

dience, is the source of those mortal woes so much in evidence today.

We cannot continue the contradiction of a world in which outward effects are planned and controlled, while attitudes of mind which use these external consequences are left without scientific control, without heading for disaster. If it is true, as it is sometimes said, that our physical knowledge has far outrun our social or humane knowledge, it is true only because we fail to employ our physical knowledge and physical technologies for social ends. The idea that we can develop social science merely by collecting and ordering facts is as futile as was the older idea that natural science could be had without the experimental control of action. When we systematically use the knowledge and instrumentalities we already have to achieve the ends of a secure and abundant life which we know to be desirable, we shall begin to build up social science, just as men built up physical science when they actively used the technique of tools and numbers in physical discovery.

The greatest scientific revolution is therefore still to come. It will ensue when men collectively organize their knowledge for social application, and when they systematically use scientific procedures for the objective control of social relations. Great as have been the changes of the last century, those who are going forth from the colleges this year and next year will see changes with which those of the past are not to be compared, provided they go forth with faith in the possibility of dealing scientifically with social changes and with the stern and courageous determination to make that faith effective in works.

Science and Society

[*Philosophy and Civilization*]

The significant outward forms of the civilization of the western world are the product of the machine and its technology. Indirectly, they are the product of the scientific revolution which took place in the seventeenth century. In its effect upon men's external habits, dominant interests, the conditions under which they work and associate, whether in the family, the factory, the state, or internationally, science is by far the most potent social factor in the modern world. It operates, however, through its undesigned effects rather than as a transforming influence of men's thoughts and purposes. This contrast between outer and inner operation is the great contradiction in our lives. Habits of thought and desire remain in substance what they were before the rise of science, while the conditions under which they take effect have been radically altered by science.

When we look at the external social consequences of science, we find it impossible to apprehend the extent or gauge the rapidity of their occurrence. Alfred North Whitehead has recently called attention to the progressive shortening of the time-span of social change. That due to basic conditions seems to be of the order of half a million years; that due to lesser physical conditions, like alterations in climate, to be of the order of five thousand years. Until almost our own day the time-span of sporadic technological changes was of the order of five hundred years; according to him, no great technological changes took place between, say, 100 A.D. and 1400 A.D. With the introduction of steam-power, the fifty years from 1780 to 1830 were marked by more changes than are found in any previous thousand years.

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The advance of chemical techniques and in use of electricity and radio-energy in the last forty years makes even this last change seem slow and awkward.

Domestic life, political institutions, international relations and personal contacts are shifting with kaleidoscopic rapidity before our eyes. We cannot appreciate and weigh the changes; they occur too swiftly. We do not have time to take them in. No sooner do we begin to understand the meaning of one such change than another comes and displaces the former. Our minds are dulled by the sudden and repeated impacts. Externally, science through its applications is manufacturing the conditions of our institutions at such a speed that we are too bewildered to know what sort of civilization is in process of making.

Because of this confusion, we cannot even draw up a ledger account of social gains and losses due to the operation of science. But at least we know that the earlier optimism which thought that the advance of natural science was to dispel superstition, ignorance, and oppression, by placing reason on the throne, was unjustified. Some superstitions have given way, but the mechanical devices due to science have made it possible to spread new kinds of error and delusion among a larger multitude. The fact is that it is foolish to try to draw up a debit and credit account for science. To do so is to mythologize; it is to personify science and impute to it a will and an energy on its own account. In truth science is strictly impersonal; a method and a body of knowledge. It owes its operation and its consequences to the human beings who use it. It adapts itself passively to the purposes and desires which animate these human beings. It lends itself with equal impartiality to the kindly offices of medicine and hygiene and the destructive deeds of war. It elevates some through opening new horizons; it depresses others by making them slaves of machines operated for the pecuniary gain of owners.

The neutrality of science to the uses made of it renders it silly to talk about its bankruptcy, or to worship it as the usherer in of a new age. In the degree in which we realize this fact, we shall devote our attention to the human purposes and motives which control its application. Science is an instrument, a method, a body of technique. While it is an end for those inquirers who are engaged in its pursuit, in the large human sense it is a means, a tool. For what ends shall it be used? Shall it be used deliberately,

systematically, for the promotion of social well-being, or shall it be employed primarily for private aggrandizement, leaving its larger social results to chance? Shall the scientific attitude be used to create new mental and moral attitudes, or shall it continue to be subordinated to service of desires, purposes and institutions which were formed before science came into existence? Can the attitudes which control the use of science be themselves so influenced by scientific technique that they will harmonize with its spirit?

