who reaped a harvest which should have been ours. It is undoubtedly due in a very large degree to the growth of our modern American graduate schools and the stimulus that has been given to research activities in these institutions that the tables have finally been reversed. To-day just as good opportunities are given in American universities for advanced research in all branches of chemistry as can be found in foreign laboratories. A certification of proficiency in chemistry received from an American university of recognized standing is just as valuable to-day as one received from a foreign university. In our advance we are gaining strength and contributing to the world's knowledge. We find scientists in both our academic and industrial institutions, and in the words of W. H. Perkin, "There is no chasm between pure and applied science, they do not even stand side by side but are linked together."

Great investigators in chemistry, like great men in anything else, are born not made, but when they are born it is necessary that they be trained and the place for their training in chemistry is the university or technical school. Let us as an institute see to it that the officers in charge of the various chemistry departments of these training schools and their teachers are properly instructed and informed of the requirements of our profession.

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SCIENCE FOR HUMANITY'S SAKE[1]

INSTEAD of attempting on this occasion to review research work which is in a limited field, of interest to but few chemists, to whom it is readily accessible, I will endeavor to visualize and depict an ideal, which, like all worthwhile goals, is at times dim and distant, but not the less inspiring.

In "Sermons of a Chemist," that fascinating and stimulating book by Edwin E. Slosson, he has suggested that just as every quadratic equation has two roots, so every question in nature has two parts, "how" and "why" does nature accomplish certain things; and of these questions science is able to answer only the first. If now we inquire regarding the work of the scientist himself, we may properly ask "How does he work?" and "Why does he work?" The annals of science consist chiefly of the answer to the first question, but only occasionally do we find the second question even mentioned, much less discussed. Surely with the greatly increased interest in science during recent decades and the present efforts to further stimulate scientific research, it is not unreasonable to ask: "Why this feverish anxiety to spend money and effort in scientific pursuits?"

In this attempt to point out some of the possible answers to this question, the illustrations will be taken largely from the field of chemistry, because the speaker and the audience are chiefly concerned with that field. It might therefore seem that the title is too comprehensive. In this day and age, however, when the border line between physics and chemistry has ceased to exist and when chemistry plays so important a part in biology and geology, it is safe to assume that much the same factors are involved in the pursuit of chemistry and of the other natural sciences and that the participants are influenced by the same motives.

No doubt the title will at once suggest to you the great service rendered by science to mankind in the prevention and cure of disease and the alleviation of pain; and the industrial chemist may dismiss the subject as having only passing interest for him. For those scientists who have expended their time, means, strength, and even their lives, in the fight against disease, too much praise can not be given. But there is a need also for high ideals and heroic service among those whose work in science deals with more prosaic subjects, such as "shoes and ships and sealing wax." The proverb is as true now as it ever was that "where there is no vision, the people perish."

Some, especially those engaged in "pure science," may resent the suggestion that there need be any reason given for scientific research, and may glibly quote "science for science's sake," or urge that the joy of the work is sufficient justification; or if they fear the appearance of affectation will say that they work just for the fun they get out of it. Beyond a doubt, the joy of discovery is one of the most potent motives of the scientist, and insofar as this attitude stimulates and encourages research in those fundamental fields of science upon which all sound applications must rest, it is indeed commendable. If, however, such an attitude induces indifference toward or even disdain for the application of the results of such researches to meet the needs of humanity, it creates a false distinction and not infrequently cuts off both the moral and the financial support that are essential to the conduct or success of exhaustive and fundamental research. Recognition of this fact is no doubt responsible for the frequency with which those interested and engaged in fundamental studies, which they urge "for science's sake," hasten to assure the public (or Congress) that "besides, one can never be sure but that the most abstract research may lead to results of definite industrial or economic value." If one is to weigh the earth, he feels called upon to explain that the results may aid in the detection of oil-

[1] Address given upon receiving the American Institute of Chemists' Medal in New York, May 8, 1926.

wells. If the structure of the atom is to be investigated, the lure of releasing vast stores of energy or of transmuting the elements is held out as a justification. And this is as it should be. If it were possible to outline any investigation, which by no stretch of the imagination could be of any earthly (or heavenly) service to any one, I doubt whether any scientist would or should feel warranted in undertaking it, much less asking large financial support for it. (If he did, it seems humanly certain that in the back of his head there would be a lurking suspicion or even a hope that he might after all unearth some knowledge of great value to mankind.)

