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33. The preparation of this manuscript was supported by NIH grant 15191.

The Code of the Scientist and Its Relationship to Ethics

André Cournand

Several decades ago, Paul Valéry, poet and essayist, declared (*1*):

> Never has humanity known so much power and so much confusion, so much worry and so much play, so much knowledge and so much uncertainty. In equal measure does now anguish, now futility, command the hours of our days.

These words were undoubtedly appropriate when Valéry gave pen to them. Yet today they are perhaps even more apposite. Indeed, they seem to apply to three distinct spheres of human action.

In the first place, we live in a time in which the industrialized countries are experiencing unparalleled technological development, in large part the fruit of science. However, the benefits of new technologies are distributed in a grossly unbalanced manner, not only within individual industrialized countries, but also among all the nations of the world. Overcrowding and environmental degradation are already significantly reducing the quality of life in the developed nations and give stark evidence of their inability to confront the problems of the future and its planning. Excess population and famine are on the increase in some regions, while in others there are those who enjoy material goods and leisure as never before. In a word, our inability to regulate the processes of cultural and technological development poses a grave threat to our ability to achieve a decent and humane future.

In the second place, as we all are aware, the trends toward nationalism, and its opposite, multinational industrialization, are growing. Many will agree with me that if a universal world order of some type is not achieved by agreement based upon reason and economic justice, the prospect is that it may be imposed by force.

And third, science is now in a state of siege. Those who in the past have praised its contributions to human understanding and material well-being are now questioning many facets of the scientific enterprise. Some even go so far as to ask whether it does not contain the potential for destroying civilization.

In this article I center my discussion on something which I shall argue is common to each of these problems, namely, the operating and ethical code of the scientist. First, I discuss some aspects of the situation of scientists and the possibilities for preserving the norms of science. Second, I deal with an even broader question: could there be a relationship between the ethical stance of the scientist, *qua* scientist, and the problem of fostering humane socioeconomic development? In turn, these reflections will prepare the way for a brief examination of the possible relationship between science and a unified world-order of some type.

Formulation of an Operational and Ethical Code of the Scientist

Scientists have developed characteristic rules of procedure that help to produce the intended outcome of their activity, which is certified knowledge. These rules also guide the conduct of individual investigators toward each other in their capacity as scientists. In 1942, Robert Merton formulated these rules as the

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general norms of scientific activity (*2*). They were, first, the requirement that the quality of a scientific work should be judged on the basis of its scientific merits or significance alone; this he called "universalism." Second, the requirement that scientific works be judged provisionally and only after the relevant evidence, so far as it can be brought together, is at hand; this he called the "principle of organized scepticism." Third, the prescription that whatever the personal motives of scientists, the advancement of scientific knowledge must be the primary concern in the evaluation of scientific achievements; this he designated the "principle of disinterestedness." And fourth, the requirement that an individual scientist should share the knowledge acquired through his research with the scientific community, which has a right to that knowledge. This principle he called "communism," but "communalism" might be more satisfactory.

Summary. Scientist's norms (principally honesty, objectivity, tolerance, doubt of certitude, and unselfish engagement) are in danger of serious distortion unless broadened to apply to the relations between scientists and nonscientists. Also needing supplementation is an ethic of development appropriate to a fast-changing society and advanced as an approach to the more effective and humane regulation of cultural and technological development. Because of their genetic relationships the code of the scientist and the ethic of development are probably complementary and together may overcome the shortcomings of each taken separately. Taken together, furthermore, they indicate the possibility of a humane world order based on the cooperation of a community of scientists and its public.

Twenty-five years later I attempted to reformulate the norms of science with explicit reference to the conduct of individual scientists. In successive publications I analyzed and discussed the future of the code of the scientist, in collaboration first with Harriet Zuckerman (*3*) and later with Michael Meyer (*4*). In this formulation the norms of scientists are mainly honesty, objectivity, tolerance, doubt of certitude, and unselfish engagement.

Intellectual integrity and objectivity. The first obligation of scientists is intellectual integrity. I take this to mean not merely that scientists must be unremittingly honest in their investigation of the natural world; they must as well avoid the undisciplined introduction of subjective elements into their perceptions. They must prevent their desires and aversions from penetrating their observations of the phenomena that they study and their analyses of these observations. Of course, the observation and analysis of facts in a form certifiable by the appropriate rules entail choices on the part of a scientist. Such choices pertain not only to the selection of problems and hypotheses in relation to which the facts have meaning, but more particularly to the selection of means of presenting data according to their proper importance. The criteria applicable to such choices depend on sensitive discernment and a strict conscience (*5*).

