cannula in a coronary artery of the living dog's heart and directly measuring the blood pressure and pulse wave in the coronary system, though the great Cohnheim had laid down the dictum that occlusion of a main coronary artery was immediately fatal to the physiological action of the heart.

In Martin's time the leaders of thought in physiology felt themselves confronted with a calamity which endangered the autonomy of their science. Physiology in this country did not exist as a profession. Its reason for existence in the mind of even the educated public rested on its relation to medical instruction and it held somewhat the same position in the technical curriculum as grammar does in the academic course. Martin, following the lead of his scientific forebears, insisted that physiology should be regarded as the benefactor not the handmaid of medicine and that it should be cultivated as a pure science absolutely independent of any so-called practical affiliation.

Martin glimpsed the future as by inspiration.

The vast development of our conceptions of vital reactions as manifested in the doctrines of immunity, has occurred wholly since his day. As he foresaw, the temptation to achieve discovery directly applicable to the cure of disease has attracted an overwhelming majority of those whose tastes and talents might have been devoted to a sounder development of the principles of science. The student and the prospector for precious metals both tend to rush to the new field of rumored richness.

The history of science is thickly studded with examples of facts and laws unearthed in the pursuit of pure knowledge which have turned out to be indispensable foundations of daily thought and action. Never could they have been discovered by one bent upon so-called "practical" or patentable information. Both theory and experience combine to uphold the doctrine that *knowledge,* irrespective of human uses, must ever be the foundation of both intellectual and material development.

To come, now, down to a focal conclusion and to try and distil in a sentence what would need a volume to elaborate, what should be our attitude towards offering facilities for research and for training in clinical practice, respectively, in medical education?

It has been postulated here that the original investigator is characterized by a specific trend of mind which makes him ever an amateur insatiate for new things, a type on which the advance of knowledge is almost wholly dependent. But such a type is no more fitted, *per se,* to carry on the details of medical practice or apply the fruits of discovery in the infinite vicissitudes of clinical experience than would the explorer or the pioneer settler of a new country be qualified by nature or training to conduct the civic affairs of a highly organized community.

To help humanity is the goal of mass education.

Science is worthless for the people until in applied art it is coordinated to approximate mechanical exactness.

The clinician must hope to acquire through long years of extramural education a method of thought and action not taught in the medical curriculum. A method to which, indeed, the requirements and attributes of experimental science are largely antagonistic; a peculiar point of view and a communistic method of dealing with human minds and conditions. It would be an egregious tactical blunder to attempt to train all students as investigators; but without injury to any, all may be given the opportunity of an environment to which may react a small percentage of minds attuned by nature to respond to the call of truth Promethean.

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RESEARCH COMMITTEES[1]

THE GROWING COMPLEXITY OF ORGANIZATION FOR RESEARCH

RESEARCH enjoys a vogue at present, fortunately and rightly. It is believed in almost as a religion, with much lip service. Lips are likely to be tightly closed when the collection plate is passed.

The organization of research and research committees proceeds apace, to the extent that the unit of ultimate value in fundamental research, that is, the individual research worker is encompassed about with so great a cloud of witnesses.

The American Society of Civil Engineers, the American Concrete Institute, the Western Society of Engineers have research committees and also certain governmental departments. There is the National Research Council, the Engineering Foundation, the research organization of the Association of Land Grant Colleges, which is one of the most powerful of the agencies.

Now, one aspect of science is the simplification and economy of thought, and one aspect of engineering is economy of action. It would be profitable to inquire into the function of any proposed committee before adding to the structure of such committees, in which duplication of effort is less defensible than in the activities of research workers themselves.

For indeed parallel attacks on any research problems are desirable. It is only necessary that researchers should have a knowledge of mutual progress, and

[1] Discussion read before American Society for Testing Materials, June, 1923.

a clearly defined objective placed in its setting in the particular field. It is well, for instance, that the highway department of Illinois, the University of Maryland and Purdue University should have attacked the problem of fatigue of concrete independently.

ON RESEARCH IN GENERAL

In academic circles special attainments in two different fields are signalized by two honors—the Phi Beta Kappa and the Sigma Xi, the former in the field of humanities and the latter in scientific research wherein the truth is sought through the study of nature. I do not know how to draw a line between the fields of so-called academic research and so-called industrial or engineering research. Each must advance, if at all, by scientific methods. Considered as a class set apart by their tastes and their aptitudes from the class of producers and constructors, research workers are of a family.

In a recent conversation with a friend whose mental acumen I admire greatly, but whose narrow definition of research I deplore, it seemed to me that there might be a need to attempt to describe some of the characteristics of research. I would suppose that the quality of a research worker is a spiritual quality and is not to be measured by specific actions. Therefore, there is a danger in attempting to formulate a measure. Certainly, there is a clear distinction between the research type of man and the other who has an instinct for controlling others or for production.

My lot has been cast in with those who experiment or perform research in groups; with a program fixed in advance, and an organization to carry it out. Some of the individuals of the group are only required to be painstaking and faithful observers, to be devoted to their task of measurement with precise instruments, whether in the heat of summer's sun or the freezing weather of winter, in confined situations and fatiguing postures. Others have envisaged the problem, organized and secured support for its solution; they may have prepared a working plan, or left that to others.

