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ADVANCE MATTER

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Address by Vannevar Bush  
 President, Carnegie Institution of Washington  
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SCIENCE AND PROGRESS?

Every man is entitled at one time in his career to declare himself regarding the idea of progress. It is an idea that in some of its aspects has been earnestly discussed by many men for over three centuries. And as usual in the case of debated subjects, the dispute turns largely on the matter of definitions. What is progress? How can it be measured? Is it a historical fact? If we have progressed, are we bound to continue progressing in the future?

When we speak of progress, we may have in mind several different conceptions of the word. Bury in his classic Idea of Progress traces the changes in its content and emphasis through the seventeenth, eighteenth, and nineteenth centuries. The idea is not an old one as ideas go. It had no place in the thinking of antiquity. Some ancient Greek and Roman writers held with Hesiod that the course of history was one of slow but steady decline from a long-past Golden Age. The Hebrew tradition of the Fall reflects a similar point of view. Others among the Greeks and Romans believed

that human history and the future of mankind followed a cyclical pattern, making no significant progress in any constant direction. Cities and empires were known to have risen and declined. Science and philosophy had flourished and faded, and flourished and faded again.

Through most of the Middle Ages the conditions of life were depressing; and men turned for their hope away from the disappointments and uncertainties of earthly existence, to dwell on a roseate dream of life after death. Material improvements were sought and achieved, but their achievement was slow and unimpressive. Knowledge was looked upon as something revealed to men of great faith, to be learned by the study of accepted texts--the scriptures, the church fathers, Aristotle, the schoolmen. It was a revolutionary suggestion of Roger Bacon, and one that had no great influence in his time, that the phenomena of nature should be studied by first-hand observation rather than through received authority.

The Renaissance brought a spirit of renewed earthly joy and enthusiasm, which at first drew its inspiration from the great men of antiquity but gradually turned its eye to the present and the future and became in the Age of Enlightenment a spirit of hopeful expectancy. Francis Bacon, noting the dramatic achievements of a few centuries--gunpowder, the printing press, the mariner's compass--regarded science and all intellectual effort as a utility, justified only as it contributed to "the endowment of human life with new inventions and riches. . . ." He saw no limit to the possibilities of science and fully expected those possibilities to be realized. But he did not regard their fulfillment as inevitable or assured by the laws of nature.

Eighteenth-century philosophers commonly accepted progress as the

MORE

normal course of history without making a particular point of the idea until the Marquis de Condorcet, in the midst of the French Revolution, wrote his Historical View of the Progress of the Human Mind, explicitly setting forth the idea that human progress is continuous and will go on until human perfection is achieved. This became the common attitude of thoughtful people in the early years of the nineteenth century. It runs through the thinking of most of the Romantic and early Victorian poets, the scientists, and the philosophers. It drew strength from the rationalists, deists, Unitarians, and Universalists, who reacted with confidence in the perfectibility of man against the dour fatalism of the Calvinistic teaching that man is essentially corrupt and beyond redemption except through the unpredictable, seemingly capricious, grace of God.

As the nineteenth century advanced, the idea was elaborated and bolstered with new evidence and arguments. The innumerable advances of science and invention, the overthrow of despots and growth of constitutional liberty throughout Western Europe and America, the adoption of humanitarian reforms--all could be pointed to as visible evidence that progress was a fact. And the principle of biological evolution (both Lamarckian and Darwinian) provided an argument of analogy that made progress seem very much like something founded in the nature of things. Darwin voiced the idea temperately in the following words:

As all the living forms of life are the lineal descendants of those which lived long before the Silurian epoch, we may feel certain that the ordinary succession by generation has never once been broken, and that no cataclysm has desolated the whole world. Hence we may look with some confidence to a secure future of equally inappreciable length. And as natural selection works solely by and for the good of each being, all corporeal and mental environments will tend to progress towards perfection.

Even before the publication of the Origin of Species, Herbert Spencer had used the evolutionary analogy in his Social Statics, and

MORE

in the course of the next three decades he carried the argument much farther than his scientific contemporaries were willing to do. He held that "Nature in its infinite complexity is ever growing to a new development" and further that "The ultimate development of the ideal man is logically certain--as certain as any conclusion in which we place the most implicit faith; for instance, that all men will die." The human progress that he envisioned was in all phases: in the minds and bodies of men, who, according to Spencer, would continue their biological change ever toward higher forms; in knowledge; in material facilities and conveniences; and in political and social structures. He regarded it not as conditional upon the deliberate efforts of men, but rather as an inevitable law of nature. Men's conscious actions might contribute to it, but those conscious actions would be only a secondary result of man's own progressive improvement.

