An Ethical Code for Scientists

Ward Pigman and Emmett B. Carmichael
University of Alabama, Medical-Dental Schools, Birmingham

A NEW PHENOMENON of our present-day society is the obviously important role played by science. Only a short time ago science was considered by many "practical" men as a plaything of inconsequential importance in contributing to the welfare of society. Although the significance of science was becoming more generally evident before World War II, this war demonstrated to the public in general and to legislators and businessmen in particular that science, especially basic science, is much more than a scholarly pursuit—that it is a vital force for the advancement or destruction of society. Science is now "big business." As a result, the scientist cannot and must not remain a scholarly recluse divorced from the remainder of society. His behavior and that of society toward him will greatly influence the progress of science and, to an increasing extent, that of society itself.

During its long period of development, science has evolved a code of professional tradition and ethics, largely in an unwritten form. This code, really the foundation of the scientific method in many of its aspects, has to a considerable extent been responsible for the achievements of science. Polanyi's (*12*) description of the effect of disregard for scientific traditions is applicable to many of our modern industrial and research organizations:

> Those who have visited the parts of the world where scientific life is just beginning, know of the backbreaking struggle that the lack of scientific tradition imposes on the pioneers. Here research work stagnates for lack of stimulus, there it runs wild in the absence of any proper directive influence. Unsound reputations grow like mushrooms: based on nothing but commonplace achievements, or even on mere empty boasts. Politics and business play havoc with appointments and the granting of subsidies for research. However rich the fund of local genius may be, such environment will fail to bring it to fruition.

The important achievements of science and its contributions to our civilization seem adequate proof of the basic validity of these traditions. On the other hand, conditions of scientific work have changed greatly, and obviously the traditions must be interpreted in terms of prevailing conditions. Science has emerged from a period in which the predominant effort was made by individuals, sometimes of almost an amateur status, to a period marked by the development of large research groups, many in the pursuit of research for profit. As a result, it is timely for the scientist to consider his professional traditions and to relate them in terms of the structure of modern scientific work.

These traditions are essentially an unwritten code of professional ethics. As pointed out by Leake (*9*), the term "professional ethics" as used generally includes the attitude of the individual scientist to society and to other scientists. It will be so used here. This concept of professional ethics inextricably involves social obligations, questions of etiquette, and adherence to accepted traditions. Claude Bernard (*1*) has contributed one of the better discussions of the ethical qualities needed in scientists, and the relationship of these qualities to the scientific method, although his remarks apply in the main to medicine and physiology.

Some of our professional organizations have established formal written codes of professional ethics.[1] In the medical field numerous papers and books have been written on the subject. One of the first extensive codifications was that of Percival (*9*) (1803), but the general precepts of Hippocrates (circa 500 B. C.) have modern acceptance. A major consideration at the first meeting of the American Medical Association in 1847 was the formulation of a code of professional ethics (*9*). The present code provides means for enforcement by its members. There has been some discussion of the professional responsibilities of industrial chemists (*6*) and a code has been proposed for this group (*7*). Scientific groups generally, however, have not formalized their traditions but have passed them on by example and by word of mouth as an informal part of the graduate student's training.

This failure of scientists as a group to consider ethics is revealed in the fact that *Chemical Abstracts,* since it was founded in 1907, listed only four refer-

[1] American Medical Association, *Principles of Medical Ethics* (*14*); American Dental Association, *Principles of Ethics* (*15*); American Association of University Professors, *Statements of Principle in Academic Freedom and Tenure* (*16*); American Institute of Chemical Engineers, *Constitution,* Article VIII (*17*); Engineers' Council for Professional Development, *Canons of Ethics for Engineers* (*18*). "The Geneticists' Manifesto" adopted at the Seventh International Congress of Genetics, held at Edinburgh in 1939. Published in *The Journal of Heredity,* September, 1939. Reprints distributed by American Genetics Association (*19*).

ences under ethics in its indices. It is true that professional codes at best can only express an ideal; their acceptance and application will depend upon the individual scientists. We believe, however, that the scientist's position in the world today makes it extremely important that his time-proved traditions be reconsidered in terms of modern circumstances and possibly written into a formal code. We believe that such an action would maintain the advance of science, increase its public support, and improve the professional relations of scientists. Improved professional relations would better morale and increase productivity among research men. Mills (*10*) has pointed out the social implications of ethical behavior in the distribution of research grants.

The planning of an ethical code for scientists should take into account first the scientist's general obligations as a member of society, and beyond that his special obligation as a scientist to protect society—here, there are many problems related to warfare, to the health and general well-being of mankind, and to nationalism versus internationalism. Such a code should preserve the scientist's ethical traditions and incorporate the scientific method. It should state the scientist's obligation to explain the nature and purposes of science, and the policies in dealing directly with the public. It should clarify the scientist's attitudes toward patents and secrecy restrictions. It should affirm the scientist's obligations to individuals —to his employer, his associates, other scientists, and his assistants and graduates—and scientists' obligation as a group to other professions.