From these obligations of objectivity and honesty flows the obligation to conquer one's vanity and to acknowledge priority of discovery by other scientists when the evidence calls for it.

Tolerance. The norm of tolerance is based partly on the recognition that respect for the creative potentialities of other scientists is closely related to respect for their good faith. They must be seen as engaged in a common enterprise. The scientist should not discard new ideas out of hand, while at the same time not waste time on obvious nonsense. He should be sufficiently receptive to new ideas to see whether they are consistent with established knowledge or furnish links to new and valuable concepts.

Doubt of certitude. The next principle is doubt of certitude; that is, questioning what is asserted authoritatively. I agree with what Michael Polanyi said about the importance of respect for the authority of science (*6*). This does not conflict with my belief that an attitude of readiness to question what is accepted as certain by established authorities in science is one of the *primum movens* in the generation of new knowledge.

Recognition of error. The cruder forms of error can quite easily be avoided by scientists; it is the more subtle forms of error that are more difficult to discern. Yet the recognition, acknowledgment, and admission of error favor progress in understanding.

Unselfish engagement. The fifth norm is unselfish engagement on behalf of the growth of scientific knowledge. The scientist's purpose should be to extend our knowledge and understanding of the universe, and not to secure personal gain or to promote the supremacy of a particular philosophy or ideology.

Communal spirit. Finally, it is incumbent on scientists to appreciate and respect their dependence on the community of scientists. Scientists must recognize that their own work is part of the larger scientific enterprise and that they themselves are linked to their colleagues through submission to its traditions and participation in its ethos, as well as through their common effort to increase and improve the body of certified knowledge.

The other rules of the code help to protect the fabric of the scientific community and in doing so they reinforce themselves.

Threats and Stresses Bearing on Science and Its Code

I believe that the operating code I have defined has been instrumental in making possible the advance of scientific knowledge and the trend toward scientific universalism. But I also believe that these principles should be extended beyond the domain of science. Before I can make this argument, I must comment on what I judge to be the main threats to the scientific enterprise, and on possible remedies.

It is convenient to discuss the stresses on science by reference to the pressures to which they give rise for modifying the code of the scientist. These pressures can be divided into four main categories: (i) failures to observe the code, (ii) the undermining of the concept of objectivity, (iii) the trend toward over-specialization, and (iv) the increasing concern of society about science.

Nonobservance of the norms of the code. Failures of observance of the norms by scientists reveal themselves usually under the form of intolerance, abuse of authority, or nonrecognition of priority. In recent years the principles of integrity and of disinterestedness and selfless engagement in scientific activities have been occasionally infringed by referees and other readers of scientific reports. They have abused their privileges by selectively disseminating the contents prior to formal publication or by using the knowledge gained from the work for their own or their immediate colleagues' advantage. Some of these infringements are known to scientists from their own experience.

Scientists' attachment to the code is under greater stress than it used to be, partly because there is, on the whole,

more emphasis placed upon speed of publication; this, in turn, is partly a result of the much increased number of scientists working on similar or closely related subjects (*7*). The dangers of anticipation are greater, and hence the desire to forestall it. The important point is that violations of the principle of intellectual integrity and objectivity are perhaps more dangerous to the public reputation and hence, to the self-respect of scientists than they were in the past.

The principle of disinterested and selfless engagement has been affronted more than any other norm of the code of the scientist. The utilization by scientists of their expertise for pecuniary gain, the intensification of the scientists' wish for fame, and the consequences of some applications of scientific work, have all raised questions regarding the adequacy of the norms I have discussed in dealing with unforeseen problems and unforeseen temptations. If many scientists were to become businessmen and seek incomes from scientific work substantially in excess of what is regarded as normal professional remuneration, doubts would be raised about the devotion of scientists to the norm of intellectual integrity and objectivity as well as about their disinterestedness. The wish to gain renown, if it overrode the obligations of selflessness, might, on the one side, increase the likelihood of plagiarism, and, on the other, might increase secretiveness (*8*).

An increased desire for publicity and personal recognition, without awaiting them as natural by-products of scientific achievement, is another of the dangers of the new situation of science. This is manifested, for example, by the now frequent practice of distributing the texts of scientific reports to representatives of the press prior to evaluation by scientific peers. It both bespeaks and threatens the loss of cohesion among scientists. The ideal of contributing to the increase in new and fundamental scientific knowledge is sometimes frustrated by the fraudulent conduct of investigators, not only by the action itself but also by its consequences. The public, whose understanding and support of scientific work are important, is not likely to look with favor on reports of the improper conduct of scientists. Scientists themselves are humiliated by such episodes, which, if they were to become widespread, would shake confidence in the good faith and integrity of other scientists (*9*).