The assumption of Darwin and Spencer that all evolution must be progress was of course only an assumption. But it was generally accepted by most of their contemporaries despite the criticism of Huxley in his later years. In the generally hopeful temper of the late nineteenth century the whole Spencerian dogma was eagerly taken up, with or without its claims of reason, by all classes of people in England and the United States. The prevailing mood of our society before the first World War was one of complacent expectation that all things would improve perpetually. Retrogression, at least, was unthinkable.

But the first World War shook our optimism, the depression shook it further, and the second War nearly destroyed it. Now, though we may still hope that our race will go forward in progress, we are confronted with facts that take all the former exuberance out of our hope, reducing it almost to a wish of despair. This is especially so with

MORE

regard to moral and political affairs. For who can have confidence in humanity's future when he looks at events of the past twenty years? Belsen and Buchenwald were poor exhibits of humanitarian progress by any standards recognized in the nineteenth century. And it is difficult to see much to choose between the erratic tyranny of the Czars and the systematic tyranny of the present Russian government, with its purges and brainwashings. Our wonted spirit of optimism has given way largely to a spirit of gloom, and some among us seem to be gradually moving toward a definite philosophy of pessimism.

In these circumstances it is perhaps well that we should look more closely at the idea of progress, take stock of the realities, and formulate a reasoned position as free as possible from both despair and wishful thinking.

Let me begin by distinguishing some of the elements of progress that we are considering. How can the fact of progress be judged or recognized? What does the word mean before it is expanded into Bury's "idea of progress"? As it is used in this phrase and as I am using it, the word carries a connotation not only of movement or even of movement in a constant direction, but of movement in a direction that is intrinsically good or desirable. Its meaning cannot be derived from experience or reason; for it is based solely on a dogmatic ethical assumption as to what constitutes the good or desirable, toward which all actions and all change ought to be directed.

Attempts have been made to define the word in such a way as to escape the element of dogma and give it a semblance of universality. But all such attempts have inevitably failed. Many writers have already pointed out that the measures of progress popularly applied to biological evolution are essentially arbitrary. Man may, indeed,

MORE

have evolved from the primordial ooze, and this may be accepted as good if we assume that it is good to have complex life on earth, but this again is an arbitrary assumption. How many other species have evolved to a certain level of adaptation in relation to a given environment, only to fail of adaptation to a superseding environment? Why cannot the same fate be in store for human kind? We may grant that the evolution of man has been a local triumph in the universe, and yet doubt whether his further evolution is bound to lead to further triumph. We may say that evolution follows a pattern that tends always toward heterogeneity and complexity, and complexity may for a time have survival value. But in the long run how can we be sure that complexity will not prove fatal? Survival value cannot be appraised before the millennium, and therefore to define progress in relation to it is meaningless.

I shall be dogmatic at this point and state some of the standards of value that I have accepted for judging progress. I have nothing new to add, I can merely reiterate what has been said many times, and, having done so, add my comments on its meaning for the great problems we now face. I believe that it is good for mankind to gain knowledge and understanding without regard for their utility in relation to other ends. I also believe that it is good that our knowledge, for whatever reason acquired, should be used to improve man's health and increase his comfort and happiness. And from these primary standards I derive certain secondary values. It is good to preserve the individual freedom of all men; for free men alone can think freely or freely acquire knowledge, and freedom is a part of the comfort and happiness toward which we legitimately aspire. It is good also to have peace, provided it is not bought at the price of greater values, for

MORE

peace in ideal circumstances contributes to our comfort and happiness and in some degree to our freedom. But on the secondary level of values we must often make difficult choices. We must sometimes forego a measure of our earned comfort and happiness in order to avoid losing all of it. We must make sacrifices to sustain and defend the freedom of our institutions, the right to continue our experiment in democratic government and refine its underlying principles. We must sometimes even be willing to go to war for these reasons.

There is a risk in the pursuit of knowledge that must not be blinked at. In our partial knowledge and limited wisdom we can encompass our own destruction without meaning to do so. Fear of such self destruction underlies all our thoughts and acts today, and with reason. But this fear often becomes distorted, being centered almost wholly on A bombs and H bombs because of their spectacular nature. There are other weapons that could prove just as deadly. Had there been no A bombs or H bombs, the danger would not be notably less. For if the nations of the earth continue to devote a large part of their productive efforts to the building of weapons, and to marshal for the purpose all the potentialities of science, engineering, and industry, they can create the means, whether of one sort or of another, which when fully exploited will be capable of erasing whole populations. Without the A bomb, chemical warfare, as it was developed, though held in reserve, during the last world war, could have a terrible effect. Biological warfare could be far more terrible. New diseases created for the purpose and introduced among an unprotected population by an attacker who had acquired immunity to them could bring back the horror of the great plagues that once

MORE

swept over the earth. The deliberate blighting of crops and herds could produce unprecedented famine. And as we now advance in finding chemotherapeutic means for the treatment of mental disorders and drugs that exert control over human emotions, these very means, in the hands of ruthless dictators, may constitute one of the greatest threats of all.

