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SCIENCE, PHILOSOPHY, AND RELIGION*

IN THE POPULAR MIND science and technology are synonyms. They are coupled in most public utterances and have grown together semantically. The first step on the way to a correct appraisal of the effects of science upon human society is to break this coupling and to examine more closely what happens when an important discovery in science is made. Since I lack competence in the area of social science, I must limit my remarks to the natural sciences, even though I believe the analysis to be valid in a larger sphere.

The *obvious* effect of science is technological; it is the visible and impressive movement from discovery through commercial development, production of new goods and devices, advertising and sale, toward the establishment of greater comforts of life. This causal chain, which in the end enhances or at any rate modifies our so-called standard of living, our external circumstances, will here for brevity be called the *obvious* movement, for it is this trend which is open and clear for all to see, and which earns the applause of people in our society today.

But every truly great scientific discovery launches also another trend, a trend much less apparent and more subtle in its progression from phase to phase through human culture. The discovery, acting as a *fact* in initiating the obvious movement, becomes the leaven of an idea in the other. It clamours to be understood, and the scientist must provide some sort of *theory* in terms of which the discovery takes on significance and organizing power. The requisite theory contains novel features, features contradicting what was previously regarded as true; and by virtue of this apostasy the discovery induces a rearrangement of thought in adjacent fields. Sooner

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or later the internal structural consistency of the science that was disturbed by discovery is restored, but in the process some cherished beliefs, some aspects of common sense, have had to be surerndered. In this way Copernican astronomy destroyed the complacency of the geocentric view; relativity theory repudiated the concept of absolute motion and, to some extent, the simple intuitions of geometry; quantum mechanics denies the continuity of motion, and a good deal of time will probably elapse before men cease to feel that such theoretical consequences of discovery violate common sense.

Results as challenging as these cannot fail to have a profound effect on philosophic speculations. Indeed philosophy, in time, must and does take account of the ideological consequences of scientific knowledge, first by changing its cosmological beliefs and perhaps its theory of knowledge. Changes in one branch will entail changes elsewhere, and even though the sequence of alterations is uncontrolled and haphazard (chiefly because we are less conscious of them than we are of the technological sequence), they nevertheless tend to embrace the entire structure of philosophic thought before their course is run.

This chain of events ends in new views with respect to the nature of the universe, the relation of man to the universe, and the relation of man to man. Ethics, sociology, and politics are ultimately subject to infestation by the germ that is born when a discovery in pure science is made. This movement, which terminates in a change of the cultural milieu of man, will be called the *obscure* movement. Perhaps "obscure" is too mild a term, for there are those who, aside from ignoring the ideological-cultural sequence of events, even deny its existence. We are prone to think that science is philosophically neutral, that its results can be contained within a single compartment of our thinking, and we convert this conviction into the assertive doctrine that science is irrelevant for the spiritual aspirations of man. This dogma of the neutrality of science is a dangerous one; it constitutes a handicap in our struggle with the East. For in the lands of dialectical materialism certain kinds of science are regarded as the final arbiters of philosophic truth, and all science is embedded in a medium that reacts at once to discovery. There is an instant ideological response, whereas the obvious movement, at least with respect to the production of consumer goods, proceeds more slowly.

In terms of our distinction, then, there is a paradox in the fact that proponents of Russian communism profess the supremacy of the obvious movement while disparaging the other, whereas the western democracies reverse the declaration and pay lip service to ideas but practise what Marxism professes.

