The Game of Science

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OF writers on the relation of scientific doctrine to Christian theology there is no end. If there were any lack of theologians who felt themselves competent to evaluate current scientific doctrine (which there is not), that lack would be abundantly compensated by the plethora of men of science who are making pronouncements on theological trends. We may all admit that there are numerous adjustments to be made between the two points of view, but we can be excused for entertaining a feeling akin to boredom whenever another "reconciler" appears on the horizon.

Yet in addition to the perfectly obvious facts that the problems in this field have not by any means been solved and that there is a general desire on the part of the thoughtful reading public for further light on the subject, there is at least one mode of approach to the situation which has not yet received adequate treatment. That is an open-minded and thoughtful *re-evaluation of scientific doctrine by men of science* in the light of current trends of thought toward both science and theology. Whatever may be said of attempted interpretations of science by men whose principal training is in theology (and some excellent work has unquestionably been done against such a background), there can be no doubt but that much confusion has been introduced into the case through theological pronouncements by prominent men of science. Whether it be a resuscitation of an outmoded post-Kantian dualism at the hands of Eddington, the hopelessly naïve conception of a creator who is primarily a mathematician in the mind of Jeans, or the caustic comments on a deity who tortures little children in Bertrand Russell's distortion of the problem of evil, all of these are examples of the consequences of failure on the part of men who are abundantly competent in their respective fields, to recognize the limits on their competence. Eddington, Jeans and Russell, in company with a number of others, are very stimulating writers. But unless the circulation of their works can be confined to those who are capable of reading with considerable discrimination, the waters of thought in this field are certain to be muddied considerably by their treatment.

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We must recognize, of course, that there is no clear boundary between science and philosophy, between physics and metaphysics, especially in these days of relativity, the wave-theory of matter and Heisenberg's principle of indeterminacy. Ventures into the borderland, from either side, are necessary in the very course of the extension of knowledge. But more is lost than gained when the tentative formulations of doctrine incident to such ventures are prematurely submitted to the layman buttressed by the prestige of the writer acquired in a field other than that in which he is publishing.

In place of the general impression among the masses that only in scientific truth can complete validity be found, in place of an implicit feeling on the part of many men of science that the so-called scientific method is a second decalog which they are divinely appointed to administer, a spirit of self-criticism is growing in the sciences which is very encouraging. It is describable, perhaps, in what will seem at first to be a very curious metaphor.

In this metaphor the scientific enterprise may be likened to a game. Curiously enough, it is possible to find in the sciences, as indeed in most of the professions, illustrations of the basic conventions and ethics of sport. At first sight this seems rather absurd, for surely science is a serious pursuit, not a mere game. One feels that the triviality of the objectives of games makes the use of any such comparison misleading. Notwithstanding this natural feeling, if one penetrates deeply into the psychology of games and into the philosophy of the sciences, the metaphor will be found to have its uses.

It is of the essence of a game that an objective is rather arbitrarily set. To place a ball in a basket or between two particular posts, or within a certain area on the ground, or in a hole in the ground; each of these objectives occupies a central place in a particular game. No inquiry is made as to the value of these objectives. Superficially regarded, they are without value, to the point of triviality, yet no participant relaxes his efforts on that account.

It is a further characteristic of games that the objective may be reached only in particular rigorously prescribed ways. To give only one example, if putting the ball in the hole were the sole objective of golf, anyone could immediately qualify for the distinction of having made a "hole in one" by picking up the ball, walking to the green, and dropping it into the cup. But so important is the way it is done that the assertion would promptly be

made not only that such an individual was violating the rules but that he was not playing golf at all.

Two of the principal characteristics of games are, then, the purely arbitrary choice of an objective and rigorous limitation of the ways in which that objective may be realized. Before inquiring how far the sciences possess these same characteristics it will be profitable to consider some other professions.

It was frequently said of business tycoons of the last fifty years that they amassed wealth, not primarily because of desire for wealth, or even for what it could purchase, but because the mere act of amassing it had become a game with them, and there was much to support that theory. As between the possession of, say, a million dollars and the possession of a hundred million dollars, there is very little choice. The less wealthy of two such men still has enough to purchase all the personal comforts and security which the more wealthy could possibly imagine. If there is any difference between the degree of comfort which attends the possession of a million-dollar estate and that which attends a hundred million, it would not be at all in the hundred-to-one ratio of the estates. Indeed, the additional ninety-nine millions would unquestionably bring more cares and responsibilities than added comforts. Why, then, do men continue to struggle for added wealth after they have secured a competence? Simply because what was originally a means has become the end. They now seek wealth for no other reason than the stimulation which the pursuit of such an objective brings. In other words, they are simply playing a game.