Some people in their unbalanced fear accuse the physicists of having brought the world to its present plight through the development of A bombs and H bombs. It is believed by some that physicists have a conviction of guilt, and some physicists by their own utterances have given grounds for this belief. But the guilt, if it is to be so regarded, must be shared by many who were not directly involved in developing the bombs. Every step in the advance of our knowledge that preceded the discovery of ways to release atomic energy contributed to the final result. If the result was a crime, then Newton must be counted as one of the arch criminals and Einstein as an accomplice. Nor should the scientists of the free world be held peculiarly responsible; for the general course of science has rendered the result inevitable; our scientists merely hastened the time a little and made it possible for us to determine the place and circumstances of the first release of atomic energy. We are fortunate that they were the first to succeed. For their success gave a temporary advantage to the free self-governing peoples of the world. Had Hitler's scientists solved the problem of exploding an atomic bomb early in the war, we might now all be under the Nazi's heel, with extermination camps ready to dispose of any group or nation that rebelled. Had the Russians found the solution at the end of the war, while we were still unarmed with atomic weapons, the sweep

MORE



of their armies would not have stopped in the Balkans, the Baltic, and Czechoslovakia; and we should now face a huge totalitarian state bent on world conquest with all the industrial power of Europe at its command.

We sometimes hear that the natural sciences in general have outrun the social sciences and that the balance must be restored if we are to cope with our great new danger. It is too late in the day for any such remedy. We should indeed give every practicable support to social science and hope that some day it will produce answers to many of our human dilemmas. But the test is upon us now and will not wait. We must grapple with it, using the systems of social relation that we have and such wisdom as we can muster. Whether we come through the ordeal will depend upon whether we are sufficiently mature to map out a wise path and adhere to it. Looking for easy ways, mysterious formulas, or scapegoats will not help.

The dogmas that I have stated are not presumptuous ones. They are dogmas of humility. They do not pretend that we know all the answers. On the contrary, they recognize that we are still comparatively ignorant and very much confused. In our scientific endeavors we have correlated some of our simpler experiences, and this has led us into contradiction and confusion. We have hardly begun to correlate those experiences that involve the emotions. We see but through a glass darkly. Yet the race is young. In a thousand years we may understand more and be able to substitute dogmas that are more satisfying to our souls than the simple ones I have been propounding. Perhaps, indeed, in a thousand years men will abandon hope entirely. But let us not now, in blind anticipation of what they may then think, abandon hope for them.

MORE

We know vastly more than our ancestors did of what nature's forces can do, but we can hardly claim to have achieved any true or profound understanding as yet. Our theoretical explanations of observed phenomena have changed completely in the past three thousand years. How can we say whether they have advanced or not, since they are not measurable by any ultimate standards? They can be judged only according to the degree to which they seem to be consistent with our accumulated experience and the range of experience which they encompass. We place increasing emphasis upon the pragmatic test of whether our theories work, and are little concerned with whether they express an absolute truth, or whether there is such a thing as truth to be expressed. The corpuscular theory of light served for a time until new observations seemed to require its abandonment in favor of the concept of waves passing through ether. Now we have revived the corpuscle under the new name of quantum, and find it useful as a means of rationalizing certain phenomena that could not be rationalized under the wave theory. We use both theories without attempting to reconcile them with each other. When we deal with the nucleus of the atom we work with a bizarre formula and care little whether it has a model to go with it.

Professor Dingle aptly states the case regarding theory in his essay "Some Reflections on the History of Science":

Amid all the changes of theories and pictures and conceptions, the relations remain and steadily accumulate. Franklin found that lightning was a manifestation of the electric ether revealed in laboratory experiments. The electric ether has disappeared, and other theories of electricity have in turn succeeded it and disappeared also, but the relation between lightning and laboratory sparks remains. Maxwell established a relation between light and electromagnetic oscillations. His ether also has gone, but the relation stays. All permanent advances in science are

MORE

discoveries of relations between phenomena, and the factor in science that shows a steady uninterrupted growth is the extent of the field of related observations. World-pictures are indispensable for progress but even the most satisfying has no hope of immortality.

We have progressed in our scientific knowledge and have the power to progress further. But I see no law of nature that makes such further progress inevitable. For the present we are limited only by our will to go ahead and our ability to preserve a world environment in which the search is possible. There probably are inherent limitations to our human mental capacities and to our conceptions of science that will eventually impede our further conceptual progress. We have come generally to question whether there can be any scientific certainty.

