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A Responsibility of the Scientist Toward Society*

By JOHN D. CLARK

THE ancients set up the skeleton in the midst of their banquets to remind the banqueters of their mortality—the festive occasions were not allowed to become too festive, lest someone thoroughly enjoy himself. We moderns have made doubtful progress, for, although it is true that we have abandoned the skeleton, and have substituted the retiring president, there is no gainsaying that, whatever gloom the skeleton may have cast on the gathering, he remained silent, yet today we expect the retiring president to speak.

These few opening words suggest my theme—that in many ways we have not progressed to the fullest extent of our capacities, that the scientist has yet a great duty to perform, and that by the practice of the scientific method, by teaching, by precept, and by example, there is something which the scientist can, and should, do for society to enable it to throw off the fetters of antiquity and to come to a full realization of its possibilities for completer and richer use of the three score years of mundane existence of the average man.

There are those who think of the older scientists as men of great curiosity, men who wanted to know why, and men who, if they could continue to seek the truth, found full compensation for their labors in the truth they discovered. Indeed, if their circumstances in life permitted their researches, the research itself was an all-satisfying end. We know only too well how the world regarded these truth seekers. They were only eccentric if their discoveries meant nothing to their fellow men of other walks of life, though they became menaces, fit for, and deserving of, banishment or death if their findings seemed capable of affecting any customs or beliefs of the times. In short, the oldest of the scientists were tolerated with kindness, only if they had no influence upon society. No wonder that the scientists

*Address of the retiring president of the Southwestern Division of the American Association for the Advancement of Science. Denver, Colorado, April 28, 1932.

of the Archean period of thinking, (not Archean period of the geologist), influenced his contemporary society to such a slight extent. In truth, if he affected one or two human individuals so that they continued his researches, he made his major influence upon his fellows.

But lo and behold! Someone sees a use for some patiently sought for fact, or clearly thought out principle—it might lead to means of fleecing some unsuspecting ruler; it may be that a suggestion arises to the effect that there is an easier and more effective way of overcoming an enemy, avoiding some drudgery or catering to some one of the more primitive desires. If the surmise proves true, then society is affected. Science is then (at first, often unwittingly) playing a new role, and so on it goes; life becomes easier, thanks to the application of science; men's hands become more skillful; men's arms are lengthened and strengthened; their legs move faster, become less fatigued and support greater burdens; their eyes see the very minute as well as travel out into the universe; they hear what they have never heard before and speak across space that never carried human voice. Our days on earth become longer, and less harrassed by pain. Our fears subside (or at least partially subside). Mechanical slaves remove our drudgery. We have more moments of leisure. The world is a better place in which to live, because the technologist, the physician and sanitarian, and the manufacturer are applying the findings of the researcher. Van Loon in his *Man, the Miracle Maker*, has covered some hundred pages in making clear that which I have so briefly stated. He is very convincing, and after reading him, we feel well satisfied with our accomplishment. But, there is another, and hideous side to the picture. Science has been applied in the intensification of all the worst of which human beings are capable. Our ancestors were intolerant of opinions of others—and so are we. Rationality is timid and slips from us so shyly, while emotionalism boldly walks in and takes possession of us. With no effort

at all, we return to primitive modes of thought, and stubbornly refuse to face facts. Our all too human minds control the tools of a super-Frankenstein. As Slosson says, "The world, like a child at Christmas, is willing to receive the material gifts of science but refuses its moral lessons. The world will accept from the hands of science railroads, radios, and soft raiment and foreign foods, airplanes and submarines, but turns a deaf ear when science would talk of peace, efficiency, economy, foresight, and the frank facing of facts."

Within the memory of every living adult is that colossal example of 1914, which cost the world twenty million lives, which destroyed the constructive work of a generation, and whose dire effects still enmesh us. Right and wrong were as clearly; or as dimly understood then as they are to-day, yet no one wanted to face the facts of justice or injustice. One can read the writings of any publicist or statesman of any country involved in the World War. All predicted its coming, and as we read their memoirs we gasp that so few really tried to prevent its arrival. It seems, on the contrary, that most of them looked forward to its coming with welcome. The battlefield stage of the catastrophe ended with the Armistice, but the states of mind which we so much deplore were present at the conference table, and emerged in print as the treaty of Versailles.