Let us then be frank and admit that the justification for the study of nature, *i.e.*, of science, is its possible "utility." And now you may accuse me of materialism. But let me hasten to say that by utility I mean the "service of humanity." Despite the recent and possibly valid arguments of some psychologists that the human being is one entity, it is still convenient to consider man as made up of body, mind and soul, even though in most cases it may not be possible to differentiate sharply between these phases. Is it then too much to ask that science should contribute alike to the material, the intellectual and the spiritual needs of man?

Our whole modern civilization, with its triumphs and its failures, with its increase in the health and happiness and longevity of civilized peoples, and the horror and destruction of modern warfare, is a literal though complicated record of the application of science, especially of physics and chemistry, to meet the physical and material needs (or desires) of humanity. The "how" of this process, as recorded in the almost innumerable scientific books and journals of the past century, is a record of which scientists may well be proud. And to even attempt to answer the "why" of it would take us too far into the field of sociology and ethics for a mere chemist to follow. No doubt it is asking too much to expect the engineer of an automobile factory to consider whether the car he perfects is to be used by a physician on an errand of mercy or by a burglar on a mission of destruction. But is it expecting too much of him or other scientists to ask occasionally whether the work for which they receive compensation is really contributing to the betterment of humanity, at least in a material sense?

In considering the material benefits of science we must not overlook the return to the scientist himself. At least we may rest assured that "society" is a hard-hearted stepmother and is not prone to reward her children, scientists or others, except as they establish and prosecute a claim for recognition. "Science for science's sake" does not provide food and housing and education for one's family. It is therefore entirely fitting that workers in science should seek for such financial recognition as is necessary for the proper continuation and extension of their service. Here we come into the complicated field of "economics," with which most scientists are less familiar than with "economies," and one would be rash indeed to even suggest the proper division of the profits of industry brought about by the application of science. But at least it is safe to say that any scientist who receives no satisfaction other than his salary, be it large or small, is poor indeed!

It is only within recent years that the value of science in the development of the mind has been appreciated. As a result there are to-day many who believe that one may be truly educated, even though he has not studied Greek and Latin. Again it would take us far afield to discuss the relative cultural value of the sciences and the classics. Possibly some ingenious scientist will solve the dilemma and provide time for both in the already crowded curricula of our colleges, perchance by some manipulation of time in the fourth dimension! At least we must admit that the study of science can and does contribute to the development of the mind and yields intellectual satisfaction that gratifies human longings as real as those for material needs.

The scientist has no right, however, to reserve to himself the intellectual benefits of his work, any more than he has to reap all the material rewards. It is possible through the use and dissemination of science to raise the general intellectual standards of a community. In this connection it is not inopportune to recall the fact that even in this land of liberal education only a minority of the people have a high-school education and a mere sprinkling have had a college course and an opportunity for intensive study of science. Is it then impossible for those without any systematic education in science, who make up not only the laborers, but also most of the foremen and executives in industry, to obtain a grasp and appreciation of science? Experience of the last ten years, to be sure in a limited field, has convinced me that many such men have the interest and capacity to master the essentials of those sciences that are directly applicable in their work. The large enrolment of these men at night schools and in correspondence schools is an evidence of this interest, which no doubt is often stimulated by the inducement of economic advantage through greater technical knowledge. But over and above such gains, many men have expressed the greatly increased satisfaction in their work that arises from a knowledge even though it be superficial, of the underlying scientific principles.