The beginning of wisdom is, I repeat, the realization that science itself is an instrument which is indifferent to the external uses to which it is put. Steam and electricity remain natural forces when they operate through mechanisms; the only problem is the purposes for which men set the mechanisms to work. The essential technique of gunpowder is the same whether it be used to blast rocks from the quarry to build better human habitations, or to hurl death upon men at war with one another. The airplane binds men at a distance in closer bonds of intercourse and understanding, or it rains missiles of death upon hapless populations. We are forced to consider the relation of human ideas and ideals to the social consequences which are produced by science as an instrument.

The problem involved is the greatest which civilization has ever had to face. It is, without exaggeration, the most serious issue of contemporary life. Here is the instrumentality, the most powerful, for good and evil, the world has ever known. What are we going to do with it? Shall we leave our underlying aims unaffected by it, treating it merely as a means by which uncooperative individuals may advance their own fortunes? Shall we try to improve the hearts of men without regard to the new methods which science puts at our disposal? There are those, men in high position in church and state, who urge this course. They trust to a transforming influence of a morals and religion which have not been affected by science to change human desire and purpose, so that they will employ science and machine technology for beneficent social ends. The recent Encyclical of the Pope is a classic document in expression of a point of view which would rely wholly upon inner regeneration to protect society from the injurious uses to which science may be put. Quite apart from any ecclesiastical connection, there are many "intellectuals" who ap-

peal to inner "spiritual" concepts, totally divorced from scientific intelligence, to effect the needed work. But there is another alternative: to take the method of science home into our own controlling attitudes and dispositions, to employ the new techniques as means of directing our thoughts and efforts to a planned control of social forces.

Science and machine technology are young from the standpoint of human history. Though vast in stature, they are infants in age. Three hundred years are but a moment in comparison with thousands of centuries man has lived on the earth. In view of the inertia of institutions and of the mental habits they breed, it is not surprising that the new technique of apparatus and calculation, which is the essence of science, has made so little impression on underlying human attitudes. The momentum of traditions and purposes that preceded its rise took possession of the new instrument and turned it to their ends. Moreover, science had to struggle for existence. It had powerful enemies in church and state. It needed friends and it welcomed alliance with the rising capitalism which it so effectively promoted. If it tended to foster secularism and to create predominantly material interests, it could still be argued that it was in essential harmony with traditional morals and religion. But there were lacking the conditions which are indispensable to the serious application of scientific method in reconstruction of fundamental beliefs and attitudes. In addition, the development of the new science was attended with so many internal difficulties that energy had to go to perfecting the instrument just as an instrument. Because of all these circumstances the fact that science was used in behalf of old interests is nothing to be wondered at.

The conditions have now changed, radically so. The claims of natural science in the physical field are undisputed. Indeed, its prestige is so great that an almost superstitious aura gathers about its name and work. Its progress is no longer dependent upon the adventurous inquiry of a few untrammelled souls. Not only are universities organized to promote scientific research and learning, but one may almost imagine the university laboratories abolished and still feel confident of the continued advance of science. The development of industry has compelled the inclusion of scientific inquiry within the processes of production and distribution. We find in the public prints as many demonstrations of

the benefits of science from a business point of view as there are proofs of its harmony with religion.

It is not possible that, under such conditions, the subordination of scientific techniques to purposes and institutions that flourished before its rise can indefinitely continue. In all affairs there comes a time when a cycle of growth reaches maturity. When this stage is reached, the period of protective nursing comes to an end. The problem of securing proper use succeeds to that of securing conditions of growth. Now that science has established itself and has created a new social environment, it has (if I may for the moment personify it) to face the issue of its social responsibilities. Speaking without personification, we who have a powerful and perfected instrument in our hands, one which is determining the quality of social changes, must ask what changes we want to see achieved and what we want to see averted. We must, in short, plan its social effects with the same care with which in the past we have planned its physical operation and consequences. Till now we have employed science absent-mindedly as far as its effects upon human beings are concerned. The present situation with its extraordinary control of natural energies and its totally unplanned and haphazard social economy is a dire demonstration of the folly of continuing this course.

The social effects of the application of science have been accidental, even though they are intrinsic to the private and unorganized motives which we have permitted to control that application. It would be hard to find a better proof that such is the fact than the vogue of the theory that such unregulated use of science is in accord with "natural law," and that all effort at planned control of its social effects is an interference with nature. The use which has been made of a peculiar idea of personal liberty to justify the dominion of accident in social affairs is another convincing proof. The doctrine that the most potent instrument of widespread, enduring, and objective social changes must be left at the mercy of purely private desires for purely personal gain is a doctrine of anarchy. Our present insecurity of life is the fruit of the adoption in practice of this anarchic doctrine.