There never was, indeed, any true basis for certainty; but when we were in a more optimistic mood we sometimes allowed ourselves to suppose that there was. The present tendency of scientists to emphasize uncertainty is symptomatic of the times; it is perhaps their subconscious reaction as their former roseate vision of endless progress is dimmed by the lowering aspect of the present state of world affairs. The great generalizations of Heisenberg and Gödel have but stated the fact more explicitly and completely than it had been stated before, and led us to see more clearly some of its implications. The inductive method of science, from which have emerged its great triumphs, can yield only a strong probability of truth in a restricted area. No matter how many confirmatory experiments may be made, or how closely they are in accord with a hypothesis, there is no guarantee that the next similar experiment will not contradict it, and no basis for its extrapolation into regions where test is impossible. Man may find order among his experiences and in so doing gain control over nature for his own ends, but he cannot in this way

MORE

acquire certainty. Even the deductive method is severely limited, as Gödel has shown. No system, logically based on a set of premises, can be demonstrated to be free from contradiction without stepping outside of that system.

As we, then, accumulate generalizations to bind together the facts of experience into useful formulations, as we establish hypotheses and test them by experience, are we indeed coming closer to reality? We cannot know. We can gain mastery over the course of events and thus control our subsequent experience with a high probability of success. But we cannot say that we have arrived at truth with any more assurance than when we specify truth by dogma, without all the paraphernalia of experiment, logic, and mathematics. Thus science is, in these days, becoming more humble in its assertions.

We may feel that the ordering of our observations of the heavens by Newton gives us a grasp of the swinging of the planets about the sun that is closer to reality than the system of Ptolemy with its spheres, deferents, and epicycles, even if the latter were refined to be in full accord with observation, as it could be. We may feel that, having added Einstein's refinements, we are still closer to reality. But this is a feeling only, a faith if you will; and what constitutes the truth is not demonstrable by logic of any sort.

Yet there is more than mere utility in the endeavor to systematize the evidence of our senses, and this we may forget when the limitations of science are emphasized. The extension of our observations into space, the translation of our bindings into cosmological hypotheses, is pursued with intensity and satisfaction; and the motivation is not to learn a bit more about the nucleus of the atom

MORE

just to make more powerful bombs or even to provide a new source of energy so that civilization may continue after it has exhausted its oil and coal. The musings and speculations of one who thinks in terms of receding galaxies or of primordial explosions are far different in content, though perhaps not in nature, from the ponderings of the peasant who sees the stars glued to a celestial sphere rotating over his head. Are they better or of a higher order? Have they a possibility of coming nearer to grasping eternal truths? This too we cannot know. We have only the evidence of a powerful, inner urge to pursue the path of inquiry, to learn more in the sense of extending and systematizing our observations and experiments over a wider field, to grasp more in the sense of greater generalizations--not so that we may be more prosperous, but so that our spirits may have a freer rein in those aspirations which transcend the mere mechanisms of existence.

The limitations upon our understanding have not yet, at any rate, begun to cramp our progress. Who can say that they are not themselves merely the expression of the limited view that we have thus far attained? We have not reached the boundaries of our finite capabilities, we have only proved for a time that the assumption of our fathers that they are boundless is probably false. We must go on until we can go no farther, for it is not in our inquisitive nature to abandon the quest for knowledge merely because we are told that we shall never know all that can conceivably be known or know anything with certainty. Must every adventurer be assured success before he will take a step forward? We are all born to die, and yet we spend every waking hour of our lives in striving as if we were to live forever. We may observe historically that man's progress has been intermittent and has alternated with retrogression; but

MORE

observing this we do not sink back from effort in despair; it is not in our nature to do so. And the search for knowledge and truth has its daily rewards unrelated to any ultimate achievements.

Without any presupposition, then, of the inevitability of progress, we may reasonably expect each day to learn more and accomplish something in a material way that will add to the comfort or convenience of our living. These same material accomplishments will bring us new and more terrible instruments of death. But this fact will not deter us from further scientific inquiry. Our simple survival is not worth so much that it is to be purchased at the cost of intellectual stultification. Nor would the suppression of dangerous inquiry save us. Although the achievements of science may, indeed, throw us back into barbarism, the abandonment of our search for knowledge and material betterment would only make vegetables of us.

There is no certainty in either science or progress. The science and technology that have carried us so far toward physical comfort and prosperity may blow us back with an atom blast to barbarism--to wars and pestilence; to a world in which the pressure of population on primitive resources is controlled only by recurrent war and famine; to a world that offers only a tinsel glory for a few built on a pyramid of misery for the many. The application of science to warfare may put an end to the surge of scientific progress that began with Galileo. We may, indeed, throw ourselves into a war of extermination. Or, in an excess of caution, we may throw away our dearest freedoms in false and narrowly conceived measures of defense. Either way we lose utterly. The way to peace and continued progress is not clear. But neither confusion nor pessimism will justify inaction while there is so much that can and ought to be done. We can strive to work our way out of the confusion and not be panicked by it into rigid immobility.