There is food for thought in the theory that our whole legal structure is a vast schedule of games, the objectives of which are the winning of judicial decisions. No more attention is paid to the worthiness of the decision which is sought than to that of the placing of a ball in a cup. A lawyer works as eagerly to secure the acquittal of a man that he knows is guilty as of one that is innocent, and suffers no loss of professional prestige thereby. Moreover, the objective must be sought in particular, rigorously prescribed ways. And it is characteristic of some of these ways that they allow no cognizance to be taken of the truth unless it can be molded into certain forms. Such is the nature of legal technicalities.

The medical practitioner, too, is playing a game. He asks no questions about the value of his objective. It is his professional duty to save life, regardless of its value. He will labor as hard to save a criminal who is

ill as he will a statesman; and this would be true even if the criminal were to be executed the following day. Also, his professional ethics require that the objective be reached in particular, rigorously prescribed ways. He may not advertise, he may not solicit. It sometimes happens that a physician will allow a person not his patient to die rather than to call his attention to a cancerous growth, of the significance of which the victim is unaware. And the whole sorry story of warring medical sects is primarily a matter, not of relative effectiveness of different modes of treatment, but of scorn for players who fail to observe current arbitrary rules of the medical game.

There is a good deal to be said for the theory that the scientist, too, is the devotee of a game. He selects a certain type of objective. If he is a scientist, as distinguished from an inventor or engineer, he gives no consideration to the value of the objective. He accepts it uncritically from the general enterprise of which his profession is a part. The formulation and testing of hypotheses are as much the center of his professional life as is the amassing of wealth, the winning of decisions, or the saving of life to the other professions. The value of the hypotheses is as irrelevant as are the values of the corresponding objectives to the other professions. In the sciences as in the other professions, there are doubtless deviations from the code, but that such codes form the yardsticks of professional ethics there would seem to be little ground for doubt.

Not only do men of science accept objectives uncritically, as do other professions, but they too must pursue their objectives in particular, rigorously prescribed ways. The central point in the professional ethics of the scientist is mechanical causation. If a physical scientist sees a fire in a grate, he may take professional cognizance only of the chemical reactions and the heat transfers. He may say that the cause of the evolution of heat is the exothermic combination of oxygen with certain hydrocarbons. He is excluded from accounting for the heat on the basis of having touched a match to kindling accumulated for the purpose, and still more from accounting for it on the basis of having desired that the room should be warm. Yet from the standpoint of most human relations, the latter is the real *raison d'être* of the fire, a fact, however, which many scientists will not admit unless caught off of their professional guard.

It is to be noted that there are alternative ways of accounting for the existence of the fire, or of "explaining" it. Only three explanations were listed above, but there might have been others. Indeed, in theory,

there are always an infinite number of possible explanations for any given phenomenon. But the rules of the game of science eliminate all explanations involving any element of purpose or design, and so delimit the explanations that are left that in practice there is seldom more than one scientific explanation of a phenomenon. Even in the cases in which it is impossible for a time to choose between two or more explanations, the alternatives are always mechanical, that is, non-purposive. The exclusion of all causal sequences except the mechanical is the characteristic feature of scientific doctrine, much as the exclusion of all methods of controlling a ball except with a racquet is the characteristic feature of tennis. It would be possible to catch the tennis ball by hand, walk to the net and drop it over, but the players agree to exclude that and all other ways of handling the ball except by the racquet. The man of science, too, in playing *his* game, agrees to bar all types of treatment of his data except mechanical causation. To work in other ways would of course be possible, but by common agreement such other ways are not to be considered a part of the game of science. This deserves emphasis, for it seems not to be comprehended as generally as it should be, even in scientific circles. The exclusive use of mechanical sequences in scientific theory is simply the principal rule of the scientific game. It does not mean at all that, in "explaining" a fire in a grate, the man of science must necessarily deny the validity of purposive types of explanation, though in practice he frequently becomes guilty of doing so. Such slips, however, are traceable to human frailty and are not an integral part of basic scientific doctrine.