We may well ask whether scientists, *e.g.*, chemists connected with industrial plants, have contributed their fair share toward the encouragement and satisfaction of such an interest on the part of the men

actually engaged in the factory processes. The chemist who throws an air of mystery about his work, who adds secret "dopes" to the solutions in the plants, who embellishes his reports with high-sounding terms, unintelligible to the workman or the superintendent, is simply putting himself in a class with the charlatan and the quack. Perhaps he fears that with a little technical knowledge the foreman can get along without the chemist's service. If he can, so much the better, for there are many other tasks awaiting the application of science. The speaker was once severely criticized by a prominent chemist for teaching electrotypers to titrate the acidity of their copper solutions, with the advice that "if they needed chemistry, they should employ a chemist." But why should a chemist continue to make routine titrations or pH measurements, when the workman or foreman can be taught to do them just as well and can then enjoy his work the more because of this added experience? The best chemist, like the best physician, is the one who teaches his clients how to dispense with his services, and such a one will never lack for other clients.

There is to-day an organized and successful effort for the popularization of science, through the publication of such books as "Creative Chemistry," and "Chemistry in Industry." Pupin, in his fascinating autobiography, expresses his conviction that "every child in the public schools should be made perfectly familiar with the simple experiments which illustrate the fundamental elements of Newton's divine philosophy, as Milton calls science." We are still a long way from the realization of such an ideal in our educational system, but at least science is constantly entering more largely into the common life. That the layman is not afraid of technical terms if he is interested in them is illustrated by the rapid spread of the language of radio.

It is the duty of the scientist to translate, or have translated, the results of his research into terms that can be understood, and if need be, used by the layman. Much of the present interest in science is due to such splendid efforts as those of "Science Service," efforts which have shown that it is not necessary to employ highly specialized language to transmit the essentials of scientific truth. The work of the scientist is only half done when it is published in the annals of his profession; it must also be made available to all those who can use it. The world demands a living science, not a museum!

But even beyond the material benefits and intellectual satisfaction that come from the study and application of science is its elevating effect upon the spirit of man. Paul R. Heyl, in a masterly address to the Washington Academy of Sciences, upon the "Visions and Dreams of a Scientific Man," an address that is itself an epic, has shown that there is a poetry of science that thrills the soul and an appeal to the imagination that is an inspiration to the spiritual life of man. It is almost impossible to touch upon this phase of science without approaching that border line between science and religion that has caused so much needless and useless argument and controversy. If we agree that man's happiness is largely dependent upon his ability to adapt himself to his environment or possibly to adapt his environment to his needs, then all knowledge of science, which Pupin calls "the eternal truth," should contribute to that happiness. To fear the extension of truth is to prefer a bliss of ignorance. The scientist should not forget, however, that his research simply shows "how" God works and leaves unanswered the question which is the concern of religion, *i.e.*, "why" God works. Religion is the science of the soul, a domain in which it has not yet been proven that the laws of physics and chemistry apply.

In recent years the biologists have predicted that through the regulation or addition of "hormones" to the human system, it will be possible to modify the temperament of a person. Whether this prophecy be fulfilled or not, we know that science has already changed the disposition of man; that it has given him a new outlook on life and an inspiration to realize at least in some degree the seemingly limitless possibilities that come through unlocking the mysteries of nature. Even such abstract speculations as those of relativity may give man a more serene confidence in the marvelous coordination of our universe and withal a deep humility.

In the beginning of this talk, some surprise was expressed that scientists so seldom give a reason for their work. But we have seen that in any attempt to answer such a question, we inevitably get into fields of economics, sociology, education, religion and metaphysics; fields in which the specialized scientist may well fear to tread. To overcome this handicap it is necessary that the education of the scientist should be broadened, both during and after his collegiate course. The scientist needs culture, as much as culture needs science.

In recent years we have heard many laments that society does not properly evaluate the work of the scientist, and numerous efforts are being made to impress on the public the importance and service of science. Some writers have suggested that the lack of recognition comes from the fact that scientists have not taken themselves seriously enough. If that has been our fault, we are apparently in a fair way to remedy it! Is the situation not more probably due to the fact that scientists have not taken the rest of the world seriously? We have too often assumed

that science is an end in itself, and have failed to make it a part of the world's work. We have been too often content to be either recluses or cogs in the machinery of industry. We have left too much to others the conduct of the state or even of our own village. We need to work more with others and not simply for others.