Let us now cast a brief glance at the intervals of time which elapse between discovery and the culmination of the two movements, the obvious and the obscure. It seems reasonable to postulate, and I believe history shows, that human society enjoys maximum stability when the two movements are in balance. This was often true, both in western and in eastern cultures during the ten or twenty centuries that preceded ours, and the balance resulted from the lumbering slowness of both movements. Gunpowder was discovered in the twelfth century: it was used in warfare two hundred years later. Galileo and Newton found the laws of mechanics in the seventeenth century: the machine age arose in the eighteenth and nineteenth. Oersted discovered the magnetic field of electric currents in 1820: electric motors became industrially important about one hundred years later. Thus the technological gestation period, the time required for the obvious movement to be completed, was of the order of a century, and there is clear evidence already, in the examples mentioned and in others to be cited, that it is continually decreasing. One of the stupendous technological developments of our time, the development of the fission bomb, lasted from 1939 to 1944. Whereas two centuries were required to convert gunpowder into a mildly effective military device, five years in our time saw the conversion of a scientific discovery into the most devastating weapon. The enormous acceleration of the technological process has been well documented by Dr. L. R. Hafstad in a linear graph that provides a clear and striking illustration of the ever-decreasing interval between scientific discovery and commercial production. Extrapolation of this graph would indicate that by the year 3000 A.D., the interval will be reduced to a minimum.

In extreme contrast with these examples is the snail's pace at which even today scientific knowledge transforms itself into philosophic understanding: the obscure movement proceeds at the same slow rate as in the past. One of the best examples to illustrate this point is perhaps the quantum theory, discovered some fifty years ago. Its technical mathematical implications—the matrix theory, the Schrödinger equation, the transformation theory—are well known and have gone into the textbooks, yet the meaning of these formalisms in philosophic terms seems to be as obscure as ever. The literature on the philosophy of science is alive with controversies regarding interpretation of measurement in quantum mechanics, the causal qualities of that theory, and the ultimacy of its basic assumptions. The amazing fact is that precisely the men who are themselves the distinguished fathers of that discipline, men such as Bohr, DeBroglie, Schrödinger, Heisenberg, Einstein in the last years of his life, and Born, feel the need for clarity in this area most keenly; the are the serious contributors to the researches in the field of the philosophy of quantum mechanics. The pity is that too many young physicists smile indulgently at their efforts, regarding them as senile and too far off the beaten track of their science to be worth serious attention.

The past is full of examples suggesting that periods of the order of a century or two were needed to bring the obscure movement to its fulfillment. To consider but one, take Kepler's laws of planetary motion, shown by Newton to be consequences of the principle of universal gravitation. The striking feature of that discovery was its claim to absolute accuracy, to universal validity, the cosmic applicability of pure mathematics. The best philosophical transcription of these aspects of scientific law was given by Kant 150 years after Kepler when he suggested that it is man's mind, not nature, which reverberates in syllogisms and mathematical equations. Man projects the limitations of his understanding, the pure forms and categories of his own reason, into the world at large and finds it behaving in accordance with his own reasonable precepts. Were it not for the supreme adequacy with which that philosophy reflects the apodictic character of celestial mechanics, Kant's success would be an enigma. The intrinsic appeal of so abstruse a doctrine is necessarily low, and it can only be its cogent scientific basis which made that doctrine sweep a continent and which propelled the doctrine, despite its common-sense implausibility, into the domain of ethics and religion. It is a far cry from Kepler's laws to the categorical imperative, to the Prussian concept of duty, and to an international climate charged with conflict, but the obscure movement connects them all. And it required more than a century to do so. The same seems to be true today, whereas the obvious movement achieves its goal within a decade.

Historical instances of an imbalance between the obscure and the technological or obvious movements which proved destructive to society are not hard to find. The culture of ancience Greece suffered from a pathology that was the reverse of ours: the obscure movement was ahead of the obvious. As for an example of *balance* that proved stabilizing and beneficent, one might look at the constitution of the United States, a document perhaps unique in history for its longevity. It was based on a philosophy in accord with the science of its day, as the record shows. Locke's philosophy was a response to mediaeval science. Thomas Jefferson was a disciple of Locke. Hence the constitution reflects the balance, composure, and maturity of a philosophic view solidly based on science. Jefferson himself said, "All its authority rests upon the harmonizing sentiments of the day".

At the present time, there is evidence not only in the West but indeed every-where, of an imbalance between the two movements that started from scientific discovery. The obvious one has been vastly accelerated in all parts of the globe; the obscure has not found its goal. It flounders and gropes without rational guidance on both sides of the Iron Curtain, and the ideological cleavage between East and West is, in part at least, symptomatic of the failure of the hidden movement to have completed its course.

