Science and Life in the World

George Westinghouse Educational Foundation Forum, 16-18 May

THE GEORGE WESTINGHOUSE EDUCATIONAL FOUNDATION sponsored a three-day forum, in observance of the centennial anniversary of the birth of the founder of the Foundation, in Pittsburgh, 16–18 May. The general theme of the forum was: "Science and Life in the World."

The opening session, entitled "Science and Civilization," was addressed by A. V. Hill, foreign secretary of the Royal Society, London, who spoke on "Scientific Ethics." He called attention to the fact that "some might believe that it was a sign of approaching old age to have chosen 'Scientific Ethics' for a topic instead of something more practical and up to date," but he felt that all scientists, young and old, are really deeply concerned about ethics, whether they know it or not. He made his hearers feel that students of a scientific ethic have a definite advantage over the champions of other ethical systems in the universal cogency of scientific methods and results. "All sensible men everywhere finally agree about the facts; race, religion, and political opinion have no bearing at all on them or their interpretation," he concluded.

Prof. Hill went on to say:

> To a cynical observer of the recent behavior of *homo sapiens* these moral reflections may sound naive: I admit that I often feel skeptical, myself, about the outcome. But there seems to be no alternative: We scientists throughout the world must take the initiative in these matters. We must not leave it to others who will certainly do nothing about it. If we do, we and our civilization may perish together.
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> We in England have recently watched with admiration the example of strong and courageous initiative taken by certain American scientists in refusing to be coerced and conscripted against their conscience: I say to you, the same determination exists elsewhere. As free men we are all unwilling to be used as pawns in the game of international power politics: to consent in advance to the exploitation of science for secret purposes that we may not approve.

He spoke sympathetically of the Acheson Report (*Science,* 1946, **103**, 451), calling it a "notable example of the mixture of hard common-sense and practical idealism which is typical of America at its best."

In considering the subject of international control he pointed out that atomic explosions are not the only means by which a future aggressor might attempt to dominate the world. "Microbiologists," he said, "might make themselves as great international nuisances as physicists, with less danger, perhaps, of being found out in time."

Isaiah Bowman, president of Johns Hopkins University, spoke during the same session on "Social Composition of Scientific Power." "We shall not easily accomplish the ends of the United Nations," he said.

"Men say that world cooperation will surely work now because the swift communications of science have so obviously brought the world together." But he regretted that "our togetherness is an affair of copper wire," airplanes, and radio—technology—"rather than an affair of recognized universals of spirit and ideals."

"Our views," he held, "are no less bounded because we travel around the world swiftly, or talk to it on the instant." Even if "geographical highways" are open, psychological barriers remain.

Dr. Bowman concluded his analysis of the social composition of scientific power by saying:

> Facing the raw facts of today's world we see a special role for science. If it is not yet in the area of free discussion the world around, its tendency is unremittingly international. Discussion under free conditions will help reduce the most refractory difficulties. It has been said that government, by discussion, ''broke the bond of ages and set free the originality of mankind.'' Parliaments rather than dictators; free speech rather than ''party line''; rising standards of living to which applied science contributes powerfully; a striving for peace rather than a striving for confusion supported by a stimulated fear of war—these are some of the building blocks of our future ''good life.'' Among the agencies of construction are all forms of learning, including science.

George W. Merck, president of Merck and Company, spoke realistically, factually, of biological methods of offensive and defensive warfare. He said that "in the fall of 1941 opinion in the United States regarding the possibility of biological warfare was not uninformed," but that "common prudence dictated a serious consideration of the dangers of possible attack along these lines."

"The President," he revealed, "directed an initiation of an extensive large-scale investigation of the possibilities and potentialities of biological warfare in the United States and the establishment of active collaboration with the British and Canadians." These objectives, he said, were attained, and "defenses against the potentially dangerous biological attack were devised so that there was no possibility of surprise from this quarter."

He also said that, "while biological warfare was not actually used in military operations in World War II, enough was discovered to make it imperative that those responsible for our national welfare be ever on the alert in the future."

