Whatever operations were possible immediately after the attack would necessarily require a system of economic, social, and political organization radically different from that which we now enjoy.

In general, the development of a shelter program cannot greatly influence the conclusion that a massive nuclear attack would have the immediate effect of destroying the social structure. A particular shelter system is designed to resist a certain assumed intensity of attack, and its success depends on the validity of this assumption. But an opponent can be expected to respond to such a defensive move by stepping up the intensity of attack. Any shelter system short of one that places the nation's entire population and industry permanently underground can be negated by a corresponding increase in the attacker's power. In fact, as Brown and Real (*7*) have pointed out, the mere preparation to resist an increasingly massive nuclear attack—that is, the deeper and deeper emplacement of more and more of our activities into underground shelters—would, even in the absence of nuclear war, make profound changes in our normal social structure.

There is, we believe, no escape from these conclusions about the *immediate* effects of a full-scale nuclear war on the belligerents: it would kill a considerable portion of their populations, destroy the major cities, and disrupt the present structures of the societies which it would be intended to protect.

It is one of the tasks of the AAAS Committee on Science in the Promotion of Human Welfare to encourage discussion of scientists' obligations toward questions of public policy that arise from the social effects of scientific progress. In keeping with this responsibility, some of the members of the committee recently held a conference to discuss the relationship between science and modern war. This article summarizes the views developed by the conference and is published to stimulate further discussion. Those participating were Barry Commoner, Washington University; T. C. Byerly, Agricultural Research Service, U.S. Department of Agriculture; Lawrence K. Frank, Belmont, Massachusetts; H. J. Geiger, School of Public Health, Harvard University; Margaret Mead, American Museum of Natural History; and Frank W. Notestein, Population Council, Inc.

Long-Term Effects of Nuclear War

The long-range problem is vastly more complex than the immediate one. It presents the following general questions: (i) What lasting effects would the great fires and radioactivity produced by the attack have on the biological system (soil, water, air, plants, and animals) on which man depends? (ii) How would the increased death rate, widespread disease, and genetic effects of the war affect the vitality and viability of the survivors? (iii) Would the immediate destructive effects of a nuclear war cause major irreversible changes in the economic, social, and political organization of our society? (iv) How would the foregoing effects—and the aftermath of direct experience with the nuclear attack—influence the behavior of human beings, and how would new patterns of behavior influence social organizations and operations?

The scientific evidence that can be marshaled to answer this formidable array of questions, which is summarized in congressional hearings held in 1959 (*4*) and 1961 (*5*), is very limited and uncertain. The problems are listed above in increasing order of complexity. The simplest, though still exceedingly difficult, problem is the ecological outcome of a nuclear war. A discussion of this problem by an ecologist, John N. Wolfe (chief of the Environmental Sciences Branch, Division of Biology and Medicine, Atomic Energy Commission), begins with this statement: "The long-time ecological effects of nuclear war are nearly impossible to assess and even difficult to speculate about" (*4*, p. 840). In his opinion, ecological recovery—for example, reestablishment of the continent's plant life—would require many decades, but more optimistic opinions have been expressed by others (*5*).

The more complex problems associated with recovery of the economic and social structures following their disruption in a nuclear attack were considered at the congressional hearings of 1961 (*5*). Discussion by Sidney G. Winter, Jr., of the Rand Corporation, of the economic recovery problem concluded that sufficient industrial capacity would probably remain after a nuclear attack to support eventual economic recovery; but on questioning it developed that this estimate was based on the assumption that transportation would be unharmed in the attack (*5*, p. 327). The conclusion that economic recovery is feasible was further qualified by the statement that it does not apply "to possible future situations when extensive blast shelters might be available" (*5*, p. 326). According to this testimony, in a nuclear war that would destroy a given proportion of the nation's industrial capacity, economic recovery would be possible so long as the loss of life in the initial attack would be correspondingly large (*5*, p. 315). If the ratio of survivors to remaining industrial capacity were to become too great, the resulting demand on the limited goods available would be overwhelming and cause a general failure in social organization (*5*, p. 313). Thus, what is proposed to enhance *immediate* survival of the population (shelters) has a contradictory effect on the balance between post-attack industry and population that is deemed necessary for *long-term* survival. In a piecemeal treatment of recovery from nuclear war, separate problems appear to be soluble just because they are artificially isolated from the web of interconnections that distinguishes the complexity—and the actuality—of society, an illusion that is dispelled when the fragment is restored to its proper place in the whole.