MORE

We need not be dismayed by the uncertainty of the outcome. We can gamble cheerfully on the course suggested by our best judgment today, and play the next turn according to our better--or perhaps only different--judgment of tomorrow. And there is a chance that we may continue our achievements in the realm of physical well-being and escape the worst dangers that we now so vividly see. We may reach the end of the wars that have been a scourge to man ever since he began to make tools.

In world affairs, as nearly as I can judge, we are headed for the moment toward a stalemate; and this is probably the best situation that can now be hoped for. The world will remain for a time evenly divided, its halves poised for mutual annihilation. Secondary wars will continue with restricted means, as in Korea and Indo-China. The great bombing fleets will be held in leash. Always present will be the danger of their being unleashed by some mad action or by simple accident. Our nerves will become increasingly taut, and we shall be tempted to seek the delusive relief offered by totalitarian government, authoritarianism, obscurantism, thought control. We shall be ever threatened by the panic of fear. It is not a pleasant outlook. But I see no better one in the near offing.

We can at least strive to avoid mad actions and pray to be delivered from blind accidents. We can, in fact, do more than pray. We can all of us, whatever our special calling, keep informed about the course of public affairs, recognize that they are of personal concern to us, study public problems, and through the constant pressure of an enlightened public opinion prevent those who govern us from lapsing into carelessness. We can by our indirect influence as well as by voting at the polls see to it that firebrands do not

MORE

come into power. But let us not try to conjure away our fears by propitiatory witch hunts or by fatuous acceptance of the promises of political messiahs or the dazzling spectacle of the man on a white horse. We need alert yet sober leaders who can and will think their way through the problems that confront us, who can judge wisely and act decisively. We can have such leaders if we refuse to settle for less. Remember the adage of Plato's Republic that the punishment of wise men who refuse to take part in the government is to live under the government of unwise men.

The stalemate that I envision, however, will not be a true one if it is allowed to rest only on the equal striking power of the opposing forces. We must, of course, have striking power equal or superior to that of our enemy. But equal striking power does not constitute an equilibrium of forces when one side is limited in its use of such power entirely to retaliation. And our side is so limited and must remain so. For the one thing above all others that distinguishes us from the enemy and makes him an enemy is the fact that we do not have a totalitarian form of government capable of making a surprise attack. Our enemy has such a government and will not be deterred from making a surprise attack by our mere threat to retaliate, if he has a reasonable hope of destroying at one stroke most of the forces that we must rely on for sustained retaliation. Had the Japanese been as nearly matched to us in military strength as the Soviet alliance is, they would probably have won the war in the Pacific. The only true stalemate for us is one in which we have striking power superior to the enemy's and defenses that are strong enough to balance the inherent advantage our enemies must always have of striking first. At the very least we must protect our

MORE



essential retaliatory means from destruction before they can be used. We have not thus far, in planning for defense, taken all the necessary possible measures to prevent such destruction. And unless the military corrects its thinking soon, there is real danger that the stalemate upon which we depend for relative peace will prove to be altogether illusory.

This is not the first crisis in human affairs, although it is by all odds the most intense we have yet gone through and the fastest-paced one. Yet a generation may suffice to resolve it. And the outcome will depend on how we react under almost intolerable strain. Society does not wish to commit suicide, nor does any part of it wish to do so. The question is whether it will commit suicide in spite of itself. If we can but weather this storm I believe that we may fairly hope to build a world in which there will be no more wars of any kind. The problems that cause wars--population problems, problems of access to resources--all such problems could conceivably be settled to everyone's advantage by other means than war, and science can contribute in an important way to their solution. The world's resources can be more effectively utilized and made more accessible to people by improved means of transport. The wild growth of populations can be curbed. Available materials that are not now made use of can be brought into profitable use just as has been done in the past with petroleum, natural gas, bauxite, and the magnesium in sea water. New sources of food may be found in organisms specifically developed to increase the total amount of the world's food supply.

Our future progress depends on how well free peoples have learned to govern themselves. The test is not one of how fast peoples who have been under a foreign yoke until recently will now

MORE

establish democracy or succumb to the wiles of demagogues or the tyranny of dictators. The test comes primarily in the great democracies, with experience in parliamentary processes and the operation of courts, under a new type of threat and a gnawing fear. The test in this country is whether we can truly maintain our freedoms and guard our way of life against threats from without, against subversion within, and against our own errors and aberrations. Our recent performance in this regard is not encouraging.