As Grand Duke Alexander of Russia states in his recent work: "The Peace Conference was to open in a few days. The corridors of the historic Palace of the Kings of France were burning with rumors and intrigues. The Rumanians, the Czechoslovaks, the Portuguese, and the other disputable participants of the victory were tearing apart the dead bodies of three fallen empires. The plenipotentiaries of the twenty-seven nations gathered in Versailles, swore by the name of President Wilson, but in reality the whole show was directed by the so-called Big Four—the French, the British, the Italians, and the Japanese. Look-

ing at the familiar faces of the delegates, I understood that the cannon of the Armistice signified the revival of the forces of blind selfishness: the conditions of the Eternal Peace were to be worked out by the very same statesmen who had caused the war! The joke seemed too gruesome even for the old school of diplomats, but there, leaning against a column, shaking hands and coining witticisms, stood Arthur Balfour, who had dedicated many years of his life to the business of fostering quarrels between Berlin and London. 'Here I am,' said his whimsical smile, 'ready to plant my feet under the table of the Peace Conference in company with the bunch of old foxes who did their damndest to promote the slaughter.' All the great editorial writers to the contrary, the four years of war failed to change the cast of the characters of our little drama. Kaiser Wilhelm may be imprisoned in Doorn but his spirit is marching on."

The calamity due to superstition in high places is clearly pictured in the scenes of Rasputin at the Russian court, a peasant "preventing" the recurrence of the bleeding of hemophilia in the heir apparent. No scientist should fail to read "Rasputin, the Holy Devil."

In 1918 and 1919 Bolshevism could have been laid at rest with the greatest of ease but in the face of the selfish ends to be promoted, facts could not be faced by the statesmen of the world.

One could continue to great length, giving example after example of human conduct in whose planning facts are ignored and in their place are substituted selfish ambition, hatred or greed, and even when every motive is, in these cases, as pure as the driven snow, we can point to examples of partial or complete failure because the scientific method has been ignored.

In 1920 this nation had a gasoline shortage. The scientists went to work. Old methods of geological exploration were improved, geo-physical methods of prospecting were

devised, new ways of cracking came forward, anti-knock agents were discovered, motors were improved, we found out the way to liquefy coal, and even invented new means of hydrogenation of old waste materials. The number of cars in operation increased several fold as these researches were in progress. Now, for more than two years we have had great overproduction of gasoline. The problem enters the fields of economics and government. Antiquated anti-trust laws meet the producers. Governor "Alfalfa Bill" calls out the militia. At the time when the scientist took up the problem of the gasoline shortage, this nation grappled with the problem of the evil of alcoholic drink. As far as we can learn, no scientist was called in, and certainly the methods of science were not brought to play upon the problem. The gasoline shortage is hardly a memory but the prohibition problem has front page in the press and special columns in the magazines, and often monopolizes conversation at dinner, in smoking room or at social gathering. When the Literary Digest poll is completed, we shall have a chance to see how far from unanimous is the belief that our present laws have solved our problem. As a scientist, I wonder what might have been the result had congress chosen to have the president appoint a commission of scientists, to whom their task, "Reduction, and, if possible, elimination of the evil of drink," was announced with the same simplicity that President McKinley used when he asked Rowan to carry the message to Garcia, and if this commission had been clothed with authority to perform the task as its scientific judgment indicated was necessary.

In spite of their exaggeration, I think that the words of Bertrand Russell give our best picture of science at the type of work which seems to have no social, economic, or religious consequences, and at the same time satirizes only mildly what might happen if it did.

"We have had in recent years a brilliant example of the scientific temper of mind in the theory of relativity and its reception by the world. Einstein, a German-Swiss-Jew

pacifist, was appointed to a research professorship by the German government in the early days of the war; his predictions were verified by an English expedition which observed the eclipse of 1919, very soon after the armistice. His theory upset the whole theoretical framework of traditional physics; it was almost as damaging to orthodox physics as Darwin was to Genesis. Yet physicists everywhere have shown complete readiness to accept his theory as soon as it appeared that the evidence was in its favor. None of them, least of all Einstein himself, would claim that he has said the last word. He has not built a monument of infallible dogma to stand for all time. There are some difficulties he cannot solve; his doctrines will have to be modified in their turn as they have modified Newton's. This critical, undogmatic receptiveness is the true attitude of science.