If we take the evidence presented at the recent hearings as a summary of the present state of knowledge, and consider in its entirety the problem of recovery from nuclear war, there is, we believe, no scientific basis at present for a useful prediction of what kind of society—if any—would emerge from the ruins.

It will be argued that such fears and uncertainties have always accompanied the development of new forms of power, that these hazards have always been overcome, and that the new forces have been successfully put to good use. We will be reminded that the invention of dynamite was supposed to render war inadmissibly fearful, but that society learned to accommodate itself to this new destructive force. In reply we would point out that social adaptation to new forms of destruction has always, in the past, been achieved by actual experience. Society has "learned to live" with the new inventions by a series of historical experiments, rather than by predictive analysis. What is at issue today is whether or not we can afford to take the appalling risk of attempting to learn from experience whether society—and indeed human life—can survive a nuclear catastrophe.

We are obliged to reassert that the analytical powers of science, which have until now helped to guide society toward its present levels of accomplishment, fail to predict whether human societies would ever return to their present state of competence following a nuclear war. If society embarks on the path of nuclear war, science cannot now offer enlightenment on the end result.

Even if by some unforeseen development we could tomorrow discover how to survive a nuclear war, the basic problem will remain, for other kinds of equally devastating wars are also possible. Shelters that might protect from the blast, fire, and radiation of nuclear war could yet remain vulnerable to an attack with chemical agents. If a way were found for defense against a chemical assault, farmlands would remain unshielded from fertility-destroying agents. Science has now achieved such mastery of nature as to place in human hands the power to end human life. This basic scientific knowledge is widespread, and will grow as science makes further advances. Although stockpiled bombs can be destroyed, the knowledge of how to make new ones cannot be obliterated from men's minds. From now on, mankind must live in a world in which a suicidal war—by whatever means—is always possible. Our problem is not the prevention of a particular war but the continuous protection of human society from a potential danger that will in the foreseeable future continue to threaten the human species with extinction.

We have examined the effects of modern war with respect to our own society. However, we believe that the conclusions apply with equal force to all belligerents in an unlimited war. In view of the world-wide effects of radioactive fallout and of the economic interdependence of the modern world, no nation can hope to escape the catastrophic effects of such a war.

We must conclude that society can no longer be defended by an unlimited war. If we commit the decision of conflicts between opposing societies to such a war, both will be largely destroyed within days and their remnants will face an uncertain future. If we permit such a war to occur in the future course of human history, we run the risk of ending human history altogether.

This is a major transformation in the human condition, and in the nature of human society. Peace, which was until now a human *want*, has become a human *need*. But so long as there is no alternative to war as a means of national security, the need for peace—and for survival—will conflict with the need for social protection. It is this unresolved conflict that has bred the crisis of our time.

The Responsibilities of Science

We believe that science has a commanding responsibility to help mankind survive. Whether society shall continue to rely on war—which is now so dangerously unfit for its protective function —is a social decision in which scientists have no greater or lesser rights and duties than other citizens. But, in the discussions which must precede this decision, and in the development of the means for putting it into effect, science has a special duty and an historic opportunity.

If this crisis is to be resolved by rational social action, the public must become aware of it, understand its dimensions, and appraise the possible solutions. For all these purposes, the public must have the relevant technical facts. Scientists, who are the custodians of this information, must be prepared to bring it before the public.