Scientific discoveries travel across all curtains. They cannot be contained very long when the world stage is set for them. Consequently, the discoveries themselves, and largely their technological results as well, become common knowledge in a short time. But they are partial knowledge unless their deeper meaning is apparent, unless philosophic understanding of them is as clear as their factual entailments. Until that time each partisan can put his own arbitrary interpretation upon his science. This is what is happening now.

Admittedly, it is conceivable that a given scientific discovery may be compatible with two conflicting philosophic interpretations, in which case contradictory understandings could be reached and reliance upon completion of the obscure movements would be of no avail. I am willing to discount this possibility as a highly academic one for the following reasons. First, philosophic indiscriminacy may be the lot of single discoveries in science, to be sure, but as their number in a given area increases, as groups and related complexes of discoveries appear, philosophic significance becomes more and more directed. Secondly, history shows that in the long run a single major philosophic view always wins out among the practitioners of science, even if superstitions continue in other quarters. I take it, therefore, that a common science will ultimately engender a measure of agreement in philosophic outlook across all artificial curtains when equilibrium between the two movements is finally established, when our intellectual atmosphere is congenial with our applied science.

Hence arises the suggestion, vague perhaps and insecure at this point, that two problems should be of very serious concern to the thoughtful student of science and of history: how to speed up the obscure cultural movement so as to bring it into step with the obvious; and how to make the obscure movement less obscure. Both ends can be achieved by a shift in emphasis from technical science to the philosophical problems surrounding and pervading science, by consciously taking stock of the needs for philosophic digestion of discovery and of our patent failure to achieve it.

We thus arrive at the question of "what is science" or, to be more specific, what is the method, the philosophic process, by which science has achieved its remarkable successes?

The Method of Science

The political and economic maladjustments of the times are subjects of common knowledge and cause for universal concern. No less serious, however, is the *cultural* crisis that confronts mankind. It is manifest in divisive ideologies, in fragmentation of intellectual disciplines, and in the excessive specialization of scientific research. A cleavage has developed, not only between the arts or the humanities, on the one hand, and the sciences on the other; but even with the sciences a curtain seems to be condensing between the so-called physical and the social disciplines. There are many who believe that the method of the physical sciences is totally different from that employed in the social sciences, and that it is this difference in method that accounts for the tremendous success of physical science and the relatively slow progress of social institutions. Watchful scholars in both fields are asking: What is the mainspring for success in the physical sciences? Are their methods wholly unique, or are they transferable to other departments, particularly to the field of human affairs? All these questions raise the important problem of methodology.

Concern for basic method is new on this continent. An all-pervading pragmatic spirit has kept its scientists busy with immediately profitable tasks. Interest in philosophy on the part of scientists has been frowned upon in view of the patent fact that it has kept some scientists from doing their best work. Results had to be achieved, and the less said about the way in which they were attained the better. Is it not true that a bird can fly without knowing the principles of aerodynamics? If a bumblebee studied the design of aircraft he would never venture to entrust himself to the air, for he would know that, according to the textbooks, his ratio of wing surface to body weight is far too small for sustained flight.

All this is true, and it is good advice for birds and bumblebees. But suppose that the art of flying is to be transferred from birds to men. When man wanted to fly he had to study aerodynamics. Watching the birds was not sufficient for this task. A conscious effort was required to study the phenomena of flight and to formulate the laws which regulate them. And so it would seem to be if the method of the physical sciences is to be made useful for an understanding of human behaviour. More must be known of these methods than their mere use in the physical sciences demands. The physicist, the chemist, and the astronomer each must become reflective and ponder over the meaning and the foundation of his own discipline.

Here, then, is a summary of the basic method of science. Immediate observation reveals to us certain undeniable facts, like the shapes and colours we see, the sounds we hear. These are largely incoherent; they lack order and rationality. Science provides this order, this rationality, and it does so by transcending the facts, by constructing ideas, by forming concepts which correspond to the facts. When science has developed these concepts and their correspondences to the facts, it possesses the ability to reason, to calculate, to predict. Concepts, or ideas, are related amongst themselves by the laws of logic and mathematics; while they correspond to facts they cannot be fully explained in terms of facts; ideas are the life of science, and their meaning is not exhausted by the meaning of facts, that is, by sensations, observations, and experiments.