"What would have happened if Einstein had advanced something equally new in the sphere of religion or politics? English people would have found elements of Prussionism in his theory; anti-Semites would have regarded it as a Zionist plot; nationalists in all countries would have found it tainted with lily-livered pacifism, and proclaimed it a mere dodge for escaping military service. All the old-fashioned professors would have approached Scotland Yard to get the importation of his writing prohibited. Teachers favorable to him would have been dismissed. He, meanwhile, would have captured the government of some backward country, where it would have become illegal to teach anything except his doctrine, which would have grown into a mysterious dogma not understood by anybody. Ultimately the truth or falsehood of his doctrine would be decided on the battlefield, without the collection of any fresh evidence for or against it."

The Southwestern Division of the American Association for the Advancement of Science has been very potent among the scientists of our territory in keeping us from becoming experts or specialists in the sense of the definition

that "an expert is one who continues to know more and more about less and less." Papers on every branch of science are read at our meetings, not excluding those on social science or education. Our symposia have been held on wide-awake, up-to-date topics. To them we have admitted the general public and the public has understood the discussion. Indeed, that a paper may be announced on our program, requires that a non-technical abstract be furnished the secretary of the appropriate section, so that the Press may accurately interpret it to the man in the street. Within our membership the biologist has kept informed on the work of the archaeologist, the physicist with the astronomer, the chemist with the physician, and so on, as full opportunity has been granted to each to know of the endeavors of the others. We are a relatively small group. Contacts are easily made. I will venture to say that around this table any individual has conversed this evening during dinner, with not less than three scientists whose field of work is not his own. It has become commonplace to hear one of our members say, "I get more from the meetings of the Division than I do from the National meetings."

I have a vision that the good work of the Division may be widely extended, and that as time goes on we may make a deeper and deeper impression upon society, for as the title of my address postulates, we have a social responsibility. If society often ignores the facts may we not influence it to regard them? I certainly hope that our legislatures and others in authority accept the facts brought out in our symposium on "Readjustments of Educational and Scientific Endeavor in the Light of Changed Economic Conditions." If society makes its hypotheses and explanations with too little consideration of their adequacy, I hope that we may be influential in causing these theories to be revamped. If society acts upon emotions, I hope, that as time goes by, we may bring our influence to bear, at least, in

making these emotions less blind. But how may we do these things?

The optimist tells us that everything can be accomplished through education, yet, as Slosson says, "It may be thought that our proficiency in science and engineering will prevent the recrudescence of superstition; but history does not give us hope of immunity. Magic flourished in Mesopotamia at the time the Babylonians were raising skyscrapers that alarmed high heaven. The Romans consulted the entrails of animals when they laid the aqueducts and sewers of Rome. Today there are more believers in magic, necromancy, astrology, divination, and other forms of witchcraft than there ever were. They may not form so large a proportion of the population as they did in ancient Assyria and Rome or medieval Europe, but they are more numerous because the population is much greater.

"Science rules the laboratory and the machine shop. It does not hold sway over the minds of the people. The extension of science teaching in the public school does not seem to have increased the liking and respect for science as much as was anticipated before it was introduced. This is the age of science, but not a scientific age."

The consorting of a recent lady of the White House with a soothsayer gives illumination to Slosson's words.

But we should not be discouraged. Science is young but we have made progress. Nobody paid much attention to Franklin's kite, but today if someone made a similar discovery of as much possibility, the next morning he would be visited by representatives of General Motors, General Electric, and DuPont seeking to patent the principle. Scientists are at least appreciated for the earning power of their works.

Perhaps we scientists have not done all that we could do. I think that we have not. It is worth thinking about. I believe that we could well afford to take a suggestion from industry. If we study industry we note that three types of

men are drawing large salaries, which means that they are considered valuable as means to an end, that of producing dividends. They are the researcher, the operator, who weaves into substance the results of the researcher, and the salesman who presents to the public the work of both and makes the public understand and desirous to possess.

