CIVILIZATION AND THE PURSUIT OF KNOWLEDGE*

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Science and Invention

SCIENCE as the spirit of questioning is neither moral nor immoral; and its justification is in the accumulation and co-ordination of knowledge. A scientific discovery is an addition to knowledge; and an invention is an additional use of knowledge. On the principle that "Necessity is the mother of invention", the atom bomb was manufactured as a devastating weapon of war; but it should not be assumed that scientists, any more than other groups of people, desire to be associated with the prostitution of knowledge in any form.

When man began to accumulate experience of the properties of natural things and to apply it for his own purposes he rose above all other living creatures and began to weave the fabric of civilization. By his discoveries, he became possessed of knowledge which he is as free to use now as he always has been to distinguish between what is good for his existence and what are poisonous products of the world around him. From birth to death he has to defend himself against the many natural enemies which surround him wherever he is, or submit to be destroyed by them. He entered the world as a child beset with dangers, and under primitive conditions of life is still a victim of their aggressions.

Civilized man has, however, become a giant in his powers of meeting these attacks of natural things and forces, and has learnt how to subdue and overcome some of them, though they still demand the sacrifice of millions of human lives annually. With this knowledge has come the creation of artificial devices of destruction as antagonistic to the development of the human race as the natural processes over which a certain measure of control has been acquired. While man has been learning how to control Nature, he is still in the position of a child in his attitude and outlook towards the dangers which now encompass him, and has not realized that his duty is to overcome them, as he has always had to do to survive the perils of the natural world in which he is placed.

This world has agents of destruction far more ingenious and effective than any contrivances devised by human inventors. Man has, however, not been content to submit to suffer disease and death from these natural enemies but has battled with them, and scientific knowledge has given him the power of conquest over many of them. The same spirit is required to meet and avert the dangers to civilization created artificially, instead of pleading pathetically that they ought not to be put within his reach because he is still a child in wisdom.

At every stage of civilization there have been conflicts between communities for one reason or another, and all available resources of men and material have been used by the adversaries for their armed forces. This is as true of the weapons and machines used in warfare by primitive peoples as it is of those which have been placed at the disposal of the modern world by applications of scientific knowledge to invention.

War has always been an incentive to the use of devices to subjugate opposed armed forces; and the weapons employed have reflected the position of the

industrial arts. These have advanced with knowledge of the natural properties of things, from the time when prehistoric man found that he could make cutting and piercing implements from flints, and thus started a new industry, through the bow and arrow period to gunpowder and modern high explosives to the atom bomb. It is for leaders of nations to determine among themselves whether their hearts are strong enough to make the splitting of the hearts of atoms a means of improving conditions of life on the earth and the beginning of a new era, or utterly to destroy what faiths and works have achieved in the history of civilization.

Though the machine age is regarded as having begun in the eighteenth century, the foundations of it were laid ten centuries earlier through the general use of the Latin language and the institution of monasteries in which labour was combined with devotion to high ideals in the shaping of what has become modern European or Western civilization. The distinctive feature of the present epoch is the harnessing of natural sources of energy to do work instead of using the physical powers of human beings and domestic animals to accomplish it. The inventions of the eighteenth and early nineteenth centuries came from the workshop rather than from the scientific laboratory, though revolutionary social and economic developments were brought about by them. Discoveries of science were used in those prosperous times with as much indifference to science as to humanity. There was then no moral indignation, such as is now often expressed, against mechanisms as degrading elements in civilization and destructive of spiritual goodness.

It is natural to long for a more peaceful and less-exacting condition of life than that which prevails in most modern cities and towns in this age of speed, hustle and noise; but there is no historical evidence to prove that before the machine age labouring people in large communities were any happier than they are to-day. The primary needs of human life are food, clothing and shelter, and in the search of them man follows instinctively his animal instincts. He may be contented when these wants are supplied from natural or national resources without undue effort, but his condition is that of the beast in the field or a cave-dweller of prehistoric times. Civilization begins when intelligence is used to increase these resources and to construct a cultural pattern, however primitive this may be.