To solve a scientific problem means this: that one starts by making careful observations which, when analyzed, are placed in correspondence with certain concepts governed by laws and principles in such a way that reasoning about the concepts reproduces the observations and indeed allows the prediction of new observations. Three elements are thus crucial in the working of scientific method: the facts or observations; the rules of correspondence between facts and ideas; and the rational principles which control the ideas.

Modern research on methodology is increasingly devoted to the interplay between these entities.

Physical science is sometimes regarded as a great mass of *inductive* activity. This inductive activity is understood to be the enterprise of carefully collecting, comparing, sifting, and cataloguing facts with a zeal and an honesty characteristic of the scientific worker. This limited view, however, ignores some of the theoretical or ideal elements which are always present within true scientific understanding. It underestimates the use of reason as well as the illuminating connections which this faculty provides among facts inductively discovered. If science were nothing more than induction, it would merely move from discovery to collation and tabulation, ending with a statement of regularities gleaned by an inspection of tabulated facts. Scientific knowledge then would be a surface texture of incidental observations loosely joined together and devoid of the solid ground of logical relations into which the roots of the facts always extend. The view which regards science as nothing more than an inductive undertaking in the Baconian sense is one-sided, limited, and incapable of sufficient generalization. Unfortunately it is quite common in the social field and may be responsible in part for the separation between the science of nature and that of society.

In a survey of the entire domain of scholarly endeavour called science, two large areas can be distinguished roughly. One may be called, for want of a better name, correlational science, the other theoretical science. The distinction is not clear cut; there are many disciplines which fall partly into one and partly into the other of these two categories. By correlation science is meant one which remains largely on the primary ground of observed facts, which describes, orders, and judges these facts, and exhausts itself in establishing correlations between them. Researchers in these fields often pride themselves upon their independence of theories, which to them are odious things that ought to be avoided. They draw inferences from their observed facts and announce their conclusions with probability, spurning the certainty which flows from the basic theoretical understanding they deem illusory.

The theoretical scientist, on the other hand, links observed facts with concepts which often depart widely from the immediately sensed. These concepts, ideas, or constructs take on greater and greater reality and importance as they enter into more extensive connections with observed facts. Modern physics is a theoretical science, as indeed it must be if it is to deal with the unobservable entities of the atomic realm. Knowledge of electrons springs largely from abstract principles which are not obtained by induction, but which are nevertheless checked in a more indirect way against the facts of observation. Among the sciences which are largely theoretical, and therefore called exact, are applied mathematics, physics, astronomy, and much of chemistry. Predominantly correlational sciences are botany, zoology, and large parts of both sociology and medicine. Some sciences might be said to be intermediate between these two classes; these include psychology, genetics, economics, and many phases of engineering.

The distinction just drawn is a time-bound one; it describes merely a given stage of a science. The history of science shows that all of its branches passed through a formative stage in which they were descriptive, that is, correlational. This stage is then followed by a theoretic one. Physics, for instance, was correlational in the days of Aristotle and attained exact or deductive status in Galileo's and Newton's day. Biology is in the process of transition at the present time. It well may be that all correlational sciences are on the way toward becoming theoretic in the end. This is a conjecture which obviously cannot be proved. To clarify the meaning of the distinction made, it seems well to study in slightly more detail the process of deduction.

To reason deductively means to draw conclusions from premises, not from incidental facts. The simplest example of the deductive process is the syllogism, typified by this time-honoured example: "All men are mortal; Socrates is a man; therefore Socrates is mortal." To use a more modern version, the performance of mental arithmetic is a deduction, the result being already implied in the postulates constituting the meaning of number. More interesting perhaps is the kind of deduction often employed in modern electrical engineering. Here it is possible to start, for example, with Maxwell's equations, using them together with boundary conditions to compute the modes of electro-magnetic waves that can be transmitted by wave guides. By purely mathematical operations, predictions can be made with respect to actual occurrences, and the labour involved in making these predictions is often far less than the work of direct experimentation. On many occasions, of course, such a deductive process is not available. There exists no general principle which can guide the engineer in a search for materials having specified properties. However, when deductive methods are available, they are usually time-saving, powerful, and elegant.

