SCIENCE

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MSS. intended for publication and books, etc., intended for review should be sent to Professor J. McKeen Cattell, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

SCIENCE AND CIVILIZATION

THE American Association for the Advancement of Science is sixty-seven years old. It has held annual meetings successively in the eastern centers of population and education, from Boston to Denver and from New Orleans to Toronto. We are today opening the first meeting of the association west of the Rocky Mountains. It gives a more correct impression to note that the Denver meeting of 1901 and the San Francisco meeting are the only ones thus far held west of the Mississippi River cities—in the western three fifths of the United States. The San Francisco meeting has been appointed with the double purpose of encouraging the development of science in the Pacific region and of uniting with other organizations in celebrating the completion of the Panama Canal.

There could scarcely be a better illustration of the relations of science to civilization than the canal supplies. This great waterway has been constructed, not so much by the potency of our national wealth in gold, not so much by the wonderful engineering and administrative ability which we all delight to honor, as by the victory of pure and applied science over the sources of malarial and yellow fever infection. Three centuries of research in the various branches of biology, as pure sciences, inaugurated by Vesalius's anatomical dissections (about 1530), by Harvey's discovery of the circulation of the blood (about 1616), by Hooker's introduction of the

[1] Address of the President, San Francisco meeting, August 2, 1915.

microscope (about 1665), by Leeuwenhoek's discovery of protozoa (1675) and indeed of bacteria (1687), and continued by a succession of unselfish men whose names are as household words to all biologists, had led up naturally to the mighty contributions of Pasteur, Lister and Koch in bacteriology. Then followed, logically, the investigations of Reed and others upon yellow fever infection, and of Laveran, Manson and Ross upon malarial infection. Except for such voluntary tests as were made at the peril of their lives by Doctors Lazear and Carroll in Cuba in the year 1900, in which Lazear paid the extreme penalty of death from yellow fever, and for the tests made by many other volunteers, especially in Italy, as to malaria, in order to determine the precise conditions under which certain mosquitoes transmit these diseases, the canal would not be complete to-day. Our government might not, in fact, have started upon its construction; or, if the government had started blindly to lead the blind, there would have been failure as miserable as that recorded by the French canal company, and for the same reason. We forget unpleasant facts quickly; for example: that of thirty-six brave French nurses who came together to the canal zone, only twelve returned to France; that out of eighteen ambitious young French engineers who crossed the Atlantic on the same ship for service on the canal, only one was alive at the end of thirty days; and that the laborers died by the thousands. The project of constructing the canal was surrendered to an unknown enemy. Let us assume, however, that such sacrifices had prevailed in their purpose and that the canal had been completed in accordance with the engineering plans. With malaria and yellow fever still ruling in the canal zone, and with the zone as a center of infection for all ports of the Atlantic and the Pacific, would a completed canal be a valued asset to commerce, or would it be a constant menace and a nuisance? Let Memphis and Havana and New Orleans answer. A grateful people could worthily erect by the Golden Gate a monument to Lazear, who gave all that he had to make the construction of the canal possible, and to make the completed canal of permanent value.

The minds of all thoughtful people are dwelling daily upon another great application of science—the European and world-wide war. During the past twelve months the resources of the leading European nations have been applied with the utmost intensity to purposes of destruction—to turning the hands of civilization backward. The most recent discoveries in science and the latest inventions are utilized in dealing death to the foe, from the air, from the land, from the sea, and from under the sea. It is a fact that the efficiency of the engines of death in all nations is measured by the state of science in those nations. By way of comment upon this lamentable truth, what shall we who advocate the advancement of science say for the faith that is in us? The prostitution of science to the killing and crippling of men is indeed an ugly fact, but its results are negligible in comparison with the daily ministrations of science to the people's needs. A conflagration may burn a great city; but the inhabitants of that city do not ask that fire, the most useful servant of the human race, shall be banished from their daily lives. The remarkable advance in the civilization of the leading nations during the past four centuries has been due, chiefly, to the hourly and daily influences of accurate knowledge and scientific method; and this advance has been made not by virtue of, but in spite of, wars and the implements of warfare. In this connection, let us note