Whenever natural sources of energy are made available for mechanical work by the use of wind or water power, or combustion of coal or oil, slave labourers of giant strength and untiring capacity enter the service of man and enable higher standards of living to be attained. It is not suggested for a moment that developments of this kind necessarily increase happiness or represent more than a single factor capable of contributing to progressive human welfare. As, however, man has a mind and the unique power of making useful or decorative things from the materials and forces in the world on which he is placed, it must be his duty to bring these gifts and talents into operation.

Languages of Expression

When humanity emerged from its sub-human ancestry, its inherited instincts began to have their impulses determined by a reasoning faculty and it became possible to acquire and accumulate knowledge to be handed down from one generation to another.

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In this respect, therefore, the human race can be said to mark a distinct stage in the evolution of life, and its advances in any direction to represent progress.

All such advances originate in new concepts or ideas which may or may not take material shape. Every new idea is, however, a stimulus to further intellectual expansion or practical endeavour, and civilization is the record of their development. Measured by the means of increasing the material welfare of mankind, science and invention may claim always to have led the way. The laws and principles they discover and apply are additions to knowledge by which conditions of life can be improved in this world during the short period of occupation by the human race. What is our destiny here we do not know, but while we are alive it is our obvious duty to do everything in our power to raise standards of living and find out at the same time the relation of our small planet to the many millions of other bodies in the universe.

The moral law is apprehended by a different set of experiences from that of natural science. Recognition of its influence as well as of the utility of knowledge determine together the progress of civilization. In each case the aim must be the attainment of the highest good on this earth whatever the ultimate destiny of the human race may be. Goodness, truth and beauty are abstract ideas appealing in diverse ways and tones according to attitudes of mind, but appreciation of their qualities is not excluded from the field of natural science any more than it is from other factors which constitute human progress.

Intellectual expansion and the forms in which it is expressed are distinctive attributes of human nature and elements of progressive development. When the Sumerians became urbanized nearly five thousand years ago, they found it necessary to introduce seals and clay sealings as guarantees of authenticity of commercial contracts and legal obligations. With these seals they developed a system of pictographic writing on clay tablets, which evolved into the cuneiform script. As the temple was the centre of the Sumerian civic organisation it was also, through the development of writing, the cultural centre where knowledge was accumulated and used. The inscribed seal had a most important effect on the development of art, while the necessity for a dignified and fitting home for the god led to advance in style in building worthy of the name of architecture, to which the use of mud-brick could have contributed in no other way.

Drawings provide a universal means of representing objects, and their characters also convey individual or composite emotions and meanings. Many early forms of writing are conventional characters developed from pictographs of this kind; and out of these conventionalized marks alphabets were constructed or characters were combined to represent syllables. All human beings express certain emotions, such as anger and fear, by much the same sounds, signs and gestures, and all can interpret simple picture writing, as all can understand the meanings of actions reproduced in modern moving pictures, silent or sound. There are, however, many conventionalized forms of characters to represent these sounds and thoughts by written or printed words, and these combinations make up the many languages of the world.

Pictographs or ideographs thus evolve into symbols representing gestures and sounds and then to alphabets, the letters of which are combined in words to

convey ideas from one place or time on the earth to another, however far or long they may be separated. Sounds were combined to express emotional feelings in the earliest civilized times; but the history of the art of music cannot be traced like that of literature because no musical compositions from those times have had their forms or contents preserved.

While, therefore, the contribution of a people or a period to the expansion of the human mind can be found in its literary records, and comparisons made between them on a scale of refinement, there is no clear relationship between early and modern practices of the musical art. The melodies of primitive peoples to-day do, however, afford an indication of rudimentary combinations of sounds; and this folk-music has its own standards of excellence. Progress in music as an art, like that of literature, is in the exalted combination of the notes of a chromatic scale into a composition which arouses in its readers or listeners the emotional feelings which their writer wishes to convey. Fertility of creative ideas and the forms to which these give shape are the measures by which progress in all these arts of expression may be judged.