Still other strains on the code may arise when a scientist also occupies a different role, for example, that of physician. The physician-investigator may frequently have to reconcile his obligations as a scientist with the requirements of professional authority and responsibility, for example, in determining the boundaries between experimental procedure and treatment. Such a distinction may in the abstract seem artificial if it is agreed that any therapy involves an element of trial and error, but in the particular situation, it is intricately connected with issues of professional accountability and competence (*10*).

Denial of the principle of objectivity. The second source of stress on the code resides in the rejection of objectivity as an indispensable norm of scientists. Traditionally, according to Brush (*11*), scientists are conceived as "rational, open-minded investigators . . . grounded incontrovertibly in the outcome of controlled experiments seeking objectively for the truth." This is consonant with the traditional historiography of science, which sought to record the "process of cumulation" of positive knowledge and which appreciated the importance of objectivity in separating truth from error. However, Brush has emphasized that some contemporary philosophers, historians, psychologists, and sociologists of science assert that the scientist does not adhere to the norm of objectivity. In the words of Israel Scheffler (*12*), critics of the conventional conception of scientists' behavior tend to accept the view that:

> . . . data are manufactured by theory; that rival hypotheses cannot be rationally evaluated . . . ; that scientific change is a product . . . of intuition, persuasion, and conversion; that reality does not constrain the thought of the scientist but is rather itself a projection of that thought. . . .

Brush himself espouses this view. He declares (*11*) that:

> . . . direct experimental tests of hypotheses are often given less weight than the conformity of the hypothesis with a general theoretical superstructure or with more prestigious theories in related branches of science.

He goes on to suggest that at least to the extent that it reflects presumption of the validity of the traditional historiography of science, the insistence on objectivity is intellectually inadequate and may inhibit critical minds. In effect, Brush suggests that objectivity should be abandoned as a standard in the code of the scientist.

However, I do not believe that he has given a serious argument against the ideal of objectivity. That ideal involves not only observing data in a manner which maximizes the probability of avoiding willful distortion by desires and fears; it also requires fine discernment and discretion in the interpretation of data, which I believe is what is involved in the examples he cites in which theory is favored over observation. The abandonment of objectivity as a norm of science would practically dismantle the code of the scientist, and eventually the further growth of science. Objectivity is an essential aspiration of scientists, even though the meaning of the concept in historical, psychological, and philosophical contexts may be imprecise and its relation to science open to alternative interpretations.

An attitude almost diametrically opposed to that of Brush was expressed by the late Jacques Monod in his book *Chance and Necessity* (*13*). Since I have reviewed his argument in detail elsewhere (*4*), here I shall only cite his conclusion (*13*, p. 21):

> Only one value is compatible with science, and this is the value of objectivity, construed as the notion that nature contains no final causes. All other values are incompatible with, or hostile toward, science and should therefore be shunned.

Thus Monod's argument ends by making the code of the scientist contain only one norm, the obligation of objectivity. It might well be possible to subsume under the norm of objectivity the norms of universalism, disinterestedness, and honesty; objectivity does not, however, subsume the obligation to make one's knowledge open to other scientists and to the wider public, or the norm of respect for good faith of one's fellow students, or the more complex norm of organized skepticism, which comprehends respect for the tradition of science and respect for the norm of originality. No doubt Jacques Monod followed these rules as he was pursuing his brilliant career as a scientist—why did he ignore them in his consideration of the norms of science?

Overspecialization. The trend toward progressively more specialized subjects of inquiry, the third category of stresses on the scientist's code, provides to a substantial extent the setting for the abuses and strains we have noted so far. This tendency threatens to break up the larger scientific community. In a sense, specialization infringes on the norm of "universalism" and on the obligation of public disclosure of discovery, that is, communalism. It brings with it a danger of a weakening of the attachment to the tradition of science as an intellectual and moral enterprise.

The growing concern of society about

science. The last of the pressures for change in the code of the scientist which I shall consider has to do with the growing concern of society about science. In recent decades the many-sided interdependence of science and other social institutions has been accompanied by the emergence of new problems. The extraordinary progress of the application of scientific research has focused attention on its moral and social consequences. The concern for the social consequences of scientific research and its applications is placing a strain on the primacy of the disinterested pursuit of knowledge for some scientists. Those scientists who insist on an extreme interpretation of the principles of objectivity and disinterestedness which disregards the social consequences and the moral implications of the application of the results of research might become unintending parties to social effects so undesirable that society would turn against science and scientists.