We scientists have our researchers—men who are at their best in conducting or directing research, but we handicap them frightfully. In our universities, so often we compel them to teach under-graduate classes the work of which bores them. We say that the researcher inspires his classes. Some of them do and some of them most decidedly do not. The former is a gifted soul equally good in the research or operating department. The latter is as out of place in the classroom as he is in the industrial plant.

Concerning research and its effect on teaching, Charles H. Judd says: "Ours is an age of extreme specialization. The college teacher of today is immersed in the problems of his narrow specialty more than were the teachers of earlier generations. His attention is devoted to technical methods of investigation peculiar to the subject which he teaches. This concentration on a particular subject unfits a teacher in some measure—often in a very large measure—for that sympathetic consideration of the mental characteristics of immature students which is necessary if one is to organize instruction in conformity with the psychology of the learning process." Too often a position in an educational institution is to be filled, the candidate with the longest list of publications to his credit is awarded the position, tomorrow to find himself facing a full teaching schedule, and far, far too often, an oversupply of under-graduates who need, not a researcher, but a *teacher*.

Teaching skill which was adequate for instructing the 2.84 per centage of our population between the ages of nineteen and twenty-two preparing to enter the "learned professions" a quarter of a century ago, cannot be assumed

as adequate for the 11.77 percent, now enrolled in our colleges, training for everything imaginable.

We are generous with our handicaps. Wolfgang Ostwald says, "When the Americans discover that a man is superbly fitted for some type of research work, they reward him with some sort of position in which he can no longer pursue it." I agree with Zinnser that "no one can properly direct a department who is not professionally competent in the subject with which he deals," but I deplore the lack of competent assistant directors and assistant deans, the bents of these assistants being primarily administrative and not research.

As industry separates the duties of its researchers, and its operators, so should our educational institutions endeavor to keep the skillful teacher at his teaching, unhampered by other duties. The real teacher is rare. Many go through the motions of teaching but few are 100 per cent inspirational, bring out the best in their students and imbue them with the desire to continue their progress to the top of the ladder. He have argued that the teacher should have the point of view which he gets only from research. I grant much of this, but I also recognize that in his doctor's dissertation, he has secured that point of view, and that in his sabbatical leaves he can continue to keep it, but I also insist that he performs his best work for the future of science when his main efforts are consumed in teaching, inspiring, and guiding the immature minds, put for a time in his custody. I know a man who produces researchers in the freshman year. If freshmen have the finest teacher in the department, the world has the best chance of receiving brilliant scientists in the future.

In his inaugural address at the University of California, President Robert Gordon Sproul, some months ago said, "Under present conditions we have the strange anomaly of teachers being judged not by their ability to teach but by their research output, and investigators being forced

to devote valuable time to teaching that might be given to advancing the frontiers of knowledge . . . The investigator should be allowed to investigate and the teachers should be allowed to teach," and, Dr. Sproul adds, "The rewards for good service in either case should be the same."

Now for that greater stress—our responsibility to society, and some suggestion as to how I think we can do much more than we have ever done to have a much larger portion of our population mentally equipped for more rational thinking and acting—equipped to use the scientific method.

If we pause and consider who creates public opinion and who sets up and administers our laws, it is at once apparent that few of these have been much exposed to the scientific method of thinking, as a part of their preparation for their responsibilities. Some rare few secure this point of view as a result of the working out of their own destinies, but the majority do not. Most of our legislators rise to their positions of responsibility through politics, and politics and science are like east and west, and "never the twain shall meet." If our lawmakers and executives are ever to become more scientific, we must affect them before they enter political life. I have often wondered how different might our affairs of today be if the engineer in the White House could speak to a fair sprinkling of senators and congressmen who had also been engineers, or other scientists. However, he speaks mostly to lawyers, and few lawyers have had much training in science as a part of their training for their professions, and if they have had, it is far from certain that the training has been productive of the scientific mind. There is a wide variation between the natural inclination of mentalities, and almost as wide a variation in the presentations of science to those minds.

Crusaders are needed to teach the public to tolerate social experimentation made in the spirit of scientific research, that social science may be brought more nearly to the level of technological advance.