The technologies of industry have flowed from the intrinsic nature of science. For that is itself essentially a technology of apparatus, materials and numbers. But the pecuniary aims which

have decided the social results of the use of these technologies have not flowed from the inherent nature of science. They have been derived from institutions and attendant mental and moral habits which were entrenched before there was any such thing as science and the machine. In consequence, science has operated as a means for extending the influence of the institution of private property and connected legal relations far beyond their former limits. It has operated as a device to carry an enormous load of stocks and bonds and to make the reward of investment in the way of profit and power one out of all proportion to that accruing from actual work and service.

Here lies the heart of our present social problem. Science has hardly been used to modify men's fundamental acts and attitudes in social matters. It has been used to extend enormously the scope and power of interests and values which anteceded its rise. Here is the contradiction in our civilization. The potentiality of science as the most powerful instrument of control which has ever existed puts to mankind its one outstanding present challenge.

There is one field in which science has been somewhat systematically employed as an agent of social control. Condorcet, writing during the French Revolution in the prison from which he went to the guillotine, hailed the invention of the calculus of probabilities as the opening of a new era. He saw in this new mathematical technique the promise of methods of insurance which should distribute evenly and widely the impact of the disasters to which humanity is subject. Insurance against death, fire, hurricanes and so on have in a measure confirmed his prediction. Nevertheless, in large and important social areas, we have only made the merest beginning of the method of insurance against the hazards of life and death. Insurance against the risks of maternity, of sickness, old age, unemployment, is still rudimentary; its idea is fought by all reactionary forces. Witness the obstacles against which social insurance with respect to accidents incurred in industrial employment had to contend. The anarchy called natural law and personal liberty still operates with success against a planned social use of the resources of scientific knowledge.

Yet insurance against perils and hazards is the place where the application of science has gone the furthest, not the least, distance in present society. The fact that motor cars kill and maim

more persons yearly than all factories, shops, and farms is a fair symbol of how backward we are in that province where we have done most. Here, however, is one field in which at least the idea of planned use of scientific knowledge for social welfare has received recognition. We no longer regard plagues, famine and disease as visitations of necessary "natural law" or of a power beyond nature. By preventive means of medicine and public hygiene as well as by various remedial measures we have in idea, if not in fact, placed technique in the stead of magic and chance and uncontrollable necessity in this one area of life. And yet, as I have said, here is where the socially planned use of science has made the most, not least, progress. Were it not for the youth of science and the historically demonstrated slowness of all basic mental and moral change, we could hardly find language to express astonishment at the situation in which we have an extensive and precise control of physical energies and conditions, and in which we leave the social consequences of their operation to chance, *laissez-faire*, privileged pecuniary status, and the inertia of tradition and old institutions.

Condorcet thought and worked in the Baconian strain. But the Baconian ideal of the systematic organization of all knowledge, the planned control of discovery and invention, for the relief and advancement of the human estate, remains almost as purely an ideal as when Francis Bacon put it forward centuries ago. And this is true in spite of the fact that the physical and mathematical technique upon which a planned control of social results depends has made in the meantime incalculable progress. The conclusion is inevitable. The outer arena of life has been transformed by science. The effectively working mind and character of man have hardly been touched.

Consider that phase of social action where science might theoretically be supposed to have taken effect most rapidly, namely, education. In dealing with the young, it would seem as if scientific methods might at once take effect in transformation of mental attitudes, without meeting the obstacles which have to be overcome in dealing with adults. In higher education, in universities and technical schools, a great amount of research is done and much scientific knowledge is imparted. But it is a principle of modern psychology that the basic attitudes of mind are formed in the earlier years. And I venture the assertion that for the most

part the formation of intellectual habits in elementary education, in the home and school, is hardly affected by scientific method. Even in our so-called progressive schools, science is usually treated as a side line, an ornamental extra, not as the chief means of developing the right mental attitudes. It is treated generally as one more body of ready-made information to be acquired by traditional methods, or else as an occasional diversion. That it is the method of all effective mental approach and attack in all subjects has not gained even a foothold. Yet if scientific method is not something esoteric but is a realization of the most effective operation of intelligence, it should be axiomatic that the development of scientific attitudes of thought, observation, and inquiry is the chief business of study and learning.

Two phases of the contradiction inhering in our civilization may be especially mentioned. We have long been committed in theory and words to the principle of democracy. But criticism of democracy, assertions that it is failing to work and even to exist are everywhere rife. In the last few months we have become accustomed to similar assertions regarding our economic and industrial system. Mr. Ivy Lee, for example, in a recent commencement address, entitled "This Hour of Bewilderment," quoted from a representative clergyman, a railway president, and a publicist, to the effect that our capitalistic system is on trial. And yet the statements had to do with only one feature of that system: the prevalence of unemployment and attendant insecurity. It is not necessary for me to invade the territory of economics and politics. The essential fact is that if both democracy and capitalism are on trial, it is in reality our collective intelligence which is on trial. We have displayed enough intelligence in the physical field to create the new and powerful instrument of science and technology. We have not as yet had enough intelligence to use this instrument deliberately and systematically to control its social operations and consequences.