The code of the scientist was adequate as a guide to scientists during the period when their knowledge had less tangible consequences for society than it has now. Because of science's real successes, in increasing knowledge and understanding nature, and in becoming incorporated into technology in many spheres of life, society has acquired more of a stake in what happens in science than it had previously. The augmented capacity to affect some parts of the order of nature and man brought about the increase in scientific knowledge—particularly in nuclear physics and genetics—has made many scientists themselves believe that they bear the responsibility for the dangers associated with exploitation of new technological potentialities. The code of the scientist does not contain any implicit or explicit prescriptions concerning the ways in which scientists should conduct themselves with respect to the application of scientific knowledge to practical affairs—outside of medicine. The traditional code is insufficient to guide them in the new situation. It is difficult to conceive how the code, without modification, could still be considered to facilitate the operations of science.

Possible Remedies for the Threats and Stresses Bearing upon the Code

Thus, I come to my next topic: In what respects might the code of the scientist be revised to advantage? Before discussing some substantive recommendations for modifying the code of the scientist, let me briefly review certain ambiguities and limitations of the code.

First, the various principles of the code may in given situations reinforce one another, or they may be in competition with one another or with norms external to science.

Second, the norms do not cover all the situations in which scientists are moved to develop moral attitudes; they do not give adequate guidance in such matters as the value of scientific knowledge versus other aspects of life or the application of the knowledge gained by scientific research.

Third, the application of the norms is not always unequivocal, and in some situations depends on the implicit or explicit assignment of "weights" to each of the norms of the code, as well as, where relevant, to norms external to science.

And fourth, because of its informality and ambiguity the code encourages conduct which, in some instances at least, facilitates reconciliation of those whose positions are opposed.

Now, regarding substantive modifications of the code of the scientist, first the code should explicitly take cognizance of the fact that the scientist is an individual who lives in a society which has ends other than the cognitive ends of scientists, and that the cognitive achievements of scientists do not always and necessarily serve these ends. Scientists themselves have multiple allegiances, both within the scientific community and outside it. They need norms to help them find the right balance among these allegiances. Indeed, scientists should follow their traditional code as far as possible in their transactions with the extrascientific realm of society. For example, they should show the same honesty in their dealings with nonscientists as in their dealings with scientists; they should show the same willingness to acknowledge the imperfections of their knowledge to laymen as they do to their fellow scientists. And in their criticism of scientists with whom they disagree on grounds which are a mixture of scientific and political considerations, they should show the same matter-of-fact disinterestedness and willingness to admit the good faith of those with whom they disagree as they ordinarily do within the scientific community. In this connection, it may be reemphasized that conduct in the scientific realm of society in accordance with the principles of the scientist's code is a basis for dialogue and compromise and "pragmatic reconciliation" (*14*) of conflicting views.

It is, finally, desirable that "weighting" or balancing principles should be developed in order to afford guidance with regard to the order of priority with which the tenets of the code are to be applied. This will not be an easy task. It will need experience and reflection and these require time. It will require informed and reasonable public debate, to which scientists and nonscientists must contribute. Intensive case studies, carried on without polemical intention, will help to refine sensibility about these problems.

It would also be most desirable to develop norms that refer to the ethical attitudes linked with the pursuit of science which are touched on inadequately or not at all in traditional formulations of the code, and which concern the scientist's relationship with science in general. The subjects of some of these norms might be the following:

The concept of truth has been subjected to interpretation by each major philosophical tradition, and its meaning probably cannot be defined in a way that would meet with the satisfaction of all. It is difficult, nonetheless, to conceive of a scientist in a way that would free him from the obligation to regard truth-seeking as one of the ethically highest classes of human action.

Closely related is the postulate that nature is cognitively inexhaustible, which carries with it the possibility of knowledge of the hitherto unknown. Hence the obligation arises that scientists, in addition to respecting the original contributions of others in unexplored fields of knowledge, themselves seek originality of discovery.

Finally, another area in which traditional formulations of the code do not provide guidance concerns the obligation of scientists to refrain from actions that would destroy science. This very general statement includes a continuum of possibilities, among which the perils of nuclear, biological, and ecological warfare, and greatly diminished support by the public, are not the least.