He related that "at the height of its development, the Special Projects Division of the Chemical Warfare Service of the Army, which carried the main responsibility for the biological warfare program, had a personnel of 3,900. In addition, the Navy had a separate group of nearly 100 at work on a special phase of the problem. The work of these groups, and that done in the universities, research institutes, and industries, represented a truly combined operation in which Army, Navy, civilian personnel, and allied teams worked together in the closest cooperation."

The following principal accomplishments were revealed:

1. *Methods and facilities for the mass production of pathogenic microorganisms and their products were developed.* Offensively, methods were discovered for making microorganisms as virulent as possible and for maintenance of virulence under different conditions of storage for different lengths of time. Defensively, new methods for protection of personnel, animals, and plants against these virulent strains were perfected.

2. *Methods for the rapid and accurate detection of minute quantities of disease-producing agents were elaborated.* These defenses, he held, will be of value in peacetime work in laboratories, hospitals, and industries.

3. *Significant contributions were made to the knowledge of the properties and behavior of air-borne, disease-producing agents.*

4. *A pure, crystallin, bacterial toxin was isolated and studied for the first time.* This was the toxin of *Clostridium botulinum*, Type A, which, he said, "is the most potent biological poison known to man" (*Science*, 1946, **103**, 613).

5. *Vaccines for the protection of chickens against two highly fatal diseases known as Newcastle disease and Fowl Plague.* Chickens are an important source of food for human beings.

6. *Large-scale tests of a vaccine for the protection of cattle against rinderpest, a fatal Oriental disease, were made.*

7. *Extensive studies were made on the production and control of diseases which might affect crops of economic importance.*

8. *Information was obtained regarding the effect of more than 1,000 different chemical agents on living plants* (*Science*, 1946, **103**, 469). This is a particularly fertile field that promises much to agriculture in terms of selective plant control agents, but, he said, "the work was initiated to find destructive agents against various crops and was successful." Only the rapid ending of hostilities prevented field trials in an active theater of war.

The most immediate peacetime benefit from all of this war work will be the administration, through the agency of UNRRA, of surplus rinderpest vaccine to cattle in China, where rinderpest is a disease of great importance for the survival of the Chinese who depend on cattle for food and transportation.

At a luncheon session L. W. Chubb, director of Westinghouse Research Laboratories, spoke on "Partners in Science." He made the point that the slow methods of technological application of the past, typified by Watt and his teakettle and by Goodyear and his kitchen stove, have given way to highly specialized teams requiring great skill on the part of the individual members and long periods of training in the operations involved.

He paid tribute to the first of these partners—the scientists who are producers of new knowledge subsequently applied in industrial pursuits: he spoke of these workers as being located predominantly in the universities, where they are motivated principally by the desire for new knowledge, having in mind no immediate technological application of their work.

Dr. Chubb felt that the second "partner in science" is the inventor who suggests practical uses, new combinations, and pertinent applications of abstract knowledge passed on by the first partners.

The third partner, he said, is the engineer who develops and designs new products and processes.

He pointed out that these partnership functions need not be separated but may, occasionally, be integrated in one person, although this rarely happens. He said:

> Popular opinion has put science in the saddle for several reasons. In the first place, each group of partners in science likes to think that its contribution is the most important, and I believe that the scientists and scientific journals were not at all backward in reporting their accomplishments. Then, popular reporting of scientific work is more newsy than the more prosaic work done by engineers. Finally, the most glamorous accomplishments, such as radar, the atomic bomb, and the proximity fuse, are applications of scientific knowledge more recently acquired, and they are credited mostly to the scientists, particularly physicists and chemists, who in special groups actually carried on the development. Probably well over 95 per cent of the activity on these glamorous items consisted of engineering and production. All of them were applications of prewar scientific knowledge. Although a great amount of specific research had to be done, most of the work of the scientists was invention and engineering development, and these are activities quite outside of their usual field.

He continued: "There is a general feeling that during the war a great amount of fundamental scientific work was done, and that the store of basic knowledge is full to overflowing. This, unfortunately, is not the case, because workers in pure science were taken from their usual pioneering activities and used to solve pressing war problems in industrial research, invention, and engineering development."

Now that the war is over, he said, "we need to revert to the usual sequence of technological development proven by past experience"—research scientists and professors should go back to the universities to do their chosen work in fundamental research and the training of men to carry on in industry."

