Presumably readers from the same field of science would recognize the intended meaning instantly, but the main point is that those in other fields might have to study.

We feel that we should make more effort to eliminate abbreviations from the texts of "Articles" and "Reports," particularly abbreviations that appear only occasionally. Of course, it is necessary to use them in equations and reaction schemes, and perhaps in the texts of articles when a long chemical name is used again and again.

However, as has been suggested before (*1*), judicious use of pronouns, and care on the part of authors, might reduce the number of different abbreviations used in any one article, as well as the total number of all abbreviations. The saving of space obtained by use of abbreviations is hardly worth the restriction of understanding, and only a few of these abbreviations can become any more than what they are, laboratory and notebook shorthand.

Reference

1. "Use and abuse of English in science," *Science* **123**, 720 (1956). This article was an excerpt from the leading article in *Nature* for 5 Nov. 1955.

Scientific Approach to Ethics

Anatol Rapoport

Opinions on the relation of science to ethics are usually strong ones and are often arrived at not so much by investigation of such relations as through conviction about what these relations ought to be. These opinions tend to divide those concerned with such matters into two camps. In one, the feeling runs high that science is ethically neutral, that it is concerned with what is and not with what ought to be. This view is usually stated categorically and enjoys a high degree of agreement among its adherents. No such unanimity prevails in the other camp, where it is felt that connections do exist between science and ethics. This is not surprising. Those who deny that such connections exist can readily agree, for once something is declared to be nonexistent there is nothing further to be said about it. But if something is said to exist, we wish to say more about it, and the more one says, the more controversial one's opinions are likely to be.

To preserve the lines of communication in such a discussion, it may help to agree, first of all, on what is meant by an ethics or an ethical system. It seems to me that in every ethics there is involved a set of choices and a set of rules governing the making of the choices, with a proviso, however, that these rules are not entirely instrumental in the pursuit of an explicit, unambiguously defined goal. This last restriction serves to differentiate an ethics from a strategy. For in a strategy, too, one has a set of choices and a set of rules for making choices, but the goal is explicit and unambiguous. Thus, the principles governing the choices of plays in a game of bridge are principles of strategy. But there is also an ethics which excludes acts defined as cheating. The "ethics" of bridge can also be said to have a goal—for example, the assurance that the players will continue to respect one another and will continue to play—but this goal is certainly not nearly so explicit and unambiguous as the goal of winning.

In this sense, we may speak of various professional ethics as distinguished from the "strategy" or the technique of the profession. There is an ethics in the legal and the medical professions. There is an ethics in the business community, in the military, and in the underworld.

Often strategy and ethics are not easily distinguishable. For example, the saying "honesty is the best policy" indicates that one of the ethical principles of business is seen to be also a strategic principle. On the other hand, ethics and strategy may conflict. This is dramatically shown in the frequent violations of the so-called "rules of warfare."

We note, next, that scientific practice also has an ethics, and, characteristically, that the ethical principles of scientific practice are intimately intertwined with strategic principles. The scientist is guided by certain rules of evidence in his definition of what is true. Furthermore, the scientist binds himself to hold and profess views (at least in regard to matters subject to scientific investigation) which he must acknowledge to be true according to those rules of evidence. Since these rules are remarkably consistent and remarkably easy to apply (compared with other rules that govern ethical decisions), the ideal of universal agreement on matters within the jurisdiction of science seems attainable in practice. Therefore, the scientist (if he is consistent) is bound to strive for universal agreement among scientists on these matters. Moreover, the agreement is to be attained neither by coercion nor by force of personal appeal but by examination of evidence alone. In other words, if "conversion" of an opponent to one's point of view is a desideratum (such desiderata are really not included in the ethics of scientific practice but are nevertheless carried over into scientific practice from other areas), the satisfaction of such a conversion in scientific matters is complete only if the change of view comes independently of any pressure other than the weight of evidence.

Thus, even our characteristically human tendency of wishing that others thought and acted as we do becomes modified in scientific practice, because coercive measures toward those ends are pointless. Unless the conversion is made by force of evidence, it is an empty victory to achieve it.