There was a time when the use of deductive method in science was under suspicion, and the effects of this attitude are still being suffered. Naturally, deduction must start with premises, and the conclusions drawn are never truer than the premises themselves. But where do the premises come from, and who vouches for their truth? Philosophers of the rationalist school have held them to be self-evident, have called them axioms, and the term "axiom" has carried with it an assurance of absolute and innate truth. It was thought at one time that the postulates of Euclidian geometry were axioms of indubitable truth and that the consequences following from them must be equally valid. This conviction received a rude shock when the existence and plausibility of non-Euclidian geometries was discovered during the middle of the last century. What seemed at one time absolutely certain was suddenly not only drawn into question, but actually shown to be empirically false. This experience and many others recorded in the history of science constitute an indictment of the absolute truth of premises and have brought to the deductive method a measure of disrepute. Scientists sometimes have felt that, if the premises are never certain, the conclusions are not interesting at all and, therefore, they have rejected all ideal or deductive elements in science.

The lesson with respect to the fallibility of premises used in deductions is an important one and must always be remembered. However, the value and the success of the process of deductions are not tied to infallible premises. The premises, axioms, or postulates which it does employ can be regarded, and are regarded in all proper applications, as *tentatively* true. Their value does not lie in our being certain about them, but in being able to derive from them specific consequences which can be tested against experience. The verification of these observational experiences reflects back on the certainty of the premises, and when there are sufficient instances of verification the premises are said to be "true." It is in this way that *faith* in Maxwell's equations has grown to a complete acceptance of this theoretical formalism. Please note the word "faith." Its use seems improper in science; nevertheless the logic of a scientist's commitment to postulates is the precise analogue of moral man's dedication to ethical ideals, and of a religious person's adherence to faith. Let it be noted that Maxwell's equations cannot be derived from experimental facts, no matter how numerous and convincing they are as individual instances. Such equations imply more than any finite body of experimental information, and herein lies their power. Herein also lies their capability of being wrong.

The method of theoretical science is an interplay between induction and deduction. Postulates are suggested by experimental facts, and experimental facts are in turn deduced from postulates. These postulates, although not *a priori* true, gain stature and validity as the process of experimental verification succeeds.

Science and Religion

Religion and science are said to be in conflict. The strife between them has sweeping consequences in human action, in the moral field, consequences which cannot be ignored. For religion, particularly in our Western sphere, has two aspects, one cosmological and one moral. Cosmological religion with its ancient, prescientific speculations about the universe covers in part the field of natural science. In its moral phase, religion develops a code of human conduct and tries to commit men to it by an appeal to faith. Now, if science can show that the cosmological claims of religion are wrong, religion's case in the moral field is greatly weakened. This is precisely what has happened in our time. Men believe that science has overpowered religion in the natural realm, and they look to *science* for guidance in the sphere of human action and in the spiritual sphere. The unhappy and possibly tragic feature of this attitude is that it rejects a spiritual gift religion bears because man feels doubtful about the scientific pretensions it carries along with the gift.

I do not believe that the contest between religion and science has been decided in the cosmological field, nor that it ever will be decided. This belief is based, first of all, upon a simple fact of history. Science is not an unchanging static set of propositions, not a permanent body of approved facts. Quite obviously it changes, and the changes are not merely additions of knowledge. Revision of basic tenets, overthrow of assumptions that proved erroneous are the marching orders of science, and the dynamism of this human enterprise is a result of the liberality of its method. Religion, too, is in a state of progress in spite of the reactionary insistence on codified eternal truth by so-called fundamentalists and others who refuse to enlarge their horizons. The evident fact is that both science and religion are involved in a process of growth, and if one were pitted against the other and were said to be the winner, who could guarantee the finality of that victory? Thus, if an adroit answer were sought to questions concerning the veracity of certain sacred accounts of creation, miracles and so forth, the attitude should not be one of rejection or acceptance. Rather, one must look upon them as partial, not final revelations in an ever-folding historical process of human understanding.