In the afternoon session, "The Future of Atomic Energy," Frank B. Jewett, presiding, Robert J. Oppenheimer opened with a short address on "Atomic Explosives." One gathered that Dr. Oppenheimer was not interested in explosions, whether they were "atomic" or not.

The use of nuclear energy in warfare, he thought, should definitely be barred, but not all applications should come under the ban.

Complications come because there are perfectly legitimate ways to employ our new-found knowledge of nuclear physics. These methods need some kind of authority to guide us in applying them. At this time, he said, there is "no authority for prohibiting anything" as far as international relations are concerned.

In this connection, he spoke of his belief that the Acheson-Lilienthal Report (Science, 1946, **103**, 451) offered the best solution for "making use of those differences in the requirements of fissionable materials for employment in reactors as opposed to atomic explosives."

Enrico Fermi, professor of physics, University of Chicago, spoke at a later time on the uses of nuclear energy for power. He pointed out that mobile units smaller than our largest locomotives are not likely, even though the weight of the "fuel" is negligible. Massive shielding to protect operators or even casual human visitors against biologically harmful radiations is a present requirement, he said.

Speaking on the biological phase, W. Edward Chamberlain, professor of roentgenology and radiology, Temple University School of Medicine, held that the shift in emphasis from morphology to function among biologists was in part, anyway, stimulated by the discovery of the X-ray, which permitted fluoroscopic observations of function, and that the trend in this direction is now being stimulated by the availability of biological tracers and therapeutic agents manufactured in conjunction with chain-reaction piles, cyclotrons, and betatrons. He spoke in some detail on the variety of radioactive isotopes and especially of radioactive iodine in the diagnosis of pathology of the thyroid gland.

He pointed out that "therapy with radioactive isotopes is definitely a two-edged sword" and that safe procedures must be supervised by people with adequate knowledge and experience. He also felt that supervision was going to be very difficult as radioactive materials become more generally available. As one listened to his account of early X-ray abuse by the pioneers and the poorly informed, he felt that Dr. Chamberlain was warning against a too enthusiastic and misinformed use of radioactive isotopes.

In concluding, Dr. Chamberlain said that "from the point of view of biology and medicine, a truly brilliant future can be predicted for atomic energy, provided its potentialities as an explosive do not lead to the total destruction of our civilization."

He went on to say: "If the greatest of physicists, chemists, and engineers can be brought together for the enterprise that made a place in history for Los Alamos, why cannot the greatest men in the fields of psychology, psychiatry, human history, and social technics be similarly brought together?"

Hugh S. Taylor, dean of the Graduate School, Princeton, spoke at this same session on the numerous chemical applications of the radioactive isotopes which now for the first time can be produced in sufficient quantities. The nuclear reactor, unlike the cyclotron, can produce useful quantities of these important tracers and possible therapeutic agents.

At the dinner session on 16 May Vannevar Bush, director of the Office of Scientific Research and Development and president of the Carnegie Institution of Washington, spoke on "Planning in Science." Excerpts from his address follow:

Do not mistake me, however, as blandly joining the chorus which is bewitched by the magic of the word ''science'' and sings an ill-considered and often cloying paean of praise to something summarily referred to as ''the scientific method.'' I am decidedly not one of those who speak of the scientific method as a firm and clearly defined concept and who regard it as a mystical panacea immediately applicable to any trouble and immediately productive of complete cure. Of course, there is a system of approach to specific problems which we know as the scientific method—an orderly sequence of hypothesis and analysis which, by a series of approximations and tests, culminates in a practicable theory of operation. But to give this name of ''scientific method'' to mental operations involving no more than the use of common sense, or indeed to operations which are no more than rigorous logical thinking, is a mistake. I therefore wish not to be taken as joining those who facilely argue that all we need to do to settle any difficulty is apply the scientific method to it. Nor do I wish to imply that the greater frequency which I foresee for direct intellectual contribution by scientists to our national life will consist principally in attempts to carry over into public forums, legislative committee rooms, and industrial plants a specialized technique of thinking, admittedly very effective but admittedly also best suited to the laboratory and the study.