that the scientific spirit is all but unknown among the Turks, the Moroccans, the Mohammedans in general, the Hindoos, the Egyptians, the Chinese. Amongst all of these peoples, comprising three fifths of the human race, can any one of us to-day recall the names of three men who have contributed appreciably to the advancement of science in the past two centuries? The very limited introduction of scientific method into their countries is the work of alien governors or alien influence. The unscientific nations are threatened with absorption by their more scientific neighbors, not so much because they do not invent or perfect the most powerful cannon, the sturdiest dreadnaught, the speediest aeroplane, or the subtlest submarine, as because the scientific peoples forge ahead of them in the arts of peace, in the modes of thought, in the affairs of daily life. The unscientific peoples are without influence in the world, not because they are unwarlike—the Turks and essentially all Mohammedans are warlike enough to suit the most exacting—but because they are lacking in the every-day efficiency which accompanies the scientific spirit.

The term science may be defined in several ways. From the standpoint which interests us to-day, we may say that science is the relationship of cause and effect. Wherever we observe an effect there has been a cause; wherever causes are operating there will be effects. The same causes, acting under precisely the same conditions, will produce precisely the same effects. This is the experience of every investigator in every subject, and no one has the slightest reason to doubt the correctness of the principle. There is no room for the operation of the arbitrary and the capricious; in fact, the arbitrary and the capricious do not exist in nature. If in one case out of a hundred the result which interests us is different from what we had expected we may rest assured that in this one case some change occurred in the forces acting; a new force entered, an old force became inoperative, or the relative intensities of the active forces changed. When we do not understand why certain events occurred it means that we do not understand the forces which acted to produce the events. The correct explanation of the events means that we have isolated the causes and have been able to express the laws of their action.

The forces which have interested mankind, range from those cosmic forces which operate on a scale so stupendous that we have no control over them, down through those forces which we can control to a limited extent, and on to those which are absolutely subject to human control. We are not able to limit or to increase the output of the sun's heat, and we can not guide the movements of the comets, planets and stars in their orbits. We do not know how to stay the wind and the rain, but we can apply them, in a limited degree, to our purposes, and we can do much to protect ourselves from their injurious effects. The forces which govern the daily life of the individual, the community and the nation, and which govern the relations of individuals, communities and nations to each other are, with rare exceptions, either absolutely under human control or such control is a hopeful aspect of the near future. These forces are the means to certain logical ends, and we can not question that they also operate unerringly according to law. Whether they shall be applied for civilization or against civilization is for man to decide. The automobile may be used to bring the physician on an errand of mercy, or to hasten the robber to a place of concealment and immunity. High explosives will cut a canal through the Culebra ridge, or deal destruction from a twelve-inch shell.

The American army may establish local self-government in Cuba from the highest of humanitarian motives, or it may wage a war of conquest on a weak neighboring country from the low motive of increasing the power of human slavery as a national institution.

From our experiences upon the earth we have learned to place faith in certain simple laws of nature, amongst which are the following:

1. Every particle of matter attracts every other particle of matter, in accordance with the law of gravitation.

2. Heat always flows from a hotter body to a colder body.

3. The volume of a given quantity of gas or vapor is a function of the temperature and pressure to which it is subjected.

If a rifle, elevated at a certain angle above the level surface of a lake, gives a certain muzzle velocity to the bullet, the bullet will describe the curve which the law of gravity says it should describe, and strike the water where the law says it should strike, provided we take into account two small factors that are also acting—the resistance of the air and the rotation of the earth.

A red-hot cannon ball and a red-hot bullet, thrown into a great bank of snow will both cool down to 32° Fahrenheit; the great cannon ball slowly and the little bullet rapidly.

A rubber balloon containing a given quantity of hydrogen gas can be so proportioned that if thrown from a high tower on a hot summer day it will expand and rise, or on a cold winter day it will contract and fall.