There is in fact a need for continual reappraisal of the relation between religion and science, and never was this need greater than it is today, for science has recently undergone a revolution of its fundamental concepts that is unique in history. The complete refutation of old-style materialism in modern physics, the sublimation of mechanics, the reliance placed on abstract ideas—all these are sweeping in their philosophical consequences, and many things that used to be said about the conflict in question are simply no longer true.

These are generalities; let us now face specific aspects of our theme. To me, it has always been a curious and yet significant fact that at the very beginning of the Bible, the document which many regard as divinely inspired, religion is said to grant a charter to science, with an implication that the two shall live in peace. First, you recall, there was chaos, terminated by a divine act of creation. Then followed a period of lawlessness and confusion that ended in the great flood. One interpretation of the turbulent days prior to Noah's Ark, which is elaborated in the Jewish Talmud, proposes that during this period nature, and nature's God, did not act in accordance with consistent principles; that there were no natural laws and, hence, no possibility for natural science. Lawfulness, behaviour in conformity with reasonable principles, causality, were God's gift to Noah, made in the beautiful covenant of the rainbow.

> Jehovah smelled the sweet savour; and Jehovah said in his heart, 'I will not again curse the ground any more for man's sake, for that the imagination of man's heart is evil from his youth; neither will I again smite any more everything living, as I have done. While the earth remaineth, seed-time and harvest, and cold and heat, and summer and winter, and day and night shall not cease.' And God said, 'this is the token

of the covenant which I make between Me and you, for perpetual generations, I do set my bow in the cloud, and it shall be for a token of a covenant between Me and the earth. And it shall come to pass, when I bring a cloud over the earth, that the bow shall be seen in the cloud, and I will remember my covenant, which is between Me and you and every living creature of all flesh.'

If I understand this passage correctly, it means to say that the order of the universe is a divine gift. In a sense Judaeo-Christian religion here acknowledges the legitimacy of science. Perhaps it still remains for science to make an equally generous reciprocal acknowledgment to religion.

The symbolism of this covenant has remained alive as a vague religious motive in the work of most scientists. The very word "cosmos", meaning ornament or beauty, along with the Greek myth of the harmony of the spheres, discloses a remnant of elemental religion. Expressions of reverent amazement at the regularity of physical nature, at the simplicity of natural laws, at the sweep of the human intellect in its control of nature have sounded through the ages as religious overtones of science. It is heard in the utterances of modern scientists as clearly as it speaks from the eloquent writings of the theologian, Schleiermacher, who paid tribute to the one miracle before which all others lose their meaning, that miracle being the absence of breaches in the lawfulness of nature, the absence of miracles in the pedantic sense. But the lawfulness of nature, while big with religious implications, is hardly a sufficient basis for claiming general compatibility between religion and science.

Another very large area of contact between science and religion comes into view when we consider the epistemological task of religion. Science is designed to project ideal order into the phenomena of observation, into the facts which lack systematic relations within the texture of immediacy. It does this by establishing rules of correspondence between the incomprehensible deliverances of our senses and the constructs of reason which can be controlled by clear laws of thought. Now I hope to indicate that religion has among *its* concerns the establishment of rational order in our understanding of a certain class of phenomena which are different, in substance, to be sure, from the observations and experiments of science, but resemble them in their lack of order, in their irrationality. The latter include the ineffable experience of man's existential, irrational apparent destiny, his experience of what religious persons have called the tremendum.

But to see this parallelism between science and religion I must clear one obstacle out of the way of either discipline. The obstacle is an opaque screen called dogmatism.

The judgment of science is never final. Science recognizes eternal *problems* but no eternal *truths*. It learns, it progresses; yet its job is never done. Nevertheless, science has its share of dogmatism. There are those who regard the present stage of scientific knowledge as ultimate and refuse to consider phenomena or experiences outside its momentary competence. They make a distinction between what science is now able to explain and what escapes its grasp; the former they call natural, the latter supernatural, and they believe this partition to remain meaningful. According to this unreasonable notion, radio and television were supernatural phenomena until the twentieth century, during which they were demoted, or, if you please, regularized to the status of natural. Yes, dogmatism in science arises from the mistaken belief that its present principles of explanation are forever valid and forever sufficient to embrace all experience.