The second day opened with a session devoted to the general topic, "Transportation—A Measurement of Civilization." Edward Warner, president of the Interim Council, Provisional International Civil Aviation Organization, spoke on the aviation phase.

He said that there was no guarantee that the airplane will actually improve the world, but that it has three characteristics which give it value: (1) It gives more rapid transportation than is available by any other means; (2) it can go directly from one point to another; and (3) rising, as it does, to great heights, it can give an otherwise unattainable vantage point for observation of the terrain. All of the uses to which aircraft are put arise out of some combination of these three properties. To get men together quickly may result in their quarreling, and whether or not they are going to quarrel in the future or arrive at some amicable settlement for their differences depends, the speaker said, on an understanding of the "realm of human relations." Dr. Warner said that the use of the airplane for transportation, although not limited completely to organized airlines, still, even in the future, will consist of 80 to 90 per cent of the common carrier type; and although there will be a great increase in the actual number of private planes in the United States, these will not bulk large in the percentage of total air travel.

He felt that the romantic appeal of intercontinental flight overshadows the more prosaic business of carrying day-by-day passengers between near-by points. On the airways as on the highway most travel is between adjacent points. He pointed out that, although it has been suggested that the airplane will be a factor in the enlargement of commuting areas around large cities from the present 30 or 40 miles to 100 or 200 miles, flights of this kind are still too expensive, a monthly commuting ticket costing about $200 at present rates.

In the field of international relations we run into the now familiar culture lag. In this case it seemed to the speaker a strange anomaly that, 40 years ago, crossing the Atlantic required a week, while preparation for the trip took no longer than the time required to pack a suitcase, get a ticket, and pay the fare; whereas, at the present time, when the Atlantic can be crossed in less than 12 hours, it is the very fortunate traveler who can make his way through all of the barricades of passport and visa requirements, tax receipts, and currency authorizations in less than a week of preparatory activity. The International Civilian Air Organization has to consider, among other things, the simplification of these international barriers to travel. This group believes that a passenger should not be delayed any more than 15 minutes between the time the airplane touches the ground and the time the passenger is free to leave the port, and that a similar reasonable criterion should be applied to express shipments. The ultimate effect of international air travel will be to break down international boundaries.

The PICAO plans a series of demonstrations of current work on air-navigation aids in the United States during this summer and will then proceed to a meeting in Montreal in September, at which it is hoped that standard systems and equipment for immediate installation can be agreed upon.

A problem for the future concerns the adaptation of radar equipment so that the pilot will himself be aware of obstacles and other aircraft instead of having to depend on radio contact with the ground station to avoid these hazards as he does today. Dr. Warner believed that it is inevitable that, step by step, the quality of air transport service will improve during the next half century and that it will become more reliable and more economical. "It will assume increasing status as a major element in the world's transportation systems. As it does, it will present new problems of organization and new problems of political and economic relationship among the nations. In its growth, it ought indeed to be a civilizing force."

Marine and rail transportation were treated by Adm. Emory S. Land, former chairman, U. S. Maritime Commission, and Martin W. Clement, president, Pennsylvania Railroad. Charles F. Kettering, general manager, General Motors Research Laboratories and chairman of the executive committee, AAAS, who was to have spoken on automotive transportation, was unable to be present, but his paper was read by A. L. Boegehold, director of the Metallurgical Department of the Research Laboratories of General Motors.

The luncheon session was addressed by Frank B. Jewett, president of the National Academy of Sciences, who spoke on "Horizons in Communications."

In the afternoon session there was a symposium on biological science, at which Cornelis B. van Niel, professor of microbiology, Stanford University, spoke on phytosynthesis, and Selman A. Waksman, professor of microbiology, Rutgers University, and discoverer of streptomycin, outlined our present understanding of microorganisms with special reference to those that are known to be either harmful or beneficial to man. Two other speakers treated biological groundwork: Linus Pauling, California Institute of Technology, spoke on "Molecular Architecture and Biological Reaction," and George W. Beadle, Stanford University, treated "High-frequency Radiation and the Gene."