Increase of opportunities to read and hear what is thought or said in words or music is of even greater importance in the history of civilization than the works themselves. This began with the production of books in which raised letters or other characters were impressed upon the pages with ink or other pigment. Much of the early printing was done with page-blocks of this kind; and the same plan is adopted in printing from stereotyped plates of pages to-day. The use of movable type was first introduced by a Chinese alchemist and inventor, Pi Shêng, in the eleventh century. He used type made of baked clay and experimented also with wooden type. A later improvement made in China was to use tin for the movable type. Early in the fourteenth century movable types were made in Europe of wood, tin and lead, but the modern art of typography may be said to have begun when in 1454 Johann Gutenberg issued from his printing press at Mainz, books printed from types cast in a mould.

From a cultural point of view the value of the invention was in the extension of opportunities of acquiring knowledge through book-learning. There were literary works and libraries in Assyria, Babylonia, Egypt and China in very early times, but each had to be separately written by hand. A book is a collection of scripts joined together to form an organic whole so as to be portable. The first books may thus be said to be those written on papyrus in ancient Egypt. Several rolls of this kind, with columns of hieratic writing done about 2500 B.C., have been found in tombs and are preserved in national museums. They are samples of many early Egyptian writings of a didactic and moral character, apart from religious spells and praises of the divine. Most of this secular and sacred literature preserved on rolls of papyri were made for school use by young scholar-scribes. There were wonder-tales, romances, humorous and gruesome stories, moral admonitions, types of worldly wisdom and rules of devotional conduct towards divine influences, in the East five thousand years ago, as characteristic of human life and its spirit as is the literature of classical and modern times.

The invention of mechanical printing, and the use of paper instead of papyrus, made it possible to produce the many millions of books now in libraries and for the knowledge and wisdom of all peoples to be

distributed throughout the civilized world. It is in the extension of this intellectual influence and the continuous development of processes of reproduction that the art of printing has reached the high position as a cultural force which it occupies to-day.

In so far as art, literature and music are expressions of the human spirit as well as reactions to conditions of life, any agency which multiplies their points of contact may justly be said to aid the progress of the race by expanding the outlook. This is what was done when printing presses converted the small corps of transcribers into a great mechanized force in the front line of civilization. The advance was in apparatus for manifolded literary compositions and thus giving wider range to the light of the torch of learning.

World Services

The value of devices for reproducing words and sounds, written or spoken, lies, therefore, in the increased contacts between human minds, and the measure of truth attained in the reproduction. This has reached a high degree of perfection through the combination of mathematical theory and physical experiment; with the result that broadcasting truly brought about a condition when "Their sounds went out into all the earth, and their words unto the ends of the world". These developments began with the invention of means of producing and detecting electromagnetic waves other than those in beams of light and transmitted with the same velocity of 186,000 miles a second. What has since been achieved so impressively is due to the use of increased power to create such waves, and increased sensitiveness of instruments to detect and reproduce their qualities. This has been made possible through the increase of knowledge of the atomic structure of matter in relation to the energy of electric waves. The electrons contained in the atoms of all forms of matter were found to be identically the same, and when these are torn off by thermal or electrical influence they constitute a stream of invisible particles which travel with the speed of about one tenth of the velocity of light.

The basis of all systems of radio transmission of sounds or scenes is the production of electrons and the detection of their effects. In a radiolocation equipment, the particles create pulses of waves which are reflected by objects in their path, as sound-waves are reflected in echoes. Though the interval of time between the dispatch of the waves and their reception is extremely short, it is clearly shown on the time-scale of the apparatus used and becomes a scale of distance. As radio-waves are reflected by obstacles of any kind, they can be used in darkness as well as daylight, in thick fog or other obscuring atmospheric conditions, as light to show whether the way is open or not. Radiolocation, or 'radar' as it is now termed, has thus given civilized peoples new powers of electric vision which are already being used to ensure safety of movement on the sea as in the air, in addition to the detection of small or distant enemy aeroplanes and submarines, for which purposes the instruments used were designed and applied with conspicuous success.