If a comet, a hundred million miles away, more or less, is observed very accurately as to its direction from us to-night, again next Monday night, and a third time in two weeks from to-night, Newton's law of gravitation will enable us to determine the curve in which the comet is traveling around the sun, and to say where the comet may be seen three months or six months later.

The great stars and the small stars radiate their heat energy into surrounding space: the great stars cool off extremely slowly, and the small stars comparatively rapidly. Examples of this principle, it is believed, are the great sun, on the one hand, its volume 1,300,000 times the earth's volume, its surface temperature higher than 10,000° Fahrenheit, and its interior temperature immensely higher yet; and the little earth, on the other hand, cool on the surface and relatively cool in the interior.

As the great gaseous suns radiate their heat energy unceasingly into surrounding space, they undoubtedly grow slowly smaller under the force of their own internal gravitation which strives constantly to pull each molecule of gaseous matter to the centers of the stars.

There is every reason to believe that the three simple laws which we have quoted and illustrated are fundamental, and operate invariably throughout the stellar universe.

And so it is, as far as human experience has gone, with all the laws of nature.

To some people this infallible and universal obedience to law—the strict accountability of effect to cause—seems a hard and cruel fact and counter to idealism in its various forms. This is a hasty and faulty view. It is the cause-and-effect relationship which gives us something dependable upon which to build our civilization. The recognition of this principle, whether conscious or unconscious, is the chief difference between modern civilization and the civilizations which prevailed in the days of the inquisition and of the Salem witchcraft. Looking at the subject from the idealistic standpoint, the conception that all matter in the universe is en-

dowed with the property of obeying law—unalterably obeying law—is incomparably grander than the conception of one law prevailing here, another law prevailing there, of irresponsible caprice operating both here and there.

History affords no more remarkable phenomenon than the retrograde movement in civilization which began with the decline of Roman power and continued for more than a thousand years, approximately to the epoch of the Borgias, Columbus and Copernicus. There had once existed a wonderful Greek civilization, but for twelve or fifteen centuries it was so nearly suppressed as to be without serious influence upon the life of the European people. Greek literature, one of the world's priceless possessions, not surpassed by the best modern literatures, was as complete two thousand years ago as it is to-day. Yet in the middle ages, if we except a few scattered churchmen, it was lost to the European world. A Greek science never existed. Now and then, it is true, a Greek philosopher taught that the earth is round, or that the earth revolves around the sun, or speculated upon the constitution of matter: but excepting the geometry of Euclid and Archimedes, we may say that nothing was proved and that no serious efforts were made to obtain proofs. There could be no scientific spirit in the Greek nation and civilization as long as the Greek religion lived and the Greek people and government consulted and were guided by the Greek oracles. If there had been a Greek science, equal in merit with modern science, think you that stupidity and superstition could have secured a strangle hold upon Greek civilization and have maintained a thousand years of ignorance and degradation? Intellectual life could not prosper in Europe as long as dogma in Italy, only 300 years ago, in the days of Bruno and Galileo, was able to say, "Animals, which move, have limbs and muscles; the earth has no limbs nor muscles, therefore it does not move;" or as long as dogma in Massachusetts, less than 250 years ago, was able to hang by the neck until dead the woman whom it charged with "giving a look toward the great meeting-house of Salem, and immediately a demon entered the house and tore down a part of the wainscoting." It was the rebirth of science, exemplified chiefly by astronomy, and secondarily by medicine, which gave to the people of Europe the power to dispel gradually the unthinkable conditions of the middle ages.

Shall we try to estimate what astronomy, an ideal science, sometimes called an unpractical science, has done for mankind? We shall not dwell upon its so-called practical applications, such as the supplying of accurate time, the sailing of ships precisely to their destinations on the other side of the great oceans, the making of accurate maps of the continents and islands, the running of boundary lines between nations, the predicting of times of high and low tides, and so on; we shall consider only the pure knowledge side of the subject.