To accomplish this educational task, scientists will need to overcome certain difficulties. One problem is to remove the obstacles which now tend to obstruct the flow of technical information to the scientific community. Much of the information about war is not easily accessible to scientists, for it often appears in special reports which rarely find their way into the scientists' libraries. This information must be brought more fully into the stream of ordinary scientific communication if scientists are to be adequately prepared for public education on these problems.

Another difficulty is caused by the political tension that is naturally associated with the problems of war and peace. Any scientific finding about these issues is almost certain to be construed as supporting some political beliefs and contradicting others, and there may be a tendency toward social pressure against the scientist who attempts to disseminate it. Such constraint on the free and independent scientific examination of these problems is an obstacle to understanding and a hazard to the rational development of social decisions. If scientists have the obligation to inform their fellow citizens about grave issues, citizens have a reciprocal duty to defend the scientists' right to be heard without prejudice.

By providing the public with the necessary facts—objectively and calmly—scientists can help overcome the uncertainty, confusion, and fear that have been generated by the war crisis.

Science must also assume a new obligation in the present crisis. Science has traditionally served all human needs, among them the need for protection against threatened or perceived harm. The same duty that has placed science at the command of warfare now requires that scientists should with equal devotion serve the social need for peace and find a means of protecting society that does not run the risk of destroying it. This is a great historic challenge, and we believe that science is ready to accept it.

To provide time to devise an acceptable alternative to war, negotiations to limit armaments and recourse to war are urgently needed, and scientists are already performing valuable services in facilitating them. Scientists have done a great deal—but can do considerably more—to help disseminate and apply technical information for the promotion of human welfare in all the nations of the world. If every nation becomes capable of protecting its own people against hunger and disease, political conflicts that might set off an unlimited war can be reduced. But these measures will not alone solve the basic crisis of war, for peace is a process, not a state of truce. What are lacking to establish this process are instrumentalities for the maintenance of peace and for the self-protection of society that are free of the self-defeating faults of modern war.

The importance of peaceful means of resolving social conflict has, of course, long been recognized. Students of human behavior and of social, economic, political, international, and legal processes and many research organizations and foundations have made important contributions to the understanding of social conflicts and have investigated possible methods of resolving them. But these efforts, valuable as they are, do not measure up to the urgency of the need.

Separate analyses of the different aspects of the problem of peaceful resolution of national conflicts are inadequate to the task. These problems are inherently complex, and a scientific attack on them, if it is to succeed, must acknowledge and deal with this complexity (*8*). For example, the negotiations on a nuclear test ban treaty—such a treaty represents only a rather small part of the total problem—involve a wide array of questions in the natural sciences, sociology, and economics.

We believe that if the complexity of the problem is not only recognized but accepted in advance as inescapable, it can be solved. For this purpose we will need to marshal the full resources of *all* the sciences. We shall need to use the special experimental skills of the natural sciences and the knowledge of man accumulated by the social sciences of anthropology, human biology, psychology, sociology, political science, economics, and history. We can no longer risk actual historical experiments to prove out the alternative methods of survival open to the human race. But with creative scientific imagination we can develop ways to simulate the problems in the laboratory—for example, through models based on new ideas and approaches—that will enable us to deal with the many-sided problems and to test the suitability of new procedures. In the past, the physical, biological, and social sciences have been separated by their reliance on different approaches. Today, to meet the new needs of the entire human species—which have resulted from the application of science to the protection of individual societies and the resulting obsolescence of warfare—the concepts and methods of all the sciences must be combined. We can then hope to devise new social inventions to protect all mankind from self-destruction.

Are these hopes unreal? Can such a complex scientific assault on so difficult a problem really succeed? No one knows. But we do know that modern science has the facilities, the techniques, and the material strength that can be directed toward this task. As evidence of this capacity we need only cite the current accomplishments of science, and the considerable success of recent interdisciplinary and international scientific projects (the International Geophysical Year, the various United Nations programs, and antarctic exploration).