This area of application of normative attitudes thus clearly includes the matter of the scientists' social responsibility for their actions, but it goes beyond it, in that it really has to do with the answers to the question, "For whom is science undertaken?" or "What is the proper public of science?"

I shall come back to these questions; first, however, let me turn to my next major theme, the need to regulate inequalities of geopolitical, sociocultural, and technological development. This theme leads to the formulation of an ethic—an ethic in accord with the problems of our time.

Search for an Ethic Influenced by the Impact of Science on Society

As I mentioned earlier, the technological applications of science have been seized with great avidity by industrialized countries, significantly hastening the pace of sociocultural evolution and initiating or reinforcing a host of changes affecting man's consciousness and expectations. More recently, developing countries have placed themselves on a path which, if not identical to that of the developed nations, nevertheless leads toward the goal of enormously amplifying human capability through advanced techniques for harnessing energy. In both industrialized and developing nations, these processes of evolutionary change are one-sided and unbalanced. Despite our more profound knowledge of nature and the greater use of natural resources to which this knowledge has led, the condition of affluence has not been matched by a more just distribution of these resources, either among individuals within a country, or among the nations of the world at large.

In a word, what we are witnessing are phenomena that I prefer to characterize as reflecting blind emergence, pictured as an evolutionary process having strict analogies with processes of biological evolution. From the interaction of the individual interests of men, nations, and new technological capabilities emerges, not a finely tuned system in which the needs of all are met more effectively, but rather a wildly oscillating disequilibrium in which the disparities between those who have and those who have not are broadening while technology remains unchecked. Even as available sources of energy dwindle, populations grow, and rational allocation of food and other resources continues to remain unaccomplishable, the perilous consequences of certain technologies become more menacing—for example, the growing quantities of nuclear wastes, the increasing concentrations of pesticides. Thus, the prospect of worldwide catastrophe has been repeatedly evoked.

The Need for an Ethic Adapted to Our Time

Unchecked, this blind emergence overpowers its antithesis, which, following Pierre Massé, the former Commissioner of Planning in France, I shall refer to as humanized emergence—that is, the attempt to introduce order into chaos, at once defending the individual and organizing the collectivity.

We need to find a means of establishing control over the processes of emergence so as to favor man's survival. A central requirement, it seems to me, is a new and potent ethic, one that might help to shape the development of nations, regions, and ethnic groups in desirable ways—that is, in the direction of greater humanization. The ethic in question should identify the evils of uncontrolled development, a development that does not seek, above all, to eliminate the threats to life and is not guided by the directed application of technology and positive plans for the future. This ethic should also provide a basis for going beyond the competing ideologies and religions of our day.

The "Ethic of Knowledge"—Jacques Monod

Several proposals have been made in recent years for an ethic in which science plays a crucial role. The view put forward by Jacques Monod contends that the value presupposed by science—that of objective knowledge—furnishes the basis for what he terms "the ethic of knowledge." He has characterized this ethic in the following terms (*15*):

> The only goal, the sovereign good, is not, we must admit, the happiness of man, even his temporal power or comfort, not the Socratic "know thyself"—it is objective knowledge itself. This is a rigid and constraining ethic which, if it respects man as the supporter of knowledge, nevertheless defines a value superior to man himself.

Thus, conceived as the basis of a new social order, this ethic of knowledge, by its authoritative character, is strongly reminiscent of Plato's discussion of science in the *Art of Governing the City* and in the *Laws*.

This ethic of knowledge, although admirable in its claim that science in its own right is an ascetic doctrine, is a return to a "scientism" which stands supreme and which is accessible only to qualified scientists. The scientistic technocracy which Monod appears to favor stands apart from liberal and democratic traditions and their associated values of freedom, the readiness to question established power, social self-regulation by virtue of shared values, and the principles of representative institutions and civil liberties, including freedom of thought and of expression and the rule of law—all of which as a citizen he defended during his life. How can one subscribe to an ethic that would equate the value of a man with his share in the stock of scientific knowledge? What abuses might stem from evaluating him solely in accordance with the scientific knowledge he possesses—especially when the knowledge in question is not inevitably productive of improvements in the life of ordinary men and women? Such "scientism" endangers what is valid in the code of the scientist; it is certainly not a remedy for its shortcomings.