Conceive of the earth as eternally shrouded in thick clouds so that the earth's dwellers could never see the sun, the moon, the stars and the nebulæ, but not so thick that the sun's energy could not penetrate to the soil and grow the crops. Under these conditions, we might know the earth's rock strata to the depth of a mile or two, we might know the mountains and the atmosphere to a height of two or three miles, we might acquire a knowledge of the oceans, but we should be creatures of exceedingly narrow limits. Our vision, our life, would be confined to a stratum of earth and air only four or five miles in thickness. It would be as if the human race went about its work of raising corn for food and cotton

for raiment, always looking down, never looking up, knowing nothing of the universe except an insignificant stratum of the little earth. This picture is only a moderately unfair view of life as it existed on our planet four hundred years ago, before the days of the telescope, the spectroscope and the photographic plate, and before the days of freedom of speech and thought. The earth is no longer flat, supported on the back of a great turtle which rests upon nothing; it is round, and we know why; and it revolves around the sun in exact obedience to law. The stars are not lanterns hung out in the sky by angels at night; they are suns, hundreds of millions of suns, each on the average comparable in size to our sun. Exists there an intelligent man in the world whose thoughts, every day and many times a day, are not adapted to these facts? Who can estimate the value of this knowledge to the human race?

We have not yet seen little earths revolving around any stars except our own, nor do we know that intelligent beings live upon such planets and are looking down toward our system and seeing our sun as a little star in their night sky; but everybody now holds as absurd the view that our star is the only one of the hundreds of millions of stars which has little planets revolving around it, or that our earth is the only one that is inhabited by intelligent life. Can there be a more inspiring thought than that intelligent beings are probably living here and there throughout the universe, in whatever direction we may look? The spectroscope has shown that the chemical elements which compose the earth are also the constituents of our sun and of the other suns. We have no reason to doubt that the chemistry of the earth is the chemistry of the universe. The spectroscope and the photographic plate are telling us of the close relationship of the nebulæ to those stars which we call the youngest stars, of the young stars to the middle-aged stars, and of the middle-aged stars to the old stars. We can not doubt that the stars are growing older, as we are growing older, as everything in nature is changing and growing older, and in accordance with the same laws which govern the changes on the earth. The student of double stars finds that the movements of the two components of a distant double star system are in accordance with the law of gravitation. Every particle of our experience leads us to believe that the reign of the laws which control our everyday affairs is universal; that the strict relationship of cause and effect applies throughout the stellar system. Does not this broad and stable foundation give valued confidence to those who are building the structure of the other sciences, the structure of everyday life, the structure of civilization?

The purpose of the American Association is the advancement of science in all its branches. Its scope is sufficiently broad to include every subject that is studied scientifically. Papers on the evolution of language, on the functions of governments, on the history of religions, if based upon the relations of cause and effect, have the same rights and privileges and the same welcome upon our programs as papers concerning the spectrum of the latest comet, the atomic weight of helium or the origin of volcanoes.

It is now quite difficult to find a subject that is not being studied scientifically somewhere by somebody. It is this fact which accounts for the phenomenal progress of civilization in the past half century, and especially in the last thirty years. With rare exceptions, all important interests are pulling together for the welfare of mankind, and their efforts are effective because they are advancing over the firm foundation of scientific method. Every branch of

science, every nation's literature or art, every element of "religion pure and undefiled," every element of commerce conducted upon the dignified basis of mutual respect and mutual profit of buyer and seller, is a contributor to the forward movement. It would be a pleasure to support this thesis by reference to definite contributions in many subjects, but time is available for only a few accomplishments of the past and a few needs of the future.