Some time ago I gathered together from various sources, chiefly from a report of committee of Sigma Xi, a list of the features of research, as follows:

(1) Research work may be in *industrial* fields with a definite aim or in *abstract* science without thought of particular use.
(2) The research may lie in the field of any branch of knowledge that is treated in a scientific spirit, including, of course, the natural sciences, but not excluding mathematics, history, economics and medicine.
(5) The *method* may be by *deduction*, based upon natural phenomena, and always referenced thereto, or by *induction*, using the methods of modern experimental science, both to discover new facts or uncover underlying laws, or the determination of the mechanism by which one event follows another, resulting in a substantial addition to the existing body of knowledge.
(4) The *qualities* by which true research are known are: earnestness, devotion, diligence and system, and in highest form, original and creative work.
(5) Recognition should be given to skill and initiative in devising suitable methods and apparatus for use in observations, and care and devotion shown in difficult observations, skill in arranging and interpreting data, or forming generalizations upon them.
(6) The *result* should be the discovery of something hitherto unknown.

The following are activities and workers not considered:

(1) The work of the mere routine worker without initiative or responsibility.
(2) The manual operations of the mechanic.
(3) The work of the merely critical and negative mind.
(5) Purely regulatory functions.
(6) Those with only the acquisitions of the learned scholar who may have absorbed the results of research.
(7) Inventors, unless they are scientists.

Anatole France has well expressed one fundamental quality of the research worker, namely "curiosity," in the following quotation:

> Et je songeai que la grande vertu de l'homme est peut-être la curiosité. Nous voulons savoir; il est vrai que nous ne saurons jamais rien, mais nous aurons du moins opposé au mystère universel qui nous enveloppe une pensée obstinée et des regards audacieux; toutes les raisons des raisonneurs ne nous queriront point, par bonheur, de cette grande inquiétude qui nous agite devant l'inconnu.

FUNCTION OF RESEARCH COMMITTEES

In the first place such a committee must deal gently with the individual researcher. He is often temperamental; he instinctively resents a control which will limit his freedom to follow new paths that open up in the progress of his work; he is apprehensive that he will be betrayed into premature publication by those who are charged with the duty of securing funds to keep the research alive; he guards the product of his research against appropriation by others for unfair credit. Initiative, originality and play of the imagination of the individual investigator must be given free rein.

The personality of the individual researcher should also be guarded in respect to his individual style and

expression in reports, and should not be destyled by editors who reduce everything to dull monotony of official forms. The conclusions of a man who has lived through an investigation should not be whittled down by timorous officials.

And yet here arises a practical difficulty, *viz.*, the proper balance between necessary control by an organization and the individual initiative of the research worker, in the case of large projects such as those underlying the art of highway construction where are involved large expenditures; an organization of researchers comprising various degrees of experience, from routine observers and recorders up to those who conceive and plan the researches and who are responsible for the scientific conclusions and the success attending the expenditures of such large funds. There are also individuals whose services are necessary for the orderly progress of the work, considered as a production job.

Projects are begun only after a statement of definite purpose, a working plan and an appropriation of funds, followed up by an accounting system, not only for expenditures, but from the standpoint of production. The problem here is to provide an effective organization without dampening the initiative of the individual, killing his imagination and destroying that sense of criticism and responsibility which are necessary if large projects in an unknown field are to arrive at useful and significant conclusions.

Where, then, does a research committee find its field of usefulness when not supplied with funds for operating a specific project? It seems to me that such a research committee functions as a staff organization. I have endeavored to define these functions for the research committees of the advisory board on highway research as follows:

(1) The entire purpose of a research committee is to render service to investigators, and to accelerate progress in the attack upon important problems. It avoids any attitude of proprietorship in the researches which form the subject matter of its deliberations, or of any control or direction of the individual researcher, whose initiative and freedom are necessary conditions of his work. Coordination of research is attempted, inspiration given to those who are at work, and the broad interests of research advanced by reasonable publicity concerning activities. Information of work under way is spread abroad so that seekers after knowledge may know where to find it; communications established between fields of research.

(2) Research committees do not formulate standards of methods of test, or approved practices in construction.

(3) Reports of these research committees are not channels for publication of investigations, although a summary of established conclusions from published investigations should appear in the reports to show the status of research.

(4) The unique work of the research committees is:

(a) To bring together researchers who are working in the same field in order to reach a definition of objectives, and to bring to each researcher a knowledge of the technique and progress of his fellow workers.

(b) To assemble, analyze and review the published data of investigations, or the data placed at the disposal of the committees for the purpose of judging the extent and stability of the research basis for standards, or for the principles and laws underlying the field of the work of these committees.

(c) To study needed and profitable research activities.

(d) To stimulate competent agencies to perform research in such fields.

(e) To prepare working plans for specific researches in cooperation with investigators or for submission to research agencies.

(f) To call attention to researches which need financial support, and to recommend a means for securing such support.