The Ethic of Development—Pierre Massé

An alternative to Monod's view has been put forth by Pierre Massé in his call for an ethic of development, that is, an ethic of growth to serve man. In this ethic, objective knowledge, rather than being the supreme good, is subservient to a greater aspiration, namely, man's discovery of a vector of life, the arrow of a shared adventure (*16*). The dominant attitude in this ethic is compromise, harmonization, or conciliation, derived from the thesis that the biological survival of the individual, as of the species, depends upon accommodation between rigidity and plasticity, between the imperious demands of the genes and an adaptability to the impact and pressures of the environment. Pierre Massé extends this idea to human society (*16*):

> In refuting the implacable mechanism of emergence, ruthless and unmerciful to the individual, one would like to add the dimension of justice and love [pp. 87–88]. . . . The dominant trait of the ethic of development is to hold in itself the great hope of our time, that is, an ethic with dual values: the rise of the species, and the blossoming of the individual . . . values sometimes complementary, sometimes in opposition, excluding a unique conception of the sovereign good, and giving to the human relation a conflicting basis difficult to eliminate [p. 12].

The goals sought by this ethic, far from being intellectual games, are those of helping in undertaking the successive steps required for an approach to the solution of the pressing problems of our time:

The promotion of abundance while avoiding its extension into superabundance or overloading of all spheres of human activity.

Creating consciousness of *responsibility* for the less favored nations and individuals and accepting, therefore, "sacrifices on the part of those who attempt to improve the fate of these individuals."

Distribution of the fruits of knowledge in a more equitable fashion, both with regard to health and to culture.

In seeking solutions to these problems, Massé suggests that we remember that there has been and can be no endur-

ing society without a common system of imperatives. If it is feared that the type of society toward which we seem to be headed does not defend the individual, our choice must give priority to that defense, as was suggested by Jean Hamburger in his book, *The Power and the Frailty* (*17*):

> The imperatives required for the survival of the collectivity of men must be reduced to the indispensable minimum, a minimum inviolable regardless of the sacrifices imposed on the individual.

To conclude, with Pierre Massé (*16*, pp. 121–123):

> The first exigencies of those who uphold such an ethic are: to defend freedom, to will justice, to respect all men. These exigencies characterize development, since there is no emergence without freedom, no humanization without justice, no fraternity without respect.

To them must be added a sense of terrestrial solidarity, the modern form of honor.

Justification of the Extension of the Code to an Ethic of Development

The code of the scientist—source of conciliation. Do these proposals help us to answer the question: How can the code of the scientist be modified to enable science to go on and contribute to resolution of the problems I have mentioned? The code, by facilitating the day-to-day work of the scientist and by making possible dialogue between those who are in disagreement, has been intimately and fruitfully linked to the growth of science. How can it be extended to a new situation without renouncing what is essential to it?

We have objected to the "ethic of knowledge" on the ground that the social and political values it appears to foster are likely to prove inimical to the liberal and democratic traditions that we prefer to uphold. I believe then, that the code of the scientist, which favors dialogue, harmonization of conflicting ideas, and conciliation of opposite goals, should be linked to the ethic of development, which supports this democratic tradition.

Generosity in the service of man as a norm of the code. There are at least two grounds for these claims, the ground of utility and that of intrinsic value. More than a decade ago Father Dominique Dubarle, a physicist, historian, and philosopher of science, set forth part of an argument for both positions (*18*). Descartes, according to him, in dealing with the question of the proper public of science in the sixth part of his *Discours de la Méthode* (1637), affirmed the obligation of men "to procure, as much as in us lies, the general good of all mankind" (*18*, p. 410). For scientists, this meant disseminating and sharing the results of their research with the entire community. Through "humane generosity," scientists should conceive of "science as a human achievement of immediate concern to all humanity" (*18*, p. 411). This recalls a declaration of Francis Bacon in *Valerius Terminus*, a collection of fragments written in 1603–1604 and discovered 130 years later among the papers of the Earl of Oxford (*19*):

> God has given Man the gift of thought, the ability to explore all knowledge, providing he uses it for the benefit and relief of the state and society of man; for otherwise all manner of knowledge becometh malign and serpentine.

There is a close relationship between the attitudes of both of these founders of science and the norms of universalism and intellectual honesty and objectivity; the norm of universalism is implicit in the application of Descartes' principle within the community of scientists, and, in this context, the norms of intellectual honesty and objectivity express standards for those actions of individuals which represent an indispensable condition for the attainment of universalism.