The discoveries in preventive and curative medicine undoubtedly rank amongst the most valued contributions to civilization in the entire range of scientific research. I am disposed to place the names of Louis Pasteur, Joseph Lister and Robert Koch very high on the list of the world's great benefactors. Pasteur was a professor of chemistry whose first investigations lay in the domain of abstract chemistry, and his subsequent successes, which put the world in the way of preventing and eradicating all infectious diseases, proceeded naturally from his application of the methods of research in pure chemistry to the problems of fermentation. He proved that wine, beer and milk ferment and turn sour because minute organisms, always present in the atmosphere, invade these liquids, multiply enormously and corrupt them. Break the skin of the grape, the atmospheric parasites enter the wound and fermentation develops. Exclude the air, or destroy the germs in the air, the wound in the vegetable structure remains clean and healthy indefinitely.

These discoveries by Pasteur attracted the immediate attention of Lister, who applied them in surgical operations. Antiseptic surgery, one of the most glorious works of man, is the result.

Pasteur proceeded upon the theory that just as fermentation is the work of foreign organisms, so certain diseases of animal life are the work of microbes which have entered the body of the sufferer. His first successes in preventive medicine related to cholera in the French fowls, and anthrax in the French cattle and sheep. His treatment reduced the death rate of the fowls and animals from about ten per cent. to less than one per cent. The great British authority, Thomas Huxley, estimated that the savings in these sources of wealth to the French nation in two decades were sufficient to pay the war indemnity of 1871. Proceeding further along the same lines, Pasteur inaugurated the curative treatment of hydrophobia. The fatalities from this horrible malady dropped suddenly from nearly one hundred per cent. to less than one per cent. Do we realize that this was only thirty years ago?

In the next three decades followed the preventive and curative treatments by several renowned investigators for diphtheria, tetanus, yellow fever, malaria, spinal meningitis, typhoid fever and other maladies. Progress has been notable in the treatment of tuberculosis, bubonic plague, cholera, typhus fever and sleeping sickness. There are faith and hope in the future as to preventives and cures for tuberculosis, scarlet fever, measles and cancer. The practise of extreme cleanliness and the use of anesthetics in surgery have enabled surgeons to reach hitherto inaccessible parts of the body, to reduce the death rate enormously, to diminish the suffering of the patient, and to afford health and strength after healing. Wonderful operations upon the brain, upon intestines, upon severed nerves, veins and arteries are now performed. The general health of communities has been improved by the theory and practise of cleanliness and fresh air. The average length of life has increased by many years since the principles discovered by Pasteur have been applied. The increase has been greatest for

children and women and those not in robust health, but it has also been great for those healthy men who have been accepted as risks by the life insurance companies. Life insurance business has been based upon mortality tables which represented the expectation of life under the relatively unhealthy conditions which existed a half century ago. Those tables do not fit modern conditions. The number of deaths is now smaller than the insurance tables predict. This means that the actual cost of insurance is correspondingly reduced. The statistics for the saving from this source are not readily available. It can be said, however, that the increase in the duration of the lives of those healthy men who carry insurance, during the past thirty years, has meant a money saving greater in amount than all the expenditures ever made by the universities, research institutes and individuals in support of medical investigation. This reckoning does not include the saving of the lives of women and children, nor take into account the economic values of the lives of the men, women and children saved. The reckoning likewise omits the vastly greater factor of human happiness which proceeds from healthful and complete family life.

We have referred at considerable length to progress in medical science and have said that this progress followed naturally from Pasteur's investigation of fermentation as a problem in pure chemistry. We do not intend to detract in any sense or to any extent from the glory of Pasteur's work, from the glory of Lister's, Koch's, Roux's, Behring's, Ross's, Ehrlich's and Flexner's services, when we record the simple fact that the structures which they erected and which mankind is finding of incalculable value were built upon the broad and firm foundations which the earlier investigators in biology and chemistry had made ready.

The development of the other subjects which have become so vital in modern life have essentially paralleled that of biology, chemistry and medicine.