These, then, are the ethical principles inherent in scientific practice: the conviction that there exists objective truth; that there exist rules of evidence for discovering it; that, on the basis of this objective truth, unanimity is possible and desirable; and that unanimity must be achieved by independent arrivals at convictions—that is, by examination of evidence, not through coercion, personal argument, or appeal to authority.

I submit that here is a respectable chunk of an ethical system. The question before us is whether this is, characteristically, a "professional" ethical system on a par with other such systems, like those that govern the medical, legal, military, and criminal professions, or whether there is something unique about the ethics of scientific practice which makes it a particularly suitable basis for a more general system.

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Before we attempt to answer this question, let us note that many professional ethical systems tend to become more than codes of conduct governing restricted professional groups. For one thing, a given culture or subculture may be ruled or dominated by some professional group, with the result that the code of that group becomes a model for an ethical system in that culture. Rather vivid examples come to mind in the case of warlike cultures and predominantly business cultures. Indeed, it appears that the ethical system prevailing in the United States is predominantly a reflection of the code of conduct prescribed for its members by the business community.

But if this be the case—namely, that codes of professional conduct tend to become ethical systems in cultures dominated by the respective professions—cannot one argue that the generalization of the ethics of scientific practice to a general code of conduct, should it occur, would be merely a case of such domination, no different in principle from analogous domination by some other professional group, such as business, bureaucracy, or the military?

Here we come to the fundamental differences of opinion among those who hold that there exists a connection between science and ethics. There are those who hold the view that the code of conduct of the professional scientist does have ethical implications but that such "scientific" ethics is confined to the behavior of the scientist *qua* scientist and should not influence his behavior in his other roles. There are those who maintain that ethics derived from scientific behavior may, indeed, become the ethical basis of conduct of a whole culture but that this basis is, in principle, no different from other possible bases. And there is the extreme view (to which I subscribe) that the ethical system derived from scientific behavior is qualitatively different from other ethical systems—is, indeed, a "superior" ethical system in a sense which I shall presently define.

This "superiority" of scientific ethics is extremely difficult to defend, because superiority can be established only on the basis of criteria, and whatever criteria one chooses are vulnerable to the charge of being selected in order to prove the superiority which is claimed. Thus it was easy enough for Galton to claim superiority of Englishmen over African Negroes—he set up the criteria of comparison. It is equally easy for a Brahman to prove the superiority of Hindu culture over the European, and so on. Obviously, such ethnocentric traps must be avoided. We should, however, mention in passing that the very idea that one may be caught in the trap of one's own provincialism can be entertained only from the vantage point of the scientific outlook; only this outlook allows an objective comparison of several systems. Such comparison is possible only by way of analysis, and analysis is, by definition, the core of scientific inquiry. Therein lies the qualitative difference between the scientific outlook and others. The scientific outlook is the only one capable of self-examination; it is the only one that raises questions concerning its own assertions and methods of inquiry; the only one that is able to uncover provincial biases which govern our convictions and thus at least give us the opportunity to avoid such biases.

Science, like all other systems of thought, seeks answers to questions which men hold to be of importance. But whereas, in other outlooks, answers are accepted that harmonize with particular world-views peculiar to different cultural complexes, science seeks answers which are reducible to *everyone's* experience. These cannot be answers based on esoteric or mystic experience, because such experience can be common to, at most, a few. These cannot be answers based on unquestioned authority, because such authority remains unquestioned only to the extent that experiences which could lead to questioning are excluded. These cannot be answers derived from narrowly limited experience, because science puts no limits on experience. In short, the irreducible answers to scientific questions are answers linked to those irreducible experiences which can, potentially, be shared by all mankind. The situation is most marked in the physical sciences, whose results are sometimes held to be trivial by humanists, mystics, philosophers, and others, because the assertions of these sciences are about nothing but pointer readings and so do not really touch matters of profound concern to man. Trivial or not, pointer readings are unquestionably matters of universal agreement. The concepts "larger than," "later than," "between," or "three" are the same for the Norwegian and the Hottentot. There may be other bases of universal agreement, on elementary principles of kindness, beauty, or the desirability of survival, but none of these supposes common denominators of human values that are completely unambiguous bases of communication or of human communality. For the scientist, the act of communication (the utilization of one nervous system by another without detriment to either) is the basic ethical act. And it is only on the most trivial level (the level of "extensional facts" or pointer readings) that we may be sure of perfect communication. Science, then, is the only human activity which taps the really universal communality of human experience at its roots. The remarkable thing is that the tremendous edifice of knowledge which is being created on these foundations is shared by all who participate in its creation, to the same complete degree of communality.