One of the implications of the self-imposed limitation to mechanical causation on the part of the sciences is the recognition of the circumscribed nature of scientific doctrine, even, in a certain sense, its triviality. But at this point we must move warily. It does not follow that the limitations on scientific validity indicate the abandonment of that type of approach to knowledge. On the contrary, this tagging of different types of sequence of events has proved to be of the essence of the progress of our intellectual enterprise. It cannot be commended too warmly nor used too intensively. Discrimination between the different types is a measure of the clarity of one's thought. It may be completely demonstrable, for example, that the success of a business man is primarily due to the active support of a group of friends who possess great affection for him. But even if he were fully aware of the fact, he would be aghast at any suggestion that the love of his

friends should be entered as an asset on his balance sheet. Upon pursuing this apparent paradox to its depths, we should discover that bookkeeping operations really constitute a game, the rules of which permit the listing of only certain types of asset. The only legitimate conclusion from such an attitude is that the business man's balance sheet tells only a part of the economic story. Similarly, the scientist's balance sheet tells only a part of the scientific story.

In his essay entitled "Gallio, or the Tyranny of Science" Sullivan says "Moral and æsthetic values are as much a part of the real universe as anything else. The reason why science does not find it necessary to mention them is not because they are not there, but because science is a game, played according to certain rules, and those rules have excluded values from the outset."

It is one of the merits of the "game" doctrine of science that it lends itself almost perfectly to a description of the abstractive method, the very heart of scientific strategy. To illustrate the abstractive method of science, consider the technical term "efficiency." Mechanical efficiency is defined as the ratio of the useful work accomplished by a machine to the total effort expended upon it. For example, an eight-hundred-pound elevator carries a two-hundred-pound man. The total effort is proportional to the sum of the two weights, or a thousand pounds. The useful work accomplished is the raising of the two-hundred-pound man. The efficiency is the ratio of two hundred to a thousand or twenty per cent. Now suppose the man's errand were merely to carry upstairs a piece of paper weighing, say, an ounce. The efficiency of the process is then the ratio of an ounce to a thousand pounds, one part in sixteen thousand, or a disappearingly small fraction of one per cent.

Suppose that the paper were a telegram that changed the whole course of the life of the individual to whom it was delivered. Is the efficiency of the elevator episode still the same small fraction of one per cent? It is. Or, to carry the same theme to its natural conclusion, suppose the man to be delivering a verbal message which, of course, weighs nothing at all. Is the efficiency of the process zero, regardless of the major consequences that might follow the delivery of the message? There is nothing in the definition of efficiency that provides for an estimate of the *value* of the load carried by the elevator. The only thing that counts is its weight. Is the scientist so stupid therefore as to insist that the *real significance* of the

elevator trip is to be expressed by a ridiculously small fraction of one per cent or even zero? Not at all. The answer to the paradox is simply that physics has ruled out all consideration of significances in the definition of efficiency. The only features of the elevator trip in which the physicist can be expected to take a professional interest are the measurable ones. He does not deny the value of the message on the paper, but that he cannot measure. It is outside of the class of phenomena that he is willing to study in his science.

Perhaps more illustrative of the abstractive method of science is the definition of the very fundamental concept called work. According to the elementary definition of work as force times distance, the executive and the scholar are the world's greatest loafers. The product of any forces that they may exert by accompanying distances through which they move, bears no relation whatever to the effectiveness of their intellectual efforts. In fact, Benedict of the Carnegie Institution carried out last year the first reliable measurement of the physical work involved in mental labor. His conclusion was that it was substantially zero. The maid who dusts Einstein's desk, the janitor who sweeps Roosevelt's office, are each doing measurable work at a rate more than twenty times as great as that which their principals reach at moments of deepest concentration.

This does not imply any lack of value in the labors of Einstein or Roosevelt. It simply illustrates the folly of trying to apply scientific concepts to regions which the sciences have themselves excluded from their domain.

There is in physics an interesting division of natural events into reversible and irreversible processes. Compressing a spring or lifting a weight, or performing any other act, which when reversed can be made to yield back the energy expended, are called reversible processes. Work done in this way is termed useful work. On the other hand, energy expended in sliding a box across the floor is irretrievably lost, dissipated into heat through friction. Such a process is of course irreversible and is termed non-useful work. It will be evident that the adjectives "useful" and "non-useful," when used in this connection, are really technical terms which are not to be identified with the broader non-technical uses of the same words. But suppose now, that a physicist should forget those self-imposed limitations on his terminology, and though he willingly paid a red-cap ten cents for carrying his suitcase upstairs because the act involves useful work, should

refuse to pay him for carrying it from one place to another at the same level, on the contention that the work in the latter instance had been non-useful. The physicist would merely have made his science ridiculous because he had lost sight of the very limitations which he had himself placed upon it at the outset. He would be in much the same position as a golfer who had become so enamored of the putter as a useful instrument on the golf course that he insisted on using it to putt sugar-lumps into his coffee.