It is so well known as to be a trite subject that electricity was studied a full century, following Volta and Galvani, before it was seriously applied to the arts. It is not so well known that the immense value of electricity in current life, as applied by the electrical engineers, is due chiefly to the work of two men: Faraday, in the Royal Institution of London, who, studying electricity as a pure science and with no apparent thought for its possible applications, discovered the principles of magneto electric currents, upon which all modern dynamos and transformers, electric lighting, telephoning and telegraphing, and the transmission of power depend; and Maxwell, of Cambridge University, who wrought Faraday's results into a foundation of complete and rigorous theory upon which future electrical engineers might build.

The X-rays and radium are the products of research in pure science, and quite regardless of so-called utility; yet what is to-day more useful than the X-rays, and what promises greater usefulness than radium and its related radio-active substances?

Pure science studies in the broad fields which we may call botany and chemistry have made scientific agriculture possible. We can not exaggerate the importance of science in farming for the future of the human race.

A few months ago the people of the Pacific coast acquired the power of telephoning directly to Atlantic coast points. Newspaper accounts made much of the fact as a great advance, and so it was; but the newspapers left Hamlet out of the play. Improvements in the insulating system, to reduce losses of current along the line, were

involved; but Bell at New York and Watson in San Francisco inaugurated the long-distance conversations by using the same transmitters and receivers which these same gentlemen had used in the beginning of telephoning, in 1876, over the line two miles long between Boston and Cambridge. The great improvements in the thirty-nine intervening years lie elsewhere in the system. It is possible for San Francisco to talk with New York and Boston, and at quite reasonable expense, because Professor Pupin, of Columbia University, as a result of systematic study, construction and test, discovered that by placing his invention, the so-called "loading coils," at certain appropriate intervals in an electric line, thus making what electricians call a suitable balance between inductance, electrostatic capacity and resistance, the current could be compelled to go through to its distant destination with little loss of strength. Pupin's loading coils are inserted at frequent intervals in the San Francisco-New York line. It might be possible to construct a line without the Pupin coils which would let us talk directly with New York, but the installation expenses for very large copper wires and other costly items would be so high as to impose prohibitive tolls. The happy result has been reached because the telephone company combined an exceedingly liberal and far-seeing policy with the latest discoveries in electricity as a pure and applied science; and all concerned are entitled to receive the grateful thanks of the Pacific and Atlantic peoples.

Wireless telegraphy has been a priceless servant to those whose friends go down to the sea in ships. It has averted many frightful disasters in the past decade. This branch of electricity was made possible by the researches of the lamented Herz and others who studied the properties of electrical waves as we study the light from the nebulæ—from the point of view of pure knowledge.

While the foundations of the sciences have, for the most part, been laid under the auspices of the universities and the special research institutions, it is usually the combination of men of science and successful men of affairs which makes the sciences useful to the people in general, and therefore great factors in the advancement of civilization. To mention only one subject, electricity: we can not compute the world's indebtedness to the pioneers, Volta and Galvani, nor to the great developers of the subject, Faraday and Maxwell; but it is a fact that electricity did relatively little for mankind in general before the year 1865. The world is unable to compute its indebtedness to Edison, Bell, Marconi and other great inventors and business men combined who have brought electricity to everybody's house and office, to every factory, to every village, to every ship as an obedient and ever-ready servant. That these gentlemen have made commercial successes of their ventures seems to have caused certain persons to lose interest in them as men of science. I have no sympathy with that point of view. Only those who have tried it can know how much courage is required to risk everything in a new venture, how many hours of day and night are given to thought of the subject from all possible angles, how unceasingly must be the maintenance of discipline in great business organizations. Not only is financial success doubly earned, and most desirable as an incentive to the succeeding generations, but financial success is absolutely synonymous with making the subject useful to mankind. It is a fortunate fact that there are Stephensons and Fultons, Edisons and Marconis, as well as Newtons and Laplaces, Darwins and Helmholtzes. The latter have laid the foundations broad and deep, but the former have

erected superstructures upon these foundations which the civilized world is using every minute with great advantage. And, further, these structures, which are visible in the daily life of the people, are the incentives which lead to the provision of splendid opportunities for the extension of the foundations. The value of science as a factor in advancing the race depends at least as much upon the applied as upon the theoretical side. There can be no durable structure without the foundation, but the foundation alone, possessing wonderful potentiality, is largely a latent force. History confirms the view that real progress in civilization is most rapid when applied knowledge is not too far behind theoretical knowledge.