We have merely indicated the scope of the problem. To deal with it fully in all its phases would require the efforts of scientists in many different fields of study and kinds of employment. Some of these phases have already received considerable attention. Because the results of atomic research have such unmistakable implications for society, attention has been paid to the scientist's attitude on the use of his discoveries, particularly for military purposes, and to the necessity of his being socially conscious (*3, 4, 5, 8, 10, 13*). Other phases of the problem have received little or no public consideration.

Many of the scientist's obligations are reciprocal in the sense that the scientist has grown to expect certain conditions for his work, and to a considerable extent these conditions affect the quality of his work. Sometimes his obligations are conflicting. He may at times be faced with the dilemma of obligations to his employer that conflict with obligations to the public as a whole. What should his attitude be when his employer's immediate interest causes harm to the general public? Suppose that his employer is a company that is pouring waste products into a stream and he knows that at a reasonable cost this pollution could be greatly minimized. Should he assume, as a lawyer does, that his primary obligation is to his client, and become an automatic defender of the company's position? Or should he consider that he has duties to society greater than those to the company?

A group of very pressing problems is presented in the application of traditions related to the authorship and publication of scientific researches. In the early days of science most articles carried the name of only one worker, whereas multiple authorship is now most common and sometimes ten or more persons may be involved. As a detailed example of the need for a code of professional ethics, we will discuss some of the problems involved in authorship.

General Obligations of Authors

Quality of Papers. Everyone will agree that scientific articles should be of good quality, should be original in content, and should describe all work in a reproducible fashion. These are fundamental requirements of the scientific method and yet most scientists would admit that many research articles are published that are deficient in some or all of these respects.

Claude Bernard (*2*) has described the importance of adequate details:

> In scientific investigation, minutiae of method are of the highest importance. The happy choice of an animal, an instrument constructed in some special way, one reagent used instead of another, may often suffice to solve the most abstract and lofty questions . . . . the greatest scientific truths are rooted in details of experimental investigation which form, as it were, the soil in which these truths develop.

Even casual inspection will show that many articles are not written so that the work can be repeated. Traditional procedure is often ignored in reporting new compounds; occasional articles will not give analyses of new compounds or the compounds will be poorly described so that their identity is questionable. Scientific journals lack space to print all the good material they receive today, and understandably urge authors to shorten their articles, but great care is needed to avoid eliminating important details.

Direct responsibility to prior work. The traditions of science demand that any report of scientific work must consider prior work, integrate it in the general subject, and cite proper references to it. Frequent violations of this principle must be familiar to all scientists. One of us has previously called attention to an instance of this type, particularly in relation to the naming of methods (*11*).

The basic concept behind this principle, even more fundamental than professional courtesy, is that fre-

quently the solution to a problem may already be in the literature and needless repetition is economic waste. Thorough literature searching can be defended from an economic standpoint alone. In order to speed the incorporation of new work into the general body of basic knowledge, each author has the responsibility of assisting in the integration of his work with that of previous workers.

To many scientists, establishment of priority for new discoveries is important, and organizations that seek patent protection for their work may set up involved and expensive procedures to establish the date of discovery. Is this a tradition that should be continued? Some scientific journals do not carry the date a manuscript was submitted, and few indicate whether essential changes of content have been made after that date. "Letters to the Editor" may require careful controls to prevent abuses.

Criticism and disagreement. The scientific method requires that all research work be open to critical examination and testing by researchers in the field. It also requires that dissenting theories and results be treated with tolerance, and not suppressed merely because they disagree with currently accepted ideas. Many scientists would add that mistakes and errors should be publicly acknowledged.

The widespread violation of these principles today is affecting not only the progress of science but our economy as well. Many commercial research organizations keep closed files of their researches as a matter of policy, in the belief that they will have an advantage over their competitors. Most of them do not realize that lack of criticism of the worker by qualified colleagues in his own field fosters the carrying out and perpetuation of poor or erroneous work, the continued employment and promotion of unqualified workers, and the perpetuation of poor research policies. Criticism by members of the worker's organization and by consultants is usually inadequate because of the influence of personal motives and lack of knowledge in the specific field. Objections to excessive secrecy in military research should take into account this principle as a primary consideration.

Classical examples of the value of scientific controversy are well known. When properly conducted, such debates lead to clarification and advancement of knowledge. But improperly conducted, they lead to enduring feuds, and because of this possibility, there is a tendency among editors of journals to suppress scientific polemics. A continuation or extension of this trend will be a severe blow to the scientific method. However, as stated by Wise (*13*)

> the research worker should not permit himself to become embittered or involved in useless polemics. . . . It simply means that his criticisms must be objective and that they must not descend to the plane of personalities. He must show that he is dealing with a set of data, not with an enemy.