Science and a new unified world. Although a unitary religious outlook and government appear essentially impossible for the whole of mankind, the "universal establishment of a scientific community" and its link with "a public affirming its values and sharing its outlook" (*18*, p. 414), as proposed by Robert Mallet, promotor of The Universal Movement for Scientific Responsibility, "remain . . . a definite possibility within the framework of human history." Indeed, Father Dubarle claimed that, interpreted very broadly, the "practice of science tends to become *one and the same thing as social action*" (*18*, p. 424), as distinguishable from political activity, and that there could be, and probably ought to be, a worldwide scientific community. The reason this community should come into being is to maintain the system of scientific activity by averting the particularistic applications of science to warfare and the inequality among the countries of the world in access to the results of scientific research—an inequality which has led to "heedless and uninhibited scientific advances by . . . particularly powerful nations without sufficient regard for the need to equalize the situation in different parts of the world" (*18*, p. 425). The "need to equalize the situation" seemingly refers to considerations similar to those which prompted Massé to propose an "ethic of development."

Another line of argument which appears to be germane to the problem of the relationship between scientific norms and democratic values has recently been developed by Joseph Ben-David, in the course of examining the process whereby the profession of science came to acquire the power to regulate access to the scientific occupations (*20*).

Ben-David's argument suggests that those values which the ethic of development seeks to foster are those which were incipiently developing in 17th-century England under the influence of the Puritan Revolution, and were closely connected with the flowering science there. [A similar view had previously been put forth in Merton's doctoral thesis (*21*).] However, even though this might be true, it would probably be unwarranted to argue that those social and political conditions which favored the rise of science in 17th-century England would necessarily do so in the more complex conditions of today.

The considerations put forward by Dubarle and Ben-David bring me part of the way to my goal, that is, to justify the linking of the norms of science, as reflected in its operating code, with an ethic that seeks to foster the values of egalitarianism, political pluralism, and fraternalism in sociopolitical development. If one postulates that humane generosity should become part of the wider normative system of scientists, the argument that they should favor the development of a worldwide scientific community and should concern themselves with the problem of equalizing development is persuasive, although not entirely compelling.

The arguments of Dubarle and Ben-David seem relevant to the situation of science and society today, inasmuch as they support the notion of at least a certain congruence between scientific norms and some of the political values expressed in the liberal and democratic traditions. It seems especially appropriate to suggest, as Dubarle does implicitly, that the norm of universalism as stated at the dawn of modern science by Descartes had, in addition to its cognitive reference, an ethical component signified by humane generosity.

Now, when the extraordinary development of science and society has given rise to so many riches, and at the same time poses pressing questions regarding the future of both science and society, this quality of humane generosity deserves emphasis as an ideal of the code,

particularly in its extension to society. If we agree with the Cartesian notion that all of humanity should become the audience of science, it seems also fitting to include in its education not only an appreciation of the aims and accomplishments of scientists, but also the norms of their operating code, which have contributed to the universality of science and which might have a place in a new phase of human development.

Conclusion

I have argued that the scientist's code and the ethic of development stand in a complementary relationship. The norms of science are not sufficient as they stand but need to be augmented so as to take account, if you will, of the future development of science, specifically in its relationship with extrascientific institutions. Conversely, the ethic of development which Pierre Massé has put forward to check the excesses of uncontrolled emergence should be linked with the code of the scientist, because of inherent characteristics of the scientific enterprise that favor dialogue and reconciliation of opposing views, and because of the at least partial historical conjunction of these traditions. Taken together, these reflections make attractive the conception of a worldwide scientific community as a source of humanizing influences on mankind's development.

I have already alluded to education, so inextricably linked to each of these themes. This brings me to my final comment, concerning the qualities of the education that would serve these goals. These qualities, I believe, have nowhere received as fitting expression as in the thought of the late Gaston Berger, the principal protagonist of the Prospective philosophy (*22*).

The personal qualities, so common in the comportment of scientists, which Prospective education seeks to instill in students, are these:

Adaptability to the changing circumstances of a mobile world, and the capability of realizing happiness.

The skill of analyzing in depth the consequences of actions, accomplished or proposed, and of suddenly arising new situations.

The development of an open mind, the art of making stimulating comparisons, and the skill of transforming chance events into opportunities.

The ability to take advantage of the unpredictable and the unexpected, particularly in the interaction of opposing tensions, which may be the source of new things, qualities, or ideas.

The readiness to act effectively for what is believed to be desirable.

Prospective education also seeks to develop means of communication and of dialogue which place understanding of others prior to judgment of them and, above all, to "develop a sense of the human which is not a mere orientation of the intellect, but a profound attitude involving our entire being."