The great asset of free countries in the present struggle is their freedom. The great disability of dictatorships is that they are always permeated with suspicion and distrust, conspiracy, personal spite, the deflection of justice for sinister ends, timidity in the expression of honest opinions. In a free world men may disagree and maintain their mutual respect; they may urge unpopular courses of action and be heard; it is assumed that they are loyal and seeking the best for their country and their fellows unless they are proved to be traitors by due process in independent and impartial tribunals. In a police state men express the current party line; and, if they misjudge it, they disappear.

Here is an enormous advantage for the United States if it is kept unimpaired. It ensures that the whole course of government, our relations with other countries, our military policy, will undergo the full scrutiny of uncoerced public opinion. The advantage extends even into minor matters. When a new weapon is being secretly planned about a table, when the relative priority of alternative technical or strategic programs is being considered, our system assumes that the junior participants who have honest thoughts to contribute may express them without fear of retaliation from powerful men who think otherwise,

MORE

or who have opposing vested interests. This great advantage of freedom to dissent makes the country genuinely strong in many ways. It must not be lost.

Our enemy relies chiefly on the weapons of penetration and subversion to weaken us so that later he can destroy us. His first objective is to steal our secrets. Among the thousands or even millions who have access to secret information there have been a few, a very few, traitors. We must guard against such traitors with all our skill and determination. But the importance of their acts has been exaggerated out of all reasonable proportion. Without their help we tell the world, voluntarily, nearly all we know; and our enemy has only to read and listen. In technical articles, in advertisements, in budget presentations, in the release of testimony, in open court hearings, we disclose to the enemy our technical plans and programs, the essential characteristics of new airplanes and weapons, the location and equipment of our military bases and our factories for producing military items. We freely print critical dissections of the technical controversies that arise over the explicit development of our major weapons. Skilled analysts assemble scattered information and synthesize it into speculative accounts of what is happening in areas of military development. There is very little left for an enemy espionage system to find out, and it can concentrate on that little with the full background handed to it on a platter. If we are honestly determined to keep the enemy ignorant of our plans and designs, we must indeed be careful to keep both the traitor and the spy out of our councils, laboratories, and factories. But we need much more to draw a clear line between the information which the electorate must have for its reasoned judgment, and the technical and military

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information which is not necessary for that purpose; and having drawn the line we need to hew strictly to it. Until we do this, we are protecting, at great risk to our operations, only a small part of the information that should be protected. But this first objective of our enemy's actions is today less important to him than his other objectives.

His second objective is to penetrate our organizations and influence our decisions. There is not the slightest doubt that this was done successfully in the days when we were more gullible than we now are. It is difficult to recapture the atmosphere of the immediate post-war period, when we were a pushover for attempts of this kind. Russia had been our ally, a difficult one to be sure, but often a loyal ally under stress. Remember that when we landed in Normandy, we would have been highly vulnerable if Russia had concluded a separate armistice, or even relaxed its pressure, so that the full weight of German arms could be brought to bear on us. It might perhaps have been in Russia's interest thus to prolong the struggle and stand aside until the nations of the West had become exhausted. After the war there was a strong hope that we could live in peace and understanding with our former ally. After all, Russia had plenty of land and resources and needed a generation in which to build industries and raise its standard of living. There was validity in our purpose to ease tensions and further good relations. It was some time before the free world realized that it had demolished one threat only to be faced with another, far more sinister and far more skillful in its operations. In the interim there was penetration into many organizations by men who took their orders from the Kremlin. Much harm was done by these men, with their own strange ideas of the future;

MORE

undisciplined, arrogant men, who did not hesitate to undercut their superiors and their colleagues or to connive with a foreign power against the nation. The danger from such men is much less today, for we are now alert, and we are no longer gullible. Their efforts still persist, but they are much less successful and are concentrated on auxiliary organizations rather than on the center of government. To combat their threat we must be relentlessly vigilant. But the change of attitude that has occurred in the last decade, the clear realization among loyal members of our various organizations, from government bodies to labor unions, has rendered the efforts of those who would penetrate and influence our decisions and acts in favor of the enemy ineffective except in minor ways.

The third objective of the enemy is the most important one. It is to spread confusion and distrust among us. In this purpose he has been most successful and is more successful today than ever before. In fact he has been so successful that he need hardly try further; we are carrying on the process now without his prompting, and the process grows by what it feeds on. Look about us. We have a system for the clearance of persons to do secret work, which seems almost calculated to destroy their reputations by innuendo and charges based on spite. We have adopted a principle, abhorrent to our own best tradition, of establishing guilt on the basis of simple association. We have men who contributed much to the war effort now placed in jeopardy because of the expression of unpopular opinions. We have useful men denied the opportunity to contribute to our scientific efforts because of their youthful indiscretions. Worst of all, we have the evil practice of ruthless, ambitious men, who use our loyalty procedures for political purposes. Suspicion and distrust

MORE

are rampant in the land. We are on the verge of abandoning some of our most treasured freedoms; we have nearly lost our greatest advantage over the enemy in the current struggle--our mutual regard and trust as a people.