Property rights of the scientist in his work. A currently controversial problem of the application of scientific tradition involves the rights of a researcher to his work. The decision to try to publish or reveal his research once was the sole right of the scientist. Now, with the investigator receiving financial support from others in most cases, the final decision is tending to fall on the provider of the funds. In the extreme case, what is there to prevent someone in authority from taking over the work of an associate and passing it off as his own work? What should an editor of a scientific journal do if he receives for publication a suitable manuscript from an established worker and simultaneously a letter from the supporting group saying that it should not be published? Should the supporting group be required to provide satisfactory and convincing grounds? By tradition and perhaps even by legal mandate, the rights of an artist to certain phases of the disposition of his work have been affirmed. Should these not apply equally to the scientist, whose application of his science is often an art?

At least one established graduate institution has the policy that all doctoral theses are published solely in the names of the individual graduate students. In certain instances, the idea was suggested by a member of the faculty, who carried out some preliminary work, supervised the principal research, drew or helped draw the conclusions, rewrote the thesis and wrote the final published version. Is this an example of acceptable ethics?

Publicity. Some scientists violently oppose general publicity and popularization of their work. Others seek publicity, and some even condone or support erroneous and misleading publicity. What should be the attitude of the scientist? Does he owe the public a duty to attempt to explain the purpose and significance of his work? Should chicanery and excessive or misleading publicity on the part of scientists and nonscientists be exposed as a function of scientific societies? It is of interest that the *Principles of Medical Ethics* includes a considerable discussion of the impropriety of advertising and publicity-seeking and that AMA members are required to advise the public against misrepresentation. A firm stand on this issue by scientists generally might be of considerable help in establishing the professional status of the scientist in the public mind.

Multiple Authorship

With the change in status of research, owing to its being produced not by independent individuals but by

several dependent workers or even large groups, the scientific tradition in respect to the etiquette of authorship needs reinterpretation or extension. The responsibilities involved in multiple authorship or group research must be analyzed.

"Senior" authorship and order of names. To many scientists, the order of the authors' names on a publication has a significance. Is this a tradition that should be preserved, clarified, and enforced, or is it an outmoded, unessential form of etiquette? In current publications, the application seems uncertain and haphazard. Should the concept of the "senior author" (the first one listed) be preserved? If so, should the senior author be the person highest in the administrative rank, the one who has done most of the laboratory work, the one who has written the paper, the one who furnished the original idea, or the one whose technical skill and thoughts have carried along the research?

Administrators and financial supporters. In publications, what consideration should be given to administrators and financial supporters? Some scientists might say that they should be indicated as authors only when their contribution to the actual solution of the problem has been substantial, continuous, and of a high level. Probably most scientists would agree that mere general administrative supervision of a project or even the suggestion of the original idea for the project is insufficient for an authorship. Certainly no one should be granted authorship of any type merely because he has seniority or is in charge of a laboratory. We cite as an example a man serving as technical liaison between a company and a research organization who insisted that his name be included as an author, before he would ask for supporting funds for the research, although his total contribution was limited to this action.

Graduate students and technical assistants. Criteria are necessary for assessing the role of graduate students and technical assistants in relation to authorship. Should not senior authorship for a graduate student be limited to those instances in which a real contribution, beyond adequate laboratory work, has been made? On the other hand, is it not the duty of the directing professor to encourage the student to his maximum performance, rather than use him as a laboratory assistant? If a technical assistant is to be given authorship of any type, more than an adequate performance of routine methods should be required of him.

Group projects. An example of the large group projects that characterize modern science is the penicillin research during World War II. Industrial organizations provide many more examples. Frequently there is no attempt on the part of administrators to set up the program so that the work of individual investigators is kept discrete. The improved quality of work resulting from the establishment of definite responsibility might be the basis for making a definite statement in regard to this problem. The interpretation of the scientific tradition in terms of modern group research is an extremely important and as yet unexplored field.

Preparation of manuscripts. The published paper is the final record of the finished research work, and the medium through which the information is made generally available and useful. With the present shortage of publication space, the preparation of the manuscript becomes more important than ever. Rigid adherence to established scientific traditions on the part of authors and editors becomes increasingly essential.

To many persons, the preparation of a research paper may seem to be a routine matter, but actually it requires a high order of skill and technical knowledge and an acquaintance with scientific traditions. In many researches the actual preparation of the manuscript, the integration of the findings with the prior related work, consideration of the significance of the data, and arrangements for publication may require a considerable portion of the time and skill required for the entire project. Possibly the actual preparation of the manuscript should be a factor in defining the responsibilities of the senior author. Laboratory workers without a good background of knowledge, and research administrators without close daily contact with the laboratory work and a thorough knowledge of the field probably should be discouraged from actual preparation of the manuscript. On the other hand, simple manuscript revision, in spite of the poor writing ability of many scientists, should not generally be made the basis for authorship of a research paper. Still another problem is determining the duties and responsibilities of the referees of scientific articles.