References and Notes

1. I have been unable to relocate this citation in Valéry's works, but all those whose help I sought in this connection concurred in identifying the quotation's author as Valéry, by reason of its distinctive combination of content and form.
2. R. K. Merton, "The normative structure of science," in *The Sociology of Science* (Univ. of Chicago Press, Chicago, 1973), pp. 267–278.
3. A. F. Cournand and H. Zuckerman, "The code of science: Analysis and some reflections on its future," *Studium Generale* **23**, 941 (1970).
4. A. F. Cournand and M. Meyer, "The scientist's code," *Minerva* **14**, 79 (1976).
5. In his writings on the philosophy of science, the late Imre Lakatos referred to this notion by the apt, if not currently fashionable term, "scientific honesty" [see I. Lakatos, in *Criticism and the Growth of Knowledge*, I. Lakatos and A. Musgrave, Eds. (Cambridge Univ. Press, Cambridge, 1970), pp. 91–195, especially pp. 95–96].
6. M. Polanyi, "The critique of doubt," in *Personal Knowledge: Towards a Post-Critical Philosophy* (Routledge and Kegan Paul, London, 1958), pp. 269–298.
7. In his essay, "Behavior patterns of scientists"[*Am. Sci.* **57**, 1 (1969)], R. K. Merton has amassed evidence that concerns about priority have been a prominent feature of scientific work since at least the 17th century.
8. Of course, the situation of scientists working in industrial research laboratories is somewhat different.
9. Consider, as one of several recent examples reported to the public, "The Sloan-Kettering affair (II): An uneasy resolution" [B. J. Culliton, *Science* **184**, 1154 (1974)].
10. The conflicts that may arise when scientists become advocates of public policy have been described in *Minerva* in considerable detail. See, for example, "The obligations of scientists as counselors: Guidelines for the practice of operations research," *Minerva* **10**, 105 (1972); P. Doty, "Can investigations improve scientific advice: The case of the ABM," *ibid.*, p. 280; A. M. Weinberg, "A useful institution of the republic of science," *ibid.*, p. 439; R. V. Jones, "Temptations and risks of the scientific advisor," *ibid.*, p. 441; H. J. Miser, "The scientist as advisor: The relevance of the early operations research experience," *ibid.* **11**, 95 (1973); M. J. Moravcsik, "The universal intellectual versus the expert," *ibid.*, p. 109; D. MacRae, Jr., "Science and the formation of policy in a democracy," *ibid.*, p. 228; A. Mazur, "Disputes between experts," *ibid.*, p. 243; I. D. Clark, "Expert advice in the controversy about scientific transport," *ibid.* **12**, 416 (1974). Other examples will be familiar to readers of *Science*.
11. S. G. Brush, "Should the history of science be rated X?" *Science* **183**, 1164 (1974).
12. I. Scheffler, *Science and Subjectivity* (Bobbs-Merrill, Indianapolis, 1967), pp. v–vi.
13. J. Monod, *Chance and Necessity: An Essay on the Natural Philosophy of Modern Biology* (Knopf, New York, 1971).
14. E. Shils, "*Minerva*: The past decade and the next," *Minerva* **10**, 9 (1972).
15. J. Monod, *Leçon inaugurale au Collège de France, 3 November 1967* (Collège de France, Paris, 1968), p. 31.
16. P. Massé, *La crise du développement* (Gallimard, Paris, 1973); see especially pp. v and 81–122.
17. J. Hamburger quoted by Massé (*16*, p. 190).
18. D. Dubarle, "The proper public of science: Reflections on a Cartesian theme concerning humanity and the state as audiences of the scientific community," *Minerva* **1**, 405 (1963).
19. F. Bacon, *Valerius Terminus*, cited by D. du Maurier, *The Winding Stair, Sir Francis Bacon, His Rise and Fall* (Doubleday, Garden City, N.Y., 1977), pp. 19–21).
20. J. Ben-David, "The profession of science and its powers," *Minerva* **10**, 362 (1972).
21. First published in 1938 as vol. IV, part 2, of *Osiris* and recently republished: R. K. Merton, *Science, Technology, and Society in Seventeenth Century England* (Fertig, New York, 1970), see especially chap. 5.
22. For an exposition of Berger's thought, as well as that of some of his principal colleagues, see A. Cournand and M. Lévy, Eds., *Shaping the Future: Gaston Berger and the Concept of Prospective* (Gordon & Breach, New York, 1973).

23. I acknowledge with gratitude the helpful suggestions of Professor Edward Shils and Professor Robert K. Merton in formulating certain of the ideas advanced in this article.