In "Arrowsmith," that realistic novel of research in medicine, Sinclair Lewis portrays vividly the obstacles that beset the path of one who hitches his wagon to the star of research. Every worker in science can find in this story his own weaknesses and also those of the benevolent though misguided persons who hinder the progress of truth. But we can not all devote our lives to abstract and fundamental researches. There is a glory and a satisfaction also in lesser service. To me there is a distinct sense of disappointment that in his struggle for the opportunity for pure research, Martin Arrowsmith failed to realize or grasp his opportunities on the way. "It is not alone the goal that counts, but also the path by which we travel."

If anywhere we should expect a high devotion to the ideals of the service of science, it is in the government laboratories, supported by the funds of the people, who naturally and rightly expect some definite returns. In such work there is in addition a need for vision, to prevent the demands for information of immediate value from hindering or entirely interrupting the study of fundamentals, the type of study that has been aptly called "the fountain-head of science." Whether such devotion and such vision are found among your public servants may best be judged by those with better perspective. At least it may be said that the government scientist who is not upheld by an abiding sense of service "is of all men most miserable," for then he has indeed little visible means of support!

The world expects great things of science; it expects science to "give new leases on life, and new tools, and wider visions." The historian may recount the past, but can not change it; the poet may paint the future, but can not bring it to pass; the scientist alone can make his dreams come true. He can not only harness the powers of Niagara, but can at the same time increase its grandeur; he can make the desert and the swamp alike fruitful; he can bring music and poetry through the air to the invalid. He can not only meet the needs of humanity, he can also satisfy desires that science itself has created.

You will recall the story of the visitor who asked several laborers about their work. One said, "I am cutting stone," another "I am carving wood," but a third answered proudly, "I am building a cathedral." If science is as important to humanity as its devotees have been telling the public, then when asked about our work instead of saying, "I am running carbon determinations," "I am synthesizing rubber," or "I am measuring the orbits of the electrons," we should be able to say in all humility, "I am making the world better."

We have seen much of "science for industry's sake"; we have heard much of "science for science's sake"; we need more of "science for humanity's sake."

WILLIAM BLUM

U. S. BUREAU OF STANDARDS

JOHN HOWLAND—1873–1926

DR. HOWLAND died in London, England, on June 20, at the age of fifty-three. Last February, in Baltimore, he had an illness which was regarded as mild encephalitis, but completely recovered. In accordance, therefore, with a plan formed some time previously, he sailed for Europe on March 30 in company with Mrs. Howland and Dr. and Mrs. James Gamble, of Boston. His object was to visit the European clinics, and at the same time to obtain rest and pleasure. He first went to see his brother, Mr. Charles Howland, of New York, who was at the time in Greece, and then traveled on to Budapest, Zurich, Strasbourg, Paris and London. From Paris he wrote that he was entirely well, but Mr. Abraham Flexner reported that he looked pale and thin, and complained of fatigue. On his arrival in London he was taken acutely ill and shortly afterwards had two hemorrhages, apparently of gastric or duodenal origin. An operation was performed on June 15 under the impression that the condition was duodenal ulcer. Death occurred a few days later. Howland had always been in robust health, scarcely ever missed a day's work on account of illness, had always taken excellent care of himself and was free from all habits injurious to health. The news of his death came as a great shock.

Dr. Howland was born in New York City on February 3, 1873. His father, Judge Henry E. Howland, of New York City, a New Englander by birth and descent, was a man of great personal charm, and distinguished for his wit as an after-dinner speaker; he was an extremely well-known figure in the life of the city. Though moving in fashionable circles, Judge Howland retained a freshness and simplicity of character which he handed down to his son. Howland's mother was Sarah Louise Miller, of a well-known New York family. She was an unusually accomplished pianist and gifted with a remarkably clear and vigorous mind. An ancestor was John Howland, of the Mayflower company.

Howland spent his boyhood in New York City and