And dogmatism in religion, equally indefensible and equally mistaken, rears itself upon the arrogant conviction that religious truth is laid down once and for all in a static pattern, rigid, lifeless and inexorable, incapable of progress and improvement. These bone-dry dogmatisms always clash and clatter, and the noise they make through the centuries is usually taken as the sign of conflict between science and religion.

I now turn to the epistemological role of religion. What science does in this respect is well exhibited by Kant and most modern philosophers of science, who draw attention to the features of incoherence and irrelevance in our immediate experience, which exhibits a lack of order that reason alone can fill.

Kant says sense data are unordered, capricious, requiring to be regularized by the categories of reason which bring them under *concepts*. He speaks of the rhapsody of perceptions which is converted by principles of understanding into organized knowledge:

> Concepts without factual content are empty; sense data without concepts are blind. Therefore it is equally necessary to make our concepts sensuous; i.e., to add to them their object in intuition, as it is to make our intuitions intelligible; i.e., to bring them under concepts. These two powers or faculties cannot exchange their functions. The understanding cannot see. By their union only can science (knowledge) be produced.

What science actually achieves is a correlation of facts with ideas. It needs facts as our body needs food; but within the organism of science facts are possessed, combined, organized, and connected by a texture of reason, and it is the whole of the organism, including that texture of reason, of ideas and conjectures, which is science. In a very deep sense, science has its origin in the circumstance that, in the deliverances of our senses, the facts are not sufficiently well orderd to satisfy our desire for simplicity and consistence. Science is an elaborate answer to the paradox of the bruteness of our experience. To summarize: incoherent facts are unified by science into a consistent whole with the use of reason.

It seems to me that there is also an incoherent rhapsody of unique and troubling *religious* data which human understanding is called upon to organize into an orderly and satisfying pattern. What are the brute facts of religion?

For my part, I see them residing in those experiences most men acknowledge to be peculiarly religious, in the spontaneous feeling of gratitude that wells up in a man's heart on a joyous day, the feeling of awe in the face of overwhelming beauty, the contrition that follows a sinful experience, the experience of misery and abandon at the insufficiency of human power before fate, in our longing for grace and redemption. Just like the facts of science, they are unconnected, orderless and insufficient in themselves, requiring a texture of rational organization. And this, I take it, is what formalized religion or theology aims to provide. That its theory is replete with intangible ideas, that in the terminology of its detractors it bristles with the "technicalities of salvation" is small wonder to one who is familiar with the intangibles of science. Their presence in itself is no objection. The success of religion is measured by the degree of rational coherence which it bestows upon these singular religious experiences that assail the sensitive mortal.

Christian doctrine symbolizes the unrelieved and unembellished rawness of our natural reactions to the universality of evil and misery by its thesis of *original sin*. Guilt and terror strike the soul of man, and he feels unworthy of redemption. Indeed, if one analyzes the oppressive, brute facts of religion, one finds them reflecting, I think, very largely the message that *Genesis* speaks to Adam: "cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life; thorns also and thistles shall it bring forth to thee; and thou shalt eat the herb of the field; in the sweat of thy face shalt thou eat bread, till thou return unto the ground."

Now pass from there to the words of Jesus in *Matthew* 11: "Come to me all ye that labour and are heavy laden, and I will give you peace." Here is a religious theme of supreme satisfaction, a symphonic resolution of the existential meaninglessness of clashing inner sensations, an organizing idea of power and simplicity in terms of which many crude experiences make beautiful sense. To realize this provides, on a deeper plane of human concerns, an intense gratification similar to that felt by the physicist when he opens his mind to the aesthetic appeal, for example, of

Maxwell's equations or Einstein's gravitation and beholds their integrating, their unifying action in the world of diverse facts.

To bridge this gap between *Genesis* and *Matthew* by a texture of rational connections is one of the important tasks of religion. And to me it is the same task as that performed by science when it converts "the rhapsody of sensations" into orderly rational knowledge.