No matter how "Westernized" a non-Westerner may become, it is doubtful to what extent he accepts Western "values" and rejects his own. If he rejects these completely, there is always the question of what conflicts may accompany the transformation. But the acceptance of the scientific outlook in the area of actual investigation seems to be complete, regardless of the cultural background, and there seems to be little evidence of conflict once the vantage point of scientific outlook is reached. In other words, the conversion to the scientific outlook is almost universally irreversible. It is possible for someone who believes in a magical basis of a phenomenon to reject this belief in favor of a scientific explanation, but the reverse change of view hardly ever occurs. Nor can it be argued that such unidirectional conversions result from domination by the bearer of the scientific outlook—namely, Western civilization. If that were the case, certainly conversion to Christianity (which has been energetically pursued) would have been much more universal than conversion to the scientific outlook. Not only is this not the case, but, even in the struggle within Western civilization between the religious and the scientific views on the nature of the physical and biological world, science has been unequivocally victorious.

Contrary to prevailing opinion, I should like to defend the view that science is not, like industrial capitalism, Christianity, or racism, simply another culture-bound product of Western civilization, although doubtless science has been given its greatest impetus by certain developments peculiar to Western culture. Typical of ordinary components of culture is their functional interrelation. Even if we discount the extreme position of functionalist anthropology, which views every culture as a perfectly harmonious whole, still it must be admitted that, by and large, the trend toward harmony persists. Beliefs, practices, and institutions tend to be accepted or rejected (unless, of course, they are imposed by force) according to whether they tend to support or to disrupt the cultural complex and its supporting world-view.

Science seems to be a notable exception. Science has had a disruptive influence on the European social order: first, it destroyed feudalism and its support, the spiritual hegemony of the established Church; now it is continuing to disrupt it by discrediting the convictions necessary for the maintenance of colonialism,

of nationalism, of *laissez-faire* capitalism, and of the authoritarian family structure. It is true that, for 300 years, science made possible the domination of the world by Western civilization. But now the trend is reversed, and it is again science which is making this domination an anachronism.

The ethics of Western culture—that is, the conventionally accepted criteria of right and wrong—are as vulnerable to the encroachment of the scientific outlook as any other ethical system. This is why it is a mistake to list science along with the other provincialisms of the West. Typically, a Westerner believes, or has believed until his beliefs were challenged by science, that Westerners should dominate the non-Westerners; that it is in the interest of national states to be more powerful than their neighbors; that private property is forever sacrosanct; that a man is not properly dressed unless he wears a noose around his neck; that the character of a child can be improved by beatings. Much of the so-called "moral crisis" in the Western world is traceable to the undermining of some of the most tenaciously held beliefs by the inroads of scientific views.

In view of this disruptive influence of science (disruptive in the sense of undermining holistic cultural outlooks), how are we to account for the accelerating spread of the scientific outlook? An obvious answer points to the bait of technology. Science makes technology; technology is power; men seek power and, therefore, tolerate science. I would like to argue, however, that there is another reason—namely, the ethical appeal of the scientific outlook—which marks science as not simply another of the "white man's ways" but as something *sui generis*.

There seems to be something universally satisfying about the scientific view, at least as it affects man's outlook on his environment. Once the vantage point of this view is attained, other views seem impoverished, provincial, naive. There is no going back.

I am aware that this claim had previously been made for different religions in their expansionist phase. There may have been some justification for those claims in the sense that the acceptance of those religions (particularly Christianity, Buddhism, Islam) carried with it the exhilarating feeling of revelation. Yet there turned out to be several of these so-called "great religions," and, in spite of the fact that they seem to have similar ethical cores, their theologies are "incompatible" or, rather, have no basis of comparison, so that if one adheres to a great religion, one is usually either a Buddhist or a Moslem or a Jew or a Christian, or whatever, for no explainable reason, except the accident of first contacts. Science alone has succeeded in constructing a really unified philosophy, and this is because scientific philosophy is not just another philosophy—that is, another poetically harmonious system of metaphors. Scientific philosophy makes possible the examination and comparison of *philosophies,* whether as systems of logical constructs or, more characteristically, as instances of human behavior.