All mechanical aids of this kind, whether photographic or photographic, are often referred to contemptuously as scientific gadgets which are, on the whole, detrimental to progressive spiritual development. It is suggested that because they are created by man's own efforts, without appeal to supernatural

influences for guidance or reference to religious faith, pride in them is to be deplored rather than encouraged. By the same token, the natural machine power of modern times is regarded as a failure, and a return to supernaturalism is urged as the only means of shaping a new and better world.

To assume such an attitude towards civilization is irrational and puts two different standards of value in conflict instead of regarding them as complementary to one another. It surely must be the duty of man to learn as much as he can of the material universe, and of the earth upon which he has to live: and it cannot be wrong for him to discover and apply knowledge of natural properties and forces, whether these are understood as having been created for his service or not. To condemn such knowledge as having a numbing effect upon aspirations of the human soul, and the machine age as a degrading period in the upward growth of mankind, cannot be justified either historically or rationally. What is wanted to-day more than at any other epoch of civilization, because of the powers which have been placed at the disposal of civilized peoples, is the strengthening of the human heart everywhere to act upon the principle of brotherly kindness, contained in the maxim common to all religions and ethical systems: do not unto others what you would not they should do unto you.

Civilization and Ethics

Civilization is essentially distinguished from barbarism, and man from other living creatures, by the effects of high spiritual ideals upon human conduct. Many of these ideals are common to all peoples, and the values attached to them determine both individual and social endeavour. The standard of attainment reached by a human society towards all elements of 'goodness' is a measure of the place of the society in a civilizing process. The pursuit of natural knowledge may claim to be one of these ennobling elements, as it leads not only to means of improving conditions of life but also to a broadening of man's intellectual and social horizons. Devotion to these objects, courage of enterprise, faithfulness to truth and humility of understanding represent the spirit of science as truly as they are combined in other fields of thought and action. The relation to moral goodness of the results achieved depends mainly upon the attitude taken towards natural knowledge and supernatural revelation.

As ethics is the science of morals in their widest sense, it is concerned with the influence of each of these attributes upon the character of the individual and the structure of society. What man is in himself, and what are standards of moral righteousness, have varied greatly with cultural conditions in the history of civilization. A system of ethics, or rules of conduct, by observance of which conduct in life is brought into harmony with cosmic principles, is a part of all religions and is associated with many conceptions of deities and conventional forms of worship. In all ethical systems, as in all high religions, certain elements of human goodness or virtue are esteemed, and attachment to them is a measure of righteousness of life.

Socrates taught that in itself right "knowledge is virtue"; but it was Aristotle, the greatest of the Greek naturalists, who held that happiness or goodness, which in the individual means 'well-being' and to the community 'well-doing', should be the aim of an ethical system. His knowledge of natural history was copious and comprehensive, and he used it to

co-ordinate what was thought or known about living things into a science, while at the same time he showed that appreciation of truth and beauty in Nature does not impair promotion of the quality of goodness of a way of life. The ethics of human conduct taught by Confucius two centuries earlier constituted a similar code of practical morality in a civilization which takes a high place in the history of man and his works.

The highest type of social organisation is that in which both material good and ethical goodness are rightly balanced. As material progress must in its nature be more striking, more patent to observation, than progress in man's ethical and social development, there must always be a lag in time between the operations of the two forces. The idea that the scientific and inventive mind is necessarily antagonistic to the merciful heart is as degrading to knowledge as it is untrue of the virtue of goodness. The gap between application of the two qualities is due to the selfish sides of human nature, and not to the increased power and supplies which knowledge provides for the primary needs of life.