(g) To publish information of researches under way, and of the tools of research, as instanced in Bulletin No. 21, entitled "A Census of Highway Research Projects in the United States" published by the National Research Council, and Bulletin No. 35, describing apparatus used in highway research.

Of these services the three outstanding are:

(1) The coordination of the researchers in connecting fields. For instance, the objective of certain researches by highway engineers must be established only in consideration of the traffic on the road. The automotive engineer and the highway engineer should be brought into conference for a definition of their appropriate fields of work and lay out programs of research.

(2) A committee may render valuable service in surveying the data of research to appraise progress and recommend further work; and also evaluate the application of research work in the industry.

(3) A particular field of usefulness is to bring into close relation the laboratory and the field, because very often laboratory men have very meager knowledge of the service of the material, and the requirements fixed by the laboratory may be quite unreal and not appear in the service value of the construction.

THE RESEARCH COMMITTEE FOR THE A. S. T. M.

If only for internal service in the A. S. T. M., a research committee of this society would seem to be necessary to perform these duties in the field of materials of construction where areas overlap, and there is so much of technique in common. Furthermore, the critical scrutiny by competent persons, of the fundamental data of research underlying the work of any

committee would serve to postpone premature standardization and would indicate necessary additional experimentation. I venture also to suggest that the work of such a research committee would prevent, or at least diminish, the tendency observed on the part of officials of the State Highway Commissions to go their own way in the establishment of specifications for materials that must meet the local needs and conditions of the widely varying regions of the United States.

PRACTICAL CONSIDERATIONS

It is not sufficient for such committees to set themselves at a table at scattered intervals without a large amount of preparatory work. A research committee needs analysts to prepare the data of research for scrutiny, not only published researches, but those which are complete or nearly so and have not reached channels of publication. The committee is not averaging opinions but rendering judgment upon complete evidence. It is only an illusion to suppose that a research committee can be useful without adequate financial support. Its value is expressed in terms of activity and not in an imposing roster of distinguished names.

RESEARCH AND STANDARDIZATION

The necessity of research before standardization has been well expressed by Mr. A. A. Stevenson, chairman of the American Engineering Standards Committee. To take an example: The standardization of colors for signals for highway traffic demands agreements as to conventions by a standardization committee. But underlying this agreement must be research upon the optical and psychological elements of the situation, to be cared for by a research committee. Otherwise the agreements may violate fundamental human reactions.

W. K. HATT

ADVISORY BOARD ON HIGHWAY RESEARCH,
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SCIENTIFIC EVENTS

GEORGE LEFEVRE AND THE MARINE BIOLOGICAL LABORATORY[1]

GEORGE LEFEVRE first came to Woods Hole as a Johns Hopkins University student in 1892, having a table in the Fish Commission laboratory, and he was there four summers. In 1897 he became directly connected with the Marine Biological Laboratory as an instructor in the zoology course. He served in this position for two years. Since 1905 he was continuously upon the staff for direction of zoological research; he was fourteen years a trustee and was secretary of the board for ten years. Few of the present or former members of the Woods Hole group have served the laboratory for a longer period. Five of Dr. Lefevre's publications are based wholly or in part upon investigations conducted here. Nearly every summer some of his pupils at the University of Missouri or some of the members of their zoological staff were at our laboratory, and six years the University of Missouri contributed to the financial support of the laboratory, all doubtless through Dr. Lefevre's influence.

But this bare statement of formal connections with the institution gives no adequate idea of the faithfulness of the service rendered, or of the influence of his fine personality and of his accurate work as an investigator. He was an outstanding figure in our Woods Hole group, his unfailing considerateness and courtesy, both as scientist and as friend, together with his genial sense of humor, contributing a large share to that wholesome atmosphere which has been one of the chief assets of this laboratory, so free from personal jealousies. George Lefevre was a sound zoologist who did much good technical scientific work; he was a keen critic, discriminating in suggestion; he was an inspiring teacher; he was an administrator of rare tact, good judgment and efficiency and our Woods Hole Laboratory, as well as his own university, had the benefit of his wise counsel. But, while recognizing to the full his strength as a scientist and as a leader and the thoroughness and devotion of his service to this institution, our chief remembrance of him will be as a sensitive gentleman, a tactful counsellor and a warm-hearted friend. The keen sense of our own loss in his death prompts us to try to express to his colleagues at the University of Missouri and especially to the members of his family our deep sympathy.

[1] From the Minutes of the meeting of the Board of Trustees and of the Corporation of the Marine Biological Laboratory held at Woods Hole, Mass., on August 14, 1923.

WORLD BIRD PROTECTION

MR. T. GILBERT PEARSON, president of the National Association of Audubon Societies, has demonstrated the possibility of creating a league for protecting the wild birds of the world. Leading scientific and conservation societies in nine countries have now organized and are pledged to active endeavors for the protection of the birds in their countries, and in aiding similar movements elsewhere.

This movement was launched at a conference held in London in June of last year. On invitation of Mr. Pearson delegates from several countries met in the home of the Honorable Reginald McKenna and determined that such action was necessary if much of the valuable bird life is to be saved from despoliation. Among the very active members of this conference