Despite its formidable complexity and close association with deeply held social ideas, the problem of modern war is of a type that is not wholly new to science. Science has some history of success in dealing with such issues. In a certain sense the present problem resembles the historical crisis due to the impact of Darwinism on Victorian society—or of the Copernican revolution on the medieval views of man and the universe. In these historical trials the views fostered by science finally prevailed. This success reflects the special strengths of science. Science has developed methods for using man's most powerful instrument, reason. Science has learned how to face the actualities of nature, define their limits, analyze and direct them. Science follows rules of procedure which help to assure the validity of its methods: insistence on objective open discussion of results, continuous correction of errors and omissions. Science has taught its practitioners to rely on what we know about nature, rather than on what we wish nature to be. Science has powerful means for correcting faulty human conceptions such as the continuing belief that human societies can be conserved by modern war.

We call for the establishment of a new collaborative science, *the science of human survival*, which will apply the full strength and wisdom of all the sciences to the solution of the crisis created by the obsolescence of war.

We cannot now provide a blueprint of the structure of the new science, nor specifications of all it may accomplish. But some of the problems that it must solve are now known. Given this knowledge, we believe that the new science can develop practical means for the solution of the crisis generated by the suicidal character of modern war.

The present danger of war derives from the powers of science and the decisions of society; and its resolution also depends on these agencies. It lies within the power of science to illuminate the self-destructive nature of modern war and to discover new social inventions to replace it. It is up to the citizens—in this nation and throughout the world—to determine that the powers of science will be used not to wage war but to create the conditions of peace.

The great changes that science has made in the human condition form a procession of present accomplishments that yesterday were only fantasies and dreams. This history gives us hope that science can help mankind realize tomorrow what is today the dream of peace.

References and Notes

1. The basis for this conviction is set forth in the report of AAAS Committee on Science in the Promotion of Human Welfare, *Science* **132**, 68 (1960).
2. N. Wiener, *ibid.* **131**, 1355 (1960).
3. J. B. Phelps *et al.*, "Accidental war: some dangers in the 1960's" (Mershon National Security Research Program, Ohio State University, Columbus, 1960).
4. "Biological and environmental effects of nuclear war" (Joint Congressional Committee on Atomic Energy, Aug. 1959).
5. "Civil defense—1961," Hearings before a Subcommittee of the Committee on Government Operations, House of Representatives, 87th Congress, 1–19 Aug. 1961.
6. T. Stonier, "The anticipated biological and environmental effects of detonating a 20 megaton weapon on Columbus Circle" (Scientists' Committee for Radiation Information, New York, 1961).
7. H. Brown and J. Real, "Community of fear" (Fund for the Republic, New York, 1961).
8. The importance of dealing with inherent complexity has been pointed out by Warren Weaver in the following statement [*Am. Scientist* **36**, No. 4 (1948)]:

"These problems—and a wide range of similar problems in the biological, medical, psychological, economic and political sciences—are just too complicated to yield to the old nineteenth-century techniques which were so dramatically successful on two-, three-, or four-variable problems of simplicity. These new problems, moreover, cannot be handled with the statistical techniques so effective in describing average behavior in problems of disorganized complexity.

"These new problems, and the future of the world depends on many of them, require science to make a third great advance, an advance that must be even greater than the nineteenth-century victory over problems of disorganized complexity. Science must, over the next 30 years, learn to deal with these problems of organized complexity."

A similar judgment with regard to one discipline has been made by J. David Singer, who notes [*Behavioral Sci.* **6**, No. 4 (1961)]: "The point which needs to be stressed here is that political science in general, and international relations in particular, suffer from a serious paucity of concepts and models by which we might seek to describe, explain or predict with fullness and clarity. Our conceptual poverty strikes this writer as perhaps the greatest single handicap in the development of everything from low-level empirical generalizations to a full-blown theoretical scheme."