There is a valuable lesson in this principle it seems to me, for the newly organized Pacific Division of the American Association; and perhaps I, as a representative of the most ideal of all the sciences, can with propriety outline the lesson. It is a fortunate thing that the astronomer, the geologist, the psychologist, each regards his pure science as the finest of all the sciences; it is easy to remember that medicine and surgery are returning many fold the financial support extended to them, and that agricultural science is a field of extreme need and promise; but what we should especially remember is this: a significant advance in science is not possible if the intellectual life and the physical life of the Pacific region people are seriously neglected. We should use the utmost endeavor to encourage the introduction of scientific method into the fields, the factories, the homes, the construction and care of roads, the improvement of waterways, the building of cities. There is something which every member of the Pacific Division can do to carry the leaven of scientific method into the life of his community. It is not excusable to be a pessimist, yet one can not travel, one can not be thoughtful, one can not be awake without seeing unscientific methods prevailing on every hand. Recall how often some one street in your town has been torn up for repaving in the last twenty-five years. Does the asphaltum on all the streets in your city remain firm and smooth, or does it become wrinkled and bumpy under the summer sun? Were the specifications for the asphaltum written by a man of science—a real engineer—or were the so-called improvements made under the auspices of the politicians?

There are a great many problems in the general government of our country, some of them of extreme importance, which ought to be solved along scientific lines and yet are not. The friends of high protective tariffs were in command of our government during several decades following the civil war. The friends of low tariffs, or tariffs for revenue only, when placed in command, made sudden reductions of considerable extent to meet their own views. Six years ago the schedules were sent up to record high levels, and four years later they were sent down to record low levels. The subjecting of business to such sudden changes and strains is unscientific in the extreme. We should say in fairness that the voters do not desire the schedules to fluctuate violently. No political party has received a mandate from the people in the last thirty years to revise the schedules to a new high level or to an extreme low level. The unhappy situation seems to be the fault of the machinery of control. The problem is a scientific one to which comparatively few members of congress have given conscientious study. All of the forces of interstate and international commerce are acting, not simply once in four years when the administration changes, but monthly and constantly. The schedules should be formu-

lated, in accordance with the country's adopted policy, by thoroughly trained and widely experienced students of economics; by a permanent commission, if you please, composed of the ablest economists that love of country and very high salaries will secure. These facts are recognized in many other countries, but not so by our governing forces. This is not a plea for high tariffs, or for low tariffs, or for moderate tariffs; it is a plea for reasonable stability of tariff schedules, and for a scientific treatment of the subject.

It would seem that the greatest need of the times is in the science of international relationships, to the end that truth and reason may replace deception and brute force. The word diplomacy should be rescued from the dictionary definition, "artful management with the view of securing advantages." The diplomat who seeks the advantage of his country at the expense of another is proceeding on immoral and unscientific lines, and the chances are strong that he is not a benefactor of the human race. He is liable to set in action forces of antagonism which were better not aroused. International settlements which are compelled by victorious war, or by the threat of a great army or a great navy in the background, settlements which do not take account of mutual interests, settlements which neglect the relations of causes and effects, are apt not to be settlements at all. They generally lead to unhappiness, retrogression and violence. It is a fearful comment upon diplomacy that Europe has had wars nine years out of ten since the beginnings of historical records.