It is permissible to indicate how this knowledge could be used in the construction of a new world, whether for better or worse, but no one believes that improvements of material conditions can be made a measure of ethical goodness. This, however, is what is asserted to be the position occupied by science in visions of the development of the human race in the past, present or future. It is the basis of a charge that advances in natural knowledge are inimical to the growth of the noblest attributes of the spirit of man. We have had, therefore, literary pictures of machinery being developed to such a dangerous stage that it had to be abolished, and on the biological side to conceptions of a world of planned types of inhabitants, each, like social communities of insects, with intellectually deadening functions to perform.

Literary works of this kind are parodies or satires of potentialities of applications of knowledge, and in no way represent a scientific view of the factors which have enabled man to survive and reach his present position. It is true that, by the release of atomic energy, modern civilization has been provided with the means of destroying itself, but the same power is available for making the earth a celestial dwelling place, just according to the service to which it is put. There is now, as always, freedom of choice between good and evil fruits of knowledge; and the ways in which these are cultivated or controlled will be the reply to the menace now facing civilized peoples. All who have goodness in their hearts and goodwill towards their fellows should unite in meeting this challenge to movement onward and upward.

Progressive Humanism

Faith in this spirit, in whatever way it is promoted or manifested in the works of man, is often regarded as presumptuous pride in his creative and constructive capacities and therefore irreligious in the sacred meaning of the word. The spirit is, however, associated with all aspects of intellectual and material progress which have influenced the course of civilization. Devotion to it is the religion of secular or scientific humanism, because its principles do not include knowledge of the supernatural and relate only to the practical application to life of the favourite Christian maxim of the British monk, Pelagius, "If I ought, I can".

Humanism in this sense is the integration of all influences which promote the development of the human race, whether associated with the teaching of a particular religion or not. Principles or practices which raise man out of his animal ancestry and add to his status among living creatures can rightly be termed humanistic. Their spirit is displayed in works of science as well as in art and literature; and the measure of their value is that of the opportunities these afford for improving human welfare on the highest standards that the mind can conceive and the heart will sanction.

Whatever convictions are held about the meaning and purpose of man's existence, he finds himself on a globe from which he has to obtain the needs of life, and also with a mind which can appreciate such abstract qualities as beauty and love, goodness, justice and mercy, whether seen on the earth or projected on the heavens. Modern humanism takes account of all these factors of cultural development, secular or sacred. It understands very clearly that the earth is but a temporary home, not only for the short span of individual life, but also for the whole human race. As tenants or trustees our duty is to make the best use of the resources of our heritage by the exercise of all our talents, and with the belief and hope that by so doing we are contributing to make men god-like if not godly in the sense of religious faith. So may the earth be made a part of the heavens of the universe in spirit, as it is in truth.

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DEFENCE AGAINST THE ATOMIC BOMB

THE news of any further increases in the effectiveness of the atomic bomb would at the present time be received with universal disgust or indifference. The discovery of a successful defence against it would occasion equally universal satisfaction and relief. It may be doubted whether the distribution of the world's expenditure on research between the two aspects of the subject—offensive and defensive—takes account of this world-wide prejudice in favour of survival. The publication of the recent report of the British Mission to Japan*, with its unequivocal emphasis on the defensive point of view, is therefore doubly welcome, first as indicating that the British Government does not necessarily subscribe to the view that no defence is possible, and secondly as providing a starting-point for any defensive investigation.

The plain fact, plainly stated in the report, is that an atomic bomb of power equal to those dropped in Japan, if used without warning on a large city of European construction having an average population density equal to that of London, would kill about 50,000 people, and would start fires numerous enough to be uncontrollable over an area of several square miles. The consequences of such an 'incident' can be traced in some detail, but detailed knowledge is not required to grasp the magnitude of the catastrophe.

It must apparently be assumed that a defence by counter-attack on the weapon itself—for example, by a device causing detonation before the target is

* The Effects of the Atomic Bombs at Hiroshima and Nagasaki. Report of the British Mission to Japan. (Published for the Home Office and the Air Ministry.) Pp. vi+22+24 plates. (London: H.M. Stationery Office, 1946.) 1s. net.