The bid of scientific ethics for universal acceptance rests on the claim of science to be the first instance of a universal point of view about man's environment and, moreover, a point of view not imposed by coercion or even by power of persuasion or dramatic, personal example but by its inherent, universal appeal to universal human experience, through being rooted in reliable knowledge.

Ethics, however, is not complete unless it includes man's outlook on himself as well as on his environment. The extension from scientific outlook to scientific ethics is simply the extension of the subject matter of scientific investigation from man's environment to man himself. It is, therefore, with the consequences of this extension that we are concerned.

At this point it is proper to review the divergences in the opinions of those who hold that there is a connection between science and ethics, aside from the difference of opinion on the relevance of scientific professional ethics to general ethics. Some confine the connection to the possibility of studying various existing ethical systems by the objective methods of science. Others go further and say that ethical systems, typically, contain not only ends but also convictions or tacit assumptions concerning the most effective means to reach those ends. Admitting that ends cannot be chosen by scientific inquiry, they maintain that scientific methods are applicable to the search for effective means. For example, the elimination of conflict within a society may be an end in two different ethical systems. In one, the end may be pursued by strict apportionment of status, with attached privileges and responsibilities; in another, by an approach to an egalitarian ideal. Some would differentiate between the end and the means and maintain that the former is chosen arbitrarily, while the latter could be prescribed by a scientific investigation which could, presumably, determine the efficacy of each course of action.

Both of these views, which attribute to science only a limited role in relation to ethics, assume the possibility of sharp division—in one case between an inquiry into what *is* and a conviction about what ought to be; in the other, between means pursued and goals desired.

The third view—again an extreme one, which I am defending here—is that not only is science related to ethics but that science is becoming a determinant of ethics; that is, the ethics of science must become *the* ethics of humanity. I hold this view because I do not believe that one can separate either knowledge of what is from desires of what ought to be, or means from ends. To be sure, such separation can appear temporarily to be effective. The anthropologist can, for some time, describe and attain insight into a variety of ethical systems, at the same time holding on to his own. The physicist can, for a time, use scientifically ethical means (that is, pursuit of objective truth) in the service of scientifically unethical goals (for example, imposition of coercion by war). But these positions are unstable and are doomed to extinction. It is impossible, in the long run, to hold provincial views while pursuing knowledge. Comparative ethics or the dispassionate examination of means to attain arbitrarily chosen goals are not innocent pursuits. On the contrary, they make a serious impact on the investigator and on the society which he serves. They force the firing of questions aimed at the very foundations of existing ethical systems, foundations which can remain intact only if no questions are fired at them. I know of no existing culture or ethical system (as these are conventionally understood) which does not, to some degree at least, rest on a delusion. This is in no way surprising in view of the fact that every system of knowledge, including scientific knowledge, rests ultimately on some fictions. Scientific knowledge, however, is by definition that knowledge which can weather the shattering of its fictions. It is in this sense that scientific knowledge is unique. Alone among all cognitive systems, the scientific cognitive system does not shrink from the shattering of its own foundations, and when this happens, it becomes, paradoxically, more organized rather than disorganized and demoralized.

It is, therefore, possible to hope that the same "ultrastability" will characterize the ethical system derived from scientific practice. Certainly, this ethical system, like others, must rest on fictions, but the fictions are not sacrosanct. They can be shattered without a resulting disorganization of the system.