The interpretation of scientific traditions, and their formal codification, if that is to be accomplished, are essentially a task for scientists. As this discussion demonstrates, the problems of interpretation are manifold and if they are not solved they may severely hinder the progress of science. The harm done may not only be general but may apply particularly to industrial research of the group type. Incidental effects of the code, but of considerable importance, would be the great improvement in morale among scientific workers, the improvement in the quality of scientific work, the assistance it would give to editors of scientific journals and research administrators, and the basis it would provide for exposing poor work and even instances of chicanery. It would be of great

assistance in the training of graduate students in the scientific method. The preparation of a formal code of professional ethics should be of considerable value in establishing the professional status of the scientist in the public mind. It seems more than a coincidence that the groups that already have formal statements of their social and professional responsibilities and have definite rules of professional behavior are those definitely accepted by the public as having professional status.

As we have pointed out, violations of professional ethics on the part of scientists are frequent and familiar to all scientists. Sometimes they are deliberate violations for personal power or gain. Frequently, they are the results of carelessness or unfamiliarity of research administrators or research workers with the established traditions. They may even result from excessive pressure of work, a condition that appears common in industrial research. Some violations are the result of misguided attempts by editors and reviewers of scientific journals to shorten articles.

Is not the time opportune for our scientific organizations, or some agency of Unesco, to consider the manner of the application of scientific traditions to the newly developed conditions of scientific research? We suggest that the establishment of a definite code of professional ethics and conduct by our major scientific groups would have profound and favorable effects for science, society, and the scientist.

A mere statement of principles would be of help. An extensive codification and attempt to discipline or expose gross violations might be desirable. Our societies have various ways and means of enforcing regulations. Exclusion from membership and control of publications and means of publicity are powers that could be used to control unscrupulous and continuous violations. There may appear to be an anomaly in scientists' establishing a formal code of ethics to preserve traditions that include independence in their work, but this merely reflects an anomaly in present conditions of scientific work. It seems far better for scientists to affirm such a code positively than to be regimented to an increasing extent without any control over the conditions under which they must work. A. V. Hill (*8*) puts the problem as follows:

> The important thing is not a creed "which except a man believe faithfully he cannot be saved." What matters is that scientific men should argue and discuss the matter of scientific ethics as one of infinite importance to themselves and the rest of mankind with the same honesty, humility and resolute regard for the facts they show in their scientific work.
>
> If they do, then something will surely crystallize out from their discussion, and I have faith enough in the goodness and wisdom of most scientific men to believe that the result on the whole will be good and wise. It may in the end be embodied in a new Hippocratic Oath; or it may be absorbed in trade union rules for the scientific profession; or ethical behavior in science may just come to be accepted as an honorable obligation as unbreakable as that of accuracy and integrity.

We add that all problems will not be solved, but science is expanding and moving. The rate of progress will be profoundly affected by the consideration that is given to the maintenance and proper application of time-proved scientific traditions as the conditions of scientific work change.

References

1. BERNARD, CLAUDE. *An introduction to the study of experimental medicine.* Trans. by H. C. Greene. New York: Macmillan Co., 1927.
2. *Ibid.*, p. 14.
3. BLAKESLEE, A. F. *Science,* 1940, **92**, 589.
4. CARLSON, A. J. *Science,* 1946, **103**, 377.
5. CONDON, E. U. *Science,* 1946, **103**, 415.
6. FERNELIUS, W. C. *Chem. Eng. News,* 1946, **24**, 1664.
7. GEHRKE, W. H., ANESHANSLEY, C. H., and ROTHEMUND, P. *Chem. Eng. News,* 1947, **25**, 2562.
8. HILL, ARCHIBALD V. *Chem. Eng. News,* 1946, **24**, 1343.
9. LEAKE, C. D. (Ed.) *Percival's medical ethics.* Baltimore: Williams & Wilkins, 1927.
10. MILLS, C. A. *Science,* 1948, **107**, 127.
11. PEOPLES, S. A. and CARMICHAEL, E. B. *Science,* 1945, **102**, 131.
12. POLANYI, M. *Sci. Mon.,* 1945, **60**, 141.
13. WISE, L. E. *Paper Industry & Paper World,* 1946, **28**, 1299.
14. *A.M.A. Directory,* 1942, p. 14.
15. *A.D.A. Directory,* 1947, p. 2.
16. *Bull. A. A. U. P.,* 1949, **35**, 66.
17. *A. I. C. E. Constitution,* Art. VIII.
18. Engineers' Council for Professional Development, Oct. 25, 1947.
19. *J. Hered.,* Sept. 1939.