It ought to be clear to historians that the forcible bringing into one country of a province, forcibly taken from an adjoining country, which speaks a different language and possesses different temperament and ideals, is in general a grievous mistake. It is usually a misfortune for both countries, especially if the two countries are of approximately the same degree of civilization. The repression of native language and customs, and the constant presence of alien governors, produce reactions which are as natural as the falling of an apple from the tree to the ground. If the economist is interested in balancing the finances of such a case he will seldom have difficulty in proving that the cost of holding the province for the conqueror is greater than the province is worth; and the cost of planning to get the province back is greater than the province is worth. The issues between the two countries are not settled by the process; they are left more unsettled than ever; and eventually the whole world may have to pay the cost of the false solution. It can not be pretended that wars in general settle international questions either justly or permanently; they merely repress certain forces until natural developments cause these forces to break out anew. A mistaken sense of national honor, usually combined with national selfishness, leads to settlements which are merely temporary. Settlements along scientific lines, settlements which consider cause and effect in the decades that are to follow, are so rare as to be negligible. There is scarcely any hope that the present inexcusable war will settle the differences between the nations, if the final adjustments are left to the professional diplomats of Europe. Some difficulties may be threshed out, but a new crop of difficulties will almost certainly be sown for a later generation to reap. It is an infinite pity that the plain lessons of history are so often forgetten in moments of international passion.

I should not like to have it thought that this is a plea for peace at any cost. I am speaking of war in general; there are exceptions when not to fight would be more

unfortunate than war; but just settlements of wars would go far to prevent war.

The human race needs above everything else the conviction that the principles of science rule everywhere, and that the problems of personal and national life are not solved so long as any important forces are ignored. The need is especially great in our own country where isolation from other countries and the existence of immense reservoirs of natural resources have let us seem to keep up with international progress in spite of our wasteful and inefficient methods. It were well to recognize that entry upon world affairs, which we can not long avoid, will reveal costly weaknesses.

The appeal of science for the adoption of scientific methods in the daily life of the people, in the governments of community, state and nation, in the settling of international questions, is not an appeal for efficiency at all costs. The life that is forever bent over the exact equation, two plus two are four, a life that tries to express all its experiences in equations equally exact, is liable to be narrow, distorted, unhappy and misspent. The man who worships scientific efficiency, like the man who is a slave to gold, or the man who pushes his religion too far, may acquire a harsh and selfish view of life; pity and charity may drop out of his vocabulary.

Our appeal is for the scientific method of treating the problems which are before us for solution. The scientific method is that which takes account of all the forces acting. It is therefore the just method. It is in full harmony with the Golden Rule, "Do unto others as you would have others do unto you." It is, if you please, in full harmony with the spirit of Christ. Support is given to research by the governments and by generous men and women in order that the truth may be found and be made available in the service of mankind. The investigational laboratories of the universities, the observatories, the private institutions for research, have precisely these ideal purposes, and no other purpose. The various activities of the world contribute to the advancement of civilization in proportion as they contain the ideal and the unselfish. That which is purely practical, containing no element of idealism, may sustain existence and to that extent be valuable, but it does not civilize. I believe it is the idealism of pure knowledge, the idealism in applied knowledge, the idealism in industry and commerce, the idealism in literature and art, the idealism in personal religion, which leavens the life of the world and pushes forward the boundaries of civilization.

W. W. Campbell

INDUSTRIAL ACCIDENT STATISTICS

The United States Bureau of Labor Statistics of the Department of Labor has just issued as Bulletin 157 a report on Industrial Accident Statistics by Frederick L. Hoffman. The adoption of the principle of workmen's compensation by more than half of the states within the last few years emphasizes the importance of the industrial accident problem and foreshadows the time when such compensation for industrial accidents will become universal throughout the United States.

As one method of measuring this importance, the bulletin presents an estimate of the number of fatal and nonfatal industrial accidents occurring among American wage-earners in a single year. The conclusion reached is that the number of fatal industrial accidents among American wage-earners, including both sexes, may be conservatively estimated at 25,000, and the number of injuries involving a disability of more than four weeks, using the ratio of Austrian experience, at approximately 700,000. These numbers, impressive as they are, fail to indicate fully the number of industrial accidents, for such studies as have already been made show that of the accidents involving disabilities of one day and over at