What are the elements of scientific ethics? Little can be said about them, because this ethic has not yet permeated human communities sufficiently deeply and so is not a result of actua practice. Certainly, the pursuit of trutl "wherever it may lead" is a paramoun goal. It is tempting to suppose that al other ethical principles will be derive tives of this goal. It is tempting to sup

pose that a great many of these principles will coincide with those of the ethical systems of the great religions, dignity and brotherhood of man, but only as derivatives, the condition of dignity and brotherhood being most conducive to the pursuit of truth. The hope is that those activities of man which are condemned in most ethical systems but rationalized on other than ethical grounds will disappear, because their rationalizations will become untenable in the light of scientific inquiry. The same applies to quasi-ethical systems such as totalitarian ideologies and the highly specialized codes of conduct of small isolated communities. All these rest either on coercion or on exclusion of experience. Both coercion and exclusion of experience can be maintained, in the long run, only by the maintenance of sacrosanct fictions. Therefore, all coercive and provincial ethical systems depend critically on the fictions which support them. They collapse when the fictions are shattered, and their fictions are easily shattered once even the primitive elements of scientific inquiry are directed against them.

To summarize, it is possible to approach ethics scientifically in a stronger sense than simply by scientifically investigating existing ethical systems or by offering an analysis of the efficacy of means, employed to pursue given ends. The mixing of science and ethics guarantees that science will play far more than a descriptive or an instrumental role. This is so because science brings with it its own (for the time being, only "professional") ethics. This ethics, however, can be generalized to a complete ethical system which has a viability far greater than the existing ones. This greater viability is the result of the same properties that are possessed by scientific knowledge. Although this knowledge has always rested on fictions, it did not deteriorate when the fictional foundations were repeatedly shattered by reorganizations of knowledge but, on the contrary, gained from each such crisis. There is no sharp distinction between scientific outlook and scientific ethics. Both eschew authority—that is, coercion in any form —and probably for this reason are irresistibly attractive as means of liberating man from the bonds which, in his ignorance, fear, and ethnocentrism, he has imposed on himself.

Classifying and Indexing for the Special Library

Saul Herner and Robert S. Meyer

Classification is one of the most universally applied and least appreciated methods by which scientists and librarians organize and obtain information. Classification pervades practically every selection process in human experience, whether the thing being selected is an item in a supermarket or a book in a library. The primary factors that dictate the way that things are classified are physical necessity, economic necessity, and intellectual habit.

In a supermarket, the housewife shopping for a vegetable for her family's dinner goes to the vegetable department. Here, she finds an array of vegetables of various shapes, colors, and flavors. The vegetable department is an example of classification based on physical, economic, and intellectual habit factors. The odd shapes and quantities of vegetables, their perishability, and the fact that the housewife thinks of vegetables as a single concept or class of things necessitate their being displayed together or close to one another in the market. One or more of the same three factors furnishes the basis for the existence and location of all other classes of merchandise in the supermarket.

Turning to libraries, we find the same three factors dictating the manner in which books and other publications are arranged on the shelves. For the majority of libraries, the primary factor is the presumed intellectual habit of the library user and the librarian. Books are arranged on the shelves according to subject categories that are a reflection of logical or traditional relationships. Ideally, these relationships will coincide with the subject relationships that exist in the mind of the user.

In addition, there will be an index or catalog with multiple subject entries to direct the user to the part or parts of the collection containing publications on a given subject. The library uses this device to correct for the fact that a book may deal with a number of subjects but can be in only one place at a time. Ideally, the subject headings or entries in the catalog will be in the language of the users and will serve also as a key to the classification. In addition, they will be consistent and mutually exclusive.

Thus, there is a useful artifact, an alphabetical index in the language of the user, superimposed on a physical arrangement of published materials that is a reflection of the user's intellectual habits and associations. This is an ideal situation, in which the seeker of information can choose between going to the index and then to the books or going directly to the books.

Many librarians and documentalists consider it inefficient to go directly to the books without first consulting the card catalog. The logic behind this is that the library card catalog, through its multiple subject entries, can tell the searcher *all* the publications in a library that treat of a given subject, whether in a major or minor way, whereas by going directly to the shelves the searcher is likely to find only those that treat of a subject in a major way, if indeed he finds anything at all. Nevertheless, most specialist-users of the library go directly to the books when they can, and they seem to find this arrangement satisfactory. When they use the card catalog at all, they generally use it to locate items they already know about.

This rather informal approach to the literature and the limited use of the card catalog probably stem from the fact that the professional worker in a field is not likely, except on rare occasions, to want to know everything on a given subject. He is merely looking for something to supplement or help recall what he already knows. Classification favors this approach by laying before the seeker of information a group of related publications whose major content is the subject in which he is interested.

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