The fact is that in pursuit of the abstractive strategy of science, men of science often objectify their concepts into forms which bear little relation to the commonalities of the workaday world. That can be justified by the fact that armed with those concepts they can frequently accomplish things that are beyond the capacity of the workaday world. But it would be a sad mistake for them to identify their abstracted technical terminology with the similarly-named but often utterly different concepts of everyday life. Yet one may wonder whether it is not precisely this error into which some biologists, in their insistence that all life processes are exclusively physico-chemical, are precipitating themselves. They forget their own primary self-imposed limitations. Life is physico-chemical only in the sense in which the same can be said of a fire in the grate. To denominate the fire as *exclusively* physico-chemical is to lose sight of the possibility of alternative explanations such as the purpose of heating the room, which may in fact possess a much greater degree of validity for the non-technical mind. And to denominate life as exclusively physico-chemical is simply to ignore most of the processes which are really characteristic of life.

Similarly, those men of science who, on the basis of their study of psychology, assert that man is merely a bundle of reflexes, that humanity can exercise no choice and possess no freedom of action, and who even assert that it is possible to account for all human behavior without taking the agency of mind into account, are simply doing the same thing that a physicist would be doing if he should refuse to pay a red-cap because his work was non-useful, or that a golfer would do in using his putter at the dining table, or that a chemist would do in asserting that in accounting for a fire on the basis of chemistry he had ruled out the possibility of its having been built for the purpose of warming the room. Such psychologists are applying to the workaday world technical terms which are simply inapplicable by virtue of the very limitations which their science itself has estab-

lished. Choice, freedom of action, mind, has each its own meaning in the psychological laboratory, and each a different meaning outside of the laboratory. It may be doubted whether competent psychologists are ever guilty of the muddy thinking that would be involved in confusing these two meanings. But they *do* frequently neglect to caution their readers and their audiences against the possibility of such confusion, with the result that their science is frequently misrepresented.

The extent to which *physical* scientists take their own abstractions from "reality" with a liberal sprinkling of salt seems not to be generally recognized, nor its implications realized. For example, hydrodynamics is the mathematical theory of the behavior of weightless and frictionless fluids which have the property of being created out of nothingness in unlimited quantities at points technically called sources and shrinking into nothingness at points called sinks. This curious set of concepts violates some of the fundamental doctrines of physical science itself, yet the physicist does not become excited about that. He is playing a game with these concepts much as one might play a game with a jig-saw puzzle. The physicist is not particularly concerned with the obvious absurdities of his pursuit, nor is he particularly elated when the hydraulic or the aeronautical engineer finds some new application of the subject of hydrodynamics as he occasionally does.

Again, the game of paralleling the old wave-theory of light by alternative "explanations" on the quantum theory has proven to be a very absorbing one. Some physicists have played the wave game and some the quantum game, but more have played both. Until quite recently it was common for the same teacher to account for the behavior of light on the basis of its wave properties in one course, and on the basis of its quantum or 'flying particle' properties in another course. As one academic wag put it, "Light is wave-motion on Mondays, Wednesdays and Fridays and is a stream of bullets on Tuesdays, Thursdays and Saturdays."

Comment has already been made on the arbitrary, even artificial nature of the physicist's concept of work. The same curious paradox is found in the physicist's definition of intensity of sound. According to this concept a sound which according to the physicist's measurement is thousands of times as intense as another, may be actually less loud, judged by the sensation produced in the normal ear. Again, the physicist regularly deals with electric and magnetic lines of force which he would be the first to insist are

merely convenient fictions, and one of his favorite pursuits is measuring the lengths of waves of an ether whose very existence is one of the perennial questions of physics. All these are examples of the central scientific strategy of abstractions from total experience. The physicist abstracts certain measurable aspects from the mass of material furnished by his senses and proceeds to apply his technique of measurement, largely without attention to any relation that his work may bear to the total situation out of which he has abstracted his material. Belonging to one of the oldest sciences he has had time to realize that these abstractions are often silly if he allows himself to forget that he is merely playing a game. But the newer sciences, like inexperienced players, often take their games too seriously, forgetting that in the interests of proper human perspectives they must drop many of their scientific concepts when they leave the laboratory. Joseph Needham, an English biologist, has phrased it well in the statement "In science we have to act as if mechanism were true, even though we may really believe it is not;" and again "Materialism . . . is the only philosophy upon which science can get to work; methodologically it is essential. And if I do not believe in it for a moment as a man, I recognize its fundamental importance as an experimentalist."