The enemy's actions in the cold war have been uncommonly successful. Their impact has been most severe on the scientific community, and there are several reasons for this. Scientists occupy a key position in regard to those secrets which should be most strictly kept. They have always been more involved in international relations than most men, for science is by its very nature international in character. Scientists are highly individualistic; otherwise they would not be scientists. Concentrating in one field, they are sometimes exceedingly naive in others. When we dreamed of a world of understanding to put an end to recurrent wars, there was a greater portion of gullible men among them than among most other groups. And there were traitors among them, though exceedingly few, who were capable of doing and did great damage to us. It was inevitable, therefore, that much of the hysterical witch hunt should have been concentrated on the scientific profession. Yet there is no place where it could be more disastrous to our national interest. In Russia today the scientist is respected and honored, too much so no doubt. In this country the scientist is under attack, viewed with suspicion; and young men hesitate to enter the profession or, once in, to participate in military programs because of the hazards to their reputations and careers. We had better reverse this trend if we wish to compete on even terms with the enemy.

Just as soon as this is said there are always several rejoinders. One of these is that the scientists seek special privileges. They do

MORE

not. To seek a restoration of the principles of the Bill of Rights in all the procedures of government is not to seek special privilege in this country. To urge a revision of our present security system to remove its defects, which are applicable to scientists, lawyers, diplomats, and all others alike, is not to seek special privilege. There should be an end, for all who labor in the interests of the country's safety, of trial on the basis of unsupported charges, of actions by officials of government which destroy reputation, of the assumption of guilt before trial. There should be a complete and final end of the use of the security system to discredit those who disagree. There should be a complete removal of the system from politics. To assert these things is to seek privilege, but only the privilege of all to live in a country which continues to be free.

A second rejoinder is that scientists will refuse to serve unless the system is changed to suit their wishes. It is true that many individual men shrink from entering government duty under present conditions. A father who got caught in a communist gathering when he was twenty and foolish will shield his sons from the ordeal of seeing him pilloried. Retiring persons to whom strife of any sort is emotionally impossible will avoid the hazard. Men in vulnerable positions, where a whispering campaign, or even a series of strange inquiries among their friends and associates would place their careers in jeopardy, may pull their punches and go along with proposals which they disapprove rather than stand up and be counted. All this is happening and is doing great harm to our national effort. But scientists in general, in government, in industrial laboratories, in universities, working on military programs, are hard at work as usual, and are devoting their most conscientious efforts to the good of

MORE

their country, sometimes at considerable risk to themselves. There will be no scientific strike. The scientists of the country, like all other professional groups, place the good of their country above their personal comfort or their personal fate. Among scientific groups today there is sadness and discouragement. They work assiduously, but they do not have the enthusiasm and confidence that they once had. They are making great technical progress in many fields, and they will continue to do so. But they yearn for a leadership in this country which would restore the old atmosphere in which there was a close-knit bond of mutual confidence and respect between them and the military, in which they could do their part toward the country's preservation, anonymously and without thought of personal gain, but without threat to their reputations as loyal workers.

The great question, as we try to envisage the future, is whether this madness of ours is a passing phase, or whether it will grow until the free world transforms itself into a replica of the captive world it opposes. If the latter is the outcome, the struggle will be over, for it will then not matter which tyranny prevails. The idea of progress then will no longer have any meaning. The question for us is whether we can conquer our fears, not abandoning them but rendering them sane and realistic, or whether our fears will feed upon themselves until we throw away our freedom in a wild attempt to preserve it.

There is a great threat from overseas. But the threat here at home is for the moment the greater one. This country has been through similar phases before, not as intense or dangerous, but bad enough. After the first World War we had an interval in which the guarantees of the Bill of Rights were disregarded by those in power, we had

MORE



witch hunts, and we saw spooks in every shadow. From this we recovered without much permanent damage. The situation today is much more threatening. If all people knew the wide extent of the threat--which goes far beyond the few spectacular cases that make the headlines--if they understood better how closely it fits into our enemy's designs and how successful those designs are proving, then there would be a return to reason in a hurry. One thing we need to learn is that the enemy alone stands to gain from the spread of suspicion and distrust among us, and it is in our interest to create mutual confidence. One thing we need especially to learn is that a vigorous system for throwing out the communists in our midst must be paralleled by vigorous executive action to detect those actions which are inspired by spite or attempts at thought control, to see that they are suppressed before they do real damage, and see that they backfire promptly on those who instigate them. Finally we need to learn that the use of star chamber proceedings for political purposes is dangerous in the last degree to the very foundation of a democracy.