Shortly after the close of the war there was an attempt made in this country to acquaint the public with science, as was never attempted before. A central office at Washington supplied scientific news items to the press. The press used them. Indeed, the press has become eager to secure news from scientific sources, as witness the space given to our meeting in the press of this city. More popular books on science have appeared since the war than were written in all the ages before, and they have been appreciated by the public, I think, more than by the men of science. I think that the average scientist has not realized the interests that they have aroused, and the invisible assistance they have been to him. Various societies have conducted prize essay contests, conspicuous among which was that financed by Francis Garvan, and managed by the Chemical Foundation. Some of the thoughts I am presenting in this paper have resulted from my service as Chairman for New Mexico of the American Chemical Society Prize Contests from the time they were established to the time they were discontinued. These and the other means of presenting science to the public have been productive of much good, but they have failed to bring about that which I have been stressing.

Some five years after the armistice, some of the eastern universities considered the establishment of "survey courses" in science. Wilder D. Bancroft, of Cornell, published his argument for, and a syllabus of, a course called "Pandemic Chemistry," in the April, 1926 number of the *Journal of Chemical Education*. In his introduction he says, "The universities have two functions in the teaching of sciences. They should teach a science as a professional study and as a cultural study. In the case of chemistry, the universities teach chemistry fairly well as a professional subject for chemists, the medical men, the biologists, the engineers, etc. So far as I know there is no university which teaches chemistry as a cultural study—a part of a general education. . . . Since chemistry is the fundamental

science, one which we are always encountering in some form and in some place, it is particularly desirable that everybody should have some knowledge of chemistry; and yet the teaching chemist does nothing to make this possible. The chemists complain, and very properly, that business men and the bankers are deplorably ignorant of chemistry; but the chemist provides no way for the prospective business man to get even the most rudimentary knowledge of chemistry as a whole. What we need as a cultural course in chemistry is a course which will cover all the ground in chemistry given in the universities without going into too much detail."

Last month, in a letter to me, an international figure in the chemical world wrote, "Having taught for many years; I know that fifty per cent of those I taught would have been much better citizens and much better friends of chemistry if they could have had a general educational course covering the value of chemistry in life, rather than having been required to study some real chemistry which that particular fifty per cent could never absorb."

I have stressed the need of inculcating some of the thinking of the scientist into the coming leaders of tomorrow. To do this, we need a vehicle and that vehicle can easily be the survey course in any field of science. There is real need for experimentation with such courses, and I mean open minded experimentation, which will make serious research into the possibility for good afforded by such work. The man whose love is research in his chosen profession will probably not be qualified to take up this task, for only the enthusiastic teacher, only one who so thoroughly knows his field that his whole attention may be directed to skillful presentation and weighing of results will ever succeed. He will have to work on material which has never learned the love of science, and which never hopes to pursue it, but he has a chance to be of profound influence on those who will, all their lives, be consumers of science, and upon those who will make judgments affecting the wel-

fare of science. I mean those who attain leadership in business, law, and other professional life or even in social position and who become members of boards of regents, legislators, or governmental executives.

It is astonishing to look at the programs of study and the requirements for graduation of those who are training to be the teachers of the children of this country, and to note how innocent these can be of any science. The same is true of that goodly percentage of students who major in music or in art. Elementary, but professional courses in the sciences, are utterly distasteful to these students and they avoid them. It is true that some science is often a part of graduation requirement, but because of the reputation for difficulty that these professional courses have on the campus, many a timid, non-interested student is defeated in them, as far as securing real benefit is concerned, the day he registers. I submit that a little of the spirit of science would greatly benefit our musicians and our artists. Those who have ever heard Tigh lecture on geology, Douglass lecture on the tree rings, Lester explain the significance of the electron, or Hewett cover the archaeology of the Southwest, or (to leave our section and take a national editor) have heard of H. E. Howe, the author of the popular volumes of "Chemistry in Industry" and of "Chemistry in the World's Work," know the kind of men who should take up this work. Science suffered a greater loss than it yet realizes when Edwin E. Slosson passed to his reward. As a part of our responsibility to society, for many more reasons than I have attempted to tell, we need to develop for that great group of lower division college students, some able salesmen of science.

I strongly commend the address on "The Psychology of the Learning Processes at the Higher Levels," made by Charles H. Judd, of the University of Chicago, to the last annual meeting of the American Association of University Professors, and which is published as the leading article in the February Bulletin of the Association, to anyone who finds my paper of interest.