The first lesson which the use of scientific method teaches is that control is coordinate with knowledge and understanding. Where there is technique there is the possibility of administering forces and conditions in the region where the technique applies. Our lack of control in the sphere of human relations, national, domestic, international, requires no emphasis of notice. It is

proof that we have not begun to operate scientifically in such matters. The public press is full of discussion of the five-year plan and the ten-year plan in Russia. But the fact that the plan is being tried by a country which has a dictatorship foreign to all our beliefs tends to divert attention from the fundamental consideration. The point for us is not this political setting nor its communistic context. It is that by the use of all available resources of knowledge and experts an attempt is being made at organized social planning and control. Were we to forget for the moment the special Russian political setting, we should see here an effort to use coordinated knowledge and technical skill to direct economic resources toward social order and stability.

To hold that such organized planning is possible only in a communistic society is to surrender the case to communism. Upon any other basis, the effort of Russia is a challenge and a warning to those who live under another political and economic regime. It is a call to use our more advanced knowledge and technology in scientific thinking about our own needs, problems, evils, and possibilities so as to achieve some degree of control of the social consequences which the application of science is, willy-nilly, bringing about. What stands in the way is a lot of outworn traditions, moth-eaten slogans and catchwords, that do substitute duty for thought, as well as our entrenched predatory self-interest. We shall only make a real beginning in intelligent thought when we cease mouthing platitudes; stop confining our idea to antitheses of individualism and socialism, capitalism and communism, and realize that the issue is between chaos and order, chance and control: the haphazard use and the planned use of scientific techniques.

Thus the statement with which we began, namely, that we are living in a world of change extraordinary in range and speed, is only half true. It holds of the outward applications of science. It does not hold of our intellectual and moral attitudes. About physical conditions and energies we think scientifically; at least, some men do, and the results of their thinking enter into the experiences of all of us. But the entrenched and stubborn institutions of the past stand in the way of our thinking scientifically about human relations and social issues. Our mental habits in these respects are dominated by institutions of family, state,

church, and business that were formed long before men had an effective technique of inquiry and validation. It is this contradiction from which we suffer to-day.

Disaster follows in its wake. It is impossible to overstate the mental confusion and the practical disorder which are bound to result when external and physical effects are planned and regulated, while the attitudes of mind upon which the direction of external results depends are left to the medley of chance, tradition, and dogma. It is a common saying that our physical science has far outrun our social knowledge; that our physical skill has become exact and comprehensive while our humane arts are vague, opinionated, and narrow. The fundamental trouble, however, is not lack of sufficient information about social facts, but unwillingness to adopt the scientific attitude in what we do know. Men floundered in a morass of opinion about physical matters for thousands of years. It was when they began to use their ideas experimentally and to create a technique or direction of experimentation that physical science advanced with system and surety. No amount of mere fact-finding develops science nor the scientific attitude in either physics or social affairs. Facts merely amassed and piled up are dead; a burden which only adds to confusion. When ideas, hypotheses, begin to play upon facts, when they are methods for experimental use in action, then light dawns; then it becomes possible to discriminate significant from trivial facts, and relations take the place of isolated scraps. Just as soon as we begin to use the knowledge and skills we have to control social consequences in the interest of shared abundant and secured life, we shall cease to complain of the backwardness of our social knowledge. We shall take the road which leads to the assured building up of social science just as men built up physical science when they actively used the techniques of tools and numbers in physical experimentation.

In spite, then, of all the record of the past, the great scientific revolution is still to come. It will ensue when men collectively and cooperatively organize their knowledge for application to achieve and make secure social values; when they systematically use scientific procedures for the control of human relationships and the direction of the social effects of our vast technological machinery. Great as have been the social changes of the last century, they are not to be compared with those which will emerge

when our faith in scientific method is made manifest in social works. We are living in a period of depression. The intellectual function of trouble is to lead men to think. The depression is a small price to pay if it induces us to think about the cause of the disorder, confusion, and insecurity which are the outstanding traits of our social life. If we do not go back to their cause, namely our half-way and accidental use of science, mankind will pass through depressions, for they are the graphic record of our unplanned social life. The story of the achievement of science in physical control is evidence of the possibility of control in social affairs. It is our human intelligence and human courage which are on trial; it is incredible that men who have brought the technique of physical discovery, invention, and use to such a pitch of perfection will abdicate in the face of the infinitely more important human problem.