I have spoken thus far of three elements of progress--the progress of biological evolution, the progress of knowledge and understanding, the progress of technology with its attendant dangers of self destruction. There is one other form of progress that is often questioned but upon which I base my own strongest hopes. I refer to progress in the ethical conceptions and conduct of men.

How are we to judge of progress in this field? With respect to knowledge and understanding I have already dogmatically stated my standard of values. It is good for mankind to advance in knowledge and understanding and to use his knowledge for the promotion of human welfare. I shall state dogmatically my acceptance of another standard

MORE

of value by which I am willing to judge the very dogmas of the past. It is good for men to love and respect their fellow men and deal not only justly but also kindly with one another.

By this dogmatic standard, as I have previously suggested, we may see little evidence of a steady ethical progress in the last hundred and fifty years. But we can most certainly see much progress if we look back over the whole span of recorded history. We still lie, cheat, and steal as they did in the age of which Homer sang; but we do not write epics glorifying the wiles and tricks of unscrupulous national heroes. Dishonesty and unscrupulous behavior on the part of our leaders and statesmen may still pay temporary local dividends, but they lead at last to censure and in some cases to more substantial punishment and permanent disgrace.

The ethical codes subscribed to if not followed by all liberal and thoughtful men today, regardless of their religious faiths, are more humane than they were six thousand years ago. Contrast the stern code of Draco with our present mild laws--mild, in the opinion of some, to the point of softness. Contrast the primitive ideal of conduct in the Song of Deborah, glorifying Jael, who enticed the fleeing Sisera into her tent and there drove a tent pin into his head, with the Sermon on the Mount. The ideal expressed in the Golden Rule, which we all yearn to follow, is from the point of view of peaceable human relations superior to the older rule of an eye for an eye and a tooth for a tooth.

We are sometimes depressed by the fact that men, however fine their ideals, are now and have always been governed in large measure by evil, selfish impulses. Yet, if we stop to consider, we have made some small progress even in our behavior. Most of us have moved

MORE

perceptibly away from the primitive xenophobia that hates all outlanders and strangers. We are not so callous to human suffering even as our European and colonial forebears of the sixteenth and seventeenth centuries. Mutilation and the pillory have passed out of our lexicon of punishments. No one would say with Defoe that a bankrupt who falsifies his declaration ought in justice to be hanged as a felon, or would regard the theft of a sheep or a shilling as a capital offense. We are not yet gentle in our relations with one another. But neither are we so savage as once we were. If we are at times discouraged, we must consider that the whole era of civilization has been but a moment in the largely unwritten history of mankind. On the whole, I believe, men feel more secure in their relations with one another than they did in the very early days when every man carried a club, or later when they substituted swords and daggers. Perhaps this is just an evidence of improved police protection. But it is progress of a sort. We are not, indeed, visionaries when we strive for harmonious relations among all nations of the world. Our children may live to see its advent.

In speaking of progress I have avoided the question of ultimate goals; the goals with which I have concerned myself are only those of men for their own and a few future generations. Can we suppose that for the ultimate goal of the cosmic drama man and man's works will have any significance? The species may long have been extinct before the ultimate, if we can in fact conceive of an ultimate, is reached.

I am thinking of a much smaller drama in which man is the hero. If we may hope that men will within the next generation and a reasonable number of succeeding generations become better and happier than they are, according to our present standards of judging what is better

MORE

and happier, this hope is good in itself and is in no way diminished by the thought that men may never become perfect by those standards or that their standards of judging will change. We cannot wish for what we cannot imagine.

Indeed it is a grim world, and the future for the moment looks dark. We reconcile ourselves now to the loss of that sense of certainty which we too often falsely enjoyed, and we have lost the exuberance with which we once hailed a vision of never ending progress. We struggle in confusion to maintain the privileges that were won by our fathers and that have been ours. But do we need to be glum about it all? The birds still sing in the trees; music still has the power to move us and to bring back happy memories. It is no new thing for man to confront perils in his upward struggle. Life has always been hazardous, civilization has always been threatened, our individual deaths have always been an inevitable certainty. But men have faced uncertain futures before with courage and even a light heart. Life, whatever else it may be, is not dull. We are privileged to share together in a great adventure, the very hazards of which should draw us closer together. With determination and wisdom our sorry old world may yet become a happy place to live in, where wars are no more, and where the spirit of brotherhood dominates all we think and do.