Two more aspects of this "game" doctrine of science may receive brief consideration. For the first, since it is one of the corollaries of this doctrine that no cognizance may be taken of the relation between the objectives of science and the objectives of real life, the two sets of objective will naturally occasionally become incompatible. Examples outside of the field of science are easy to find. The game played by the industrialist has involved economic fallacies that have nearly wrecked his own playground. It is one of the objects of the New Deal, however imperfectly realized, to change the rules of that game for the better. The legal game has been played in ways so damaging to even its own interests that the legal profession itself is insisting that the rules be changed. The medical game has blocked the very progress of medicine at a number of outstanding points. In all these instances a broader perspective has become mandatory not only for the welfare of society, but for the preservation of the integrity of the professions themselves.

It is a fair question whether the scientific profession is, or even should be, immune from this trend. One does not need to be deeply impressed with diatribes against a soulless science which is alleged to be destroying the

flower of culture, nor even with such assertions as the recent one of Secretary Wallace that the sciences are on the high road to self-destruction. But the game theory points definitely in that direction and suggests a candid self-examination. Other types of intellectual enterprise have been wiped, out by popular reaction, even though society committed intellectual suicide for a period of centuries in the process.

Nor is the socialization or "gleichschaltung" of science a necessary or desirable alternative. Rather than accept that, it would be better for science to accept extinction as the penalty for remaining stiff-necked. The outcome of such processes is seen in the fact that economists discover in Italian official statistics conclusive evidence of falsification at the source, in the presence of frequent laudatory comments about Lenin in the middle of Russian reports on investigations in physics, inserted as the price of the privilege of publication, and in the tragedy of the German scholars who have prostituted their professions as the price of not being "displaced." And yet, after all the objections that a conservative profession can make to broadening its horizons have been made, the question may still be asked whether the sciences are wise in choosing the objectives of their game without reference to social values.

But there is a final implication of the "game" theory which seems even more significant than any of the foregoing. It is sometimes said that the one point of contact of science with the world of values is at the point of truth; that the point of scientific departure is the search for truth and that every other consideration must give way before this one. While there is reason to think that this is somewhat of an oversimplification, and that science can be seen to have other points of contact with the world of values, than in its search for truth, it is rather the other side of the picture that is stressed here. Identifying science with the search for truth, so far from saying too little, says too much. It is not truth in its more general manifestations that science seeks, but only particular aspects of truth, and that only in particular ways.

It is a part of the doctrine of current science to confine attention to mechanical causation. Having determined in advance that we shall consider only that type of sequence of events, there is no great significance in the fact that our scientific conclusions embody no other factor. Francis Bacon in his *Novum Organum* tells the story of a man brought into a temple filled with portraits of those who had paid their vows before going to sea

and had not been drowned. Upon being asked to acknowledge the power of the gods he replied, "Aye, but where are they painted who were drowned after their vows?" Bacon supplements the story by observing "Men mark when they hit and never mark when they miss."

Bear in mind that the search for truth is also an objective of our system of jurisprudence. And yet, to our way of thinking, the legalistic approach to truth is capable of eliciting only a distorted picture of a small portion of the truth. Our interpretation of the blindfold on the eyes of justice would not be confined to its symbolism of the avoidance of partisanship and wishful thinking. Yet the almost worshipful faith of some lawyers in our system of law as an instrument for the discovery of truth is very impressive. The writer recently heard a very successful lawyer, with fifty years of experience, remark on a case that had been settled out of court, expressing doubt as to the truth of the facts upon which the contending parties had agreed. He regretted that the case had not been submitted to the operation of what he called "the judicial mind," feeling that he could then have regarded the findings with greater confidence. Yet if there is a judicial mind, to possess any value as a method of establishing truth even in law, it must be something larger than a skill in juggling the dialectic subtleties of courtroom procedure; something possessed by many not legally trained.

The legal profession has no monopoly on intellectual provincialism. All that is necessary is to listen to a man of science refer to "the scientific method." He will almost certainly use much the same tone of voice as the foregoing attorney used when he said "the judicial mind."

Now the scientific method, if there is such a thing, must be something larger than laboratory skill and a technical vocabulary if it is to possess any value even in the sciences. It must be something possessed by many not scientifically trained. Hence, to such a degree as one has confidence in the validity of the scientific method, he is bound to respect the conclusions of properly qualified workers on other aspects of the phenomena with which the sciences deal. It is no less an obligation and a privilege of those workers to cultivate an intelligent interest in the scientific method and candidly to consider the lessons which it drives home.

In the words ascribed by Goethe to the Devil:

> Do but despise reason and science,
> The highest of man's powers,
> And thou art mine for sure!