The Friday evening session followed a dinner at 7:00 o'clock in the ball room of the Hotel Schenley. There were two addresses: Charles W. Kellogg, president of the Edison Institute, spoke on "Electric Power—The Foundation of Industrial Empire," and Karl T. Compton, president, Massachusetts Institute of Technology, spoke on "Scientific and Engineering Progress—Insurance Against Aggression and Depression."

Mr. Kellogg noted that every industrial worker has the equivalent of seven horsepower of electric energy available to him, and that the electrical horsepower per man in industry grew 58 per cent in the 15-year period from 1929 to 1944. The productiveness of the individual worker is high as a result, and he can be paid more. According to Mr. Kellogg, "real wages of workers in industry grew 63 per cent in the same 15-year period." He also pointed out that workers earn, in different countries, an amount which bears a close relation to the mechanical horsepower available in these countries.

He pointed out that the first central generating station built by Thomas A. Edison in 1882 was conceived of as a means of making a filament of an electric lamp burn; the early "electric" companies were really "lighting" companies, as their names attested.

With the growth in the load on these first central stations, the use of electricity for power as well as light and the constantly increasing distance of the load from the central station, the industry encountered difficulties with transmission and distribution. With the relatively low voltage at which the direct current had to be generated for safe use by customers, substantial load growth meant either a fabulous investment in copper conductors or the necessity for many relatively small generating stations or both. This dilemma was solved by George Westinghouse, through the development of the alternating current system, which is used throughout the world today.

In 1890, Westinghouse built a small 100-horsepower, single-phase, alternating-current plant at Telluride, Colorado. The voltage was 3,000 and the transmission distance was only three miles, but the amount of copper required for the transmission line was very small compared to that needed by the direct-current plant proposed by Edison in competition. The success of this plant led to the adoption of alternating current for the first Niagara Falls plant, where Westinghouse installed three 5,000-horsepower polyphase, alternating-current generators in 1893. These machines are the forerunners of modern hydroelectric generators of well over 100,000 horsepower.

Looking back now it is easy to see that, without the alternating-current system, the size and scope of our present-day electric power systems would be quite unthinkable. The development of the years has shown the greatest economy to result from generation in large stations. Without alternating current, and consequent high voltage for transmission, it would be impossible to carry the power away from such large stations. With the direct conveyance of power through the heaviest leather belt, travelling a mile a minute, it would require a belt nearly two-thirds of a mile wide to transmit the output from the largest modern station; but with alternating current at 220,000 volts this power can be safely carried away over three wires the size of your thumb.

In distribution throughout even urban areas, the beneficial effect of alternating current still goes marching on. At the turn of the century the high-voltage distribution about cities was at 2,200 volts. This involved only 1/100 the line loss that would occur with 220 volts, but when, with the passage of time, loads became too heavy to be carried satisfactorily at 2,200 volts, substations, fed by 13,200 volt lines, were dotted about the city. Now, normal distribution is itself being stepped up to 13,200 volts, with no loss in safety, with a further cut of 36-fold in line losses and the consequent ability to improve voltage regulation and to eliminate countless substances.

Dr. Compton pointed out that although the Government has called on scientists in every great emergency since the Civil War, the period between wars has been almost wholly without governmental support or recognition. In speaking about the present legislation before Congress concerning an Atomic Energy Commission, he said that, "It will be a catastrophe and a disgrace and will leave the country in a period of doldrums," if Congress should fail to pass adequate legislation at this session.

One of the objectives of the National Science Foundation legislation is to provide for, "a great program of scholarships or fellowships in order that the scientific talent inherent in the population may have full opportunity for education and demonstration, and that the deficiency in scientifically trained personnel created by our policies during the past war may be eliminated." Without this provision, "laboratories will be only a delusion and a waste of money, and factories will before long become obsolete."

He pointed out that labor has nothing to fear from science and that "labor has its stake" in scientific progress just as the public has.

On Friday the staff of the Buhl Planetarium and Institute of Popular Science offered two programs as alternates to the regular sessions. Both of these popular treatments were well attended by the registrants.

Saturday morning was spent in a trip through the Mellon Institute of Industrial Research under the guidance of its director, Edward R. Weidlein, who has been on its staff in several different capacities for the last 34 years.