agencies. Each plays its special part. Few can compose music; most of us can enjoy music and some can help in the financial support of music. Patrons of the arts have made possible our present museums with their priceless treasuries of the best thoughts of the past. It would be as unwise to attempt to force all into careers of research as into careers of musical composition. All, however, should have the privilege of knowing and enjoying at least some phase of science. The problem regarding the supply of new leaders of science is to catch them early and give them increased opportunities for the development of their exceptional powers. The problem for those who are enjoyers of science without professional intent is the accurate but interesting presentation and dissemination of scientific knowledge. Beside the formal educational institutions, such agencies as Science Press and the members of the National Association of Science Writers are contributing to the solution of this problem. The problem for the potential patrons of science is the realization that their benefactions are investments in science which should be scrutinized as carefully as a purely financial venture in order to ensure adequate dividends in scientific returns. We congratulate this university that its patron not only provided the funds with which to erect this beautiful temple of science but also had the foresight to provide a permanent endowment in the university which could be used towards its continuing support.

These are dark days throughout the world when in many countries science has been as effectively bombed by governmental fiat as have stately edifices been bombed by missiles from the air. What of the future of civilization, we are asked, and what part has science to play? Turning the pages of history gives us scant comfort. Civilizations widely separated in time and space have flourished and disappeared. Is ours also to obey the laws of growth, decay and death? In the warm summer it is hard to think of winter's cold, and we instinctively feel that our civilization will endure; we have gone so much farther on the upward road, we say, that the curve must continue to rise. It is dangerous to extrapolate the future from the present. Think of the temperature curve of H_2O. Starting with water at room temperatures there is a gradual decrease in volume until at 5 degrees the volume begins to change in the opposite direction and a sudden expansion takes place as the liquid changes to a solid, ice. From the slight range of room temperatures it would not be possible to predict the sudden reversals of the curve, as water freezes. It is equally impossible to be sure that the curve of our civilization will continue its upward trend. There is one fact, however, that may be a ray of hope to our calculations. Science has reached a stage of development in our time that no other civilization has known. The experimental method, for example, has only recently become of use. Scientific methods are now available as never before for study of all phenomena of nature, even that of a sick civilization. It is my trust therefore (though this may be wishful thinking) that science will find a remedy for our present international ills as it has for many a pestilence that walketh in darkness. If and when the time comes for restoration of peace and good will, I believe science may lead the way. I attended the International Congress of Genetics in Edinburgh last fall which was broken up by the advent of war. Some of the members belonged to countries where now liberty is but an empty name. Science had brought us together individually as friends and we separated as friends when the congress was prematurely disbanded. We trust that the internationality of science will some day bring us together again as friends.

We are all the privileged legatees of the past, rich from the toil and sacrifice of those of other days. America is favored as nowhere else. Our science is still free. American science therefore has an especial duty to keep aflame the torch of free research for truth, which is dimmed or gone out in so many lands. We believe that when the goddess of truth is seen snatched from her temple and publicly trampled under foot, our duty is not merely to mildly protest but to summon up our emotions as men and to fight with all the moral energy at hand, fight not merely for the preservation of our own land and the spiritual values we have gained but for freedom throughout the world. In science all nations are one people and the world can not endure part free and part slave. We are not without hope in the ultimate salvation of mankind. We believe that the free search for truth by the methods of science has power to rebuild the world and we have faith that it will prevail.

THE STATE SCIENTIFIC SURVEYS OF ILLINOIS[1]

By Professor W. A. NOYES

UNIVERSITY OF ILLINOIS

THE Board of Natural Resources and Conservation is a non-political organization, the members of which are appointed by the governor of the state but are selected because of their expert scientific training in lines closely related to the work of the State Surveys. The original board was appointed in 1917 by Governor

[1] An address given at the dedication of the Natural Resources Building at Urbana, Illinois, November 15.

Lowden and included such men as T. C. Chamberlin and John M. Coulter, of the University of Chicago. William Trelease and I of the University of Illinois were also appointed by Governor Lowden and have been reappointed by successive governors, irrespective of their political affiliations or of ours. The board controls the work of the surveys and approves all appointments of the employees, including the chiefs. No member of the staffs of the surveys has ever been appointed for political reasons.

The Geological and Natural History Surveys are housed in the building which we dedicate to-day. The building has been constructed with funds supplied by the state to the Department of Education and Registration. The Federal Government has also furnished, through the P.W.A., a very considerable part of the fund used. The State Water Survey has its office and laboratories in quarters furnished by the University of Illinois in the chemistry building.

The State Water Survey studies the water resources of the state, which have a value of more than 50 million dollars annually, in spite of the fact that water is said to be free as air. During recent years it has developed methods of fermenting the organic matter of industrial wastes which were formerly allowed to run off in the streams of the state, killing the fish in some of our large rivers. The fermentation yields methane, a gas used for heat and power, and worth enough to pay for the cost of the process. Very recently the survey has been studying the structure of the water molecule in cooperation with the division of physical chemistry in the department of chemistry. The results are of great importance scientifically and also of value in biology and in industry.

The members of the State Water Survey have recently been called upon to do important work for the national defense.

The Geological Survey has become an integral factor in the industrial development of the state. Its researches aid the mining and quarrying industries, those manufacturing industries which use minerals as raw materials, the various railroads in their development of industries along these lines, engineers engaged in the design and construction of large structures, bridges and pavements, and cities and industries throughout the state who seek more adequate sources of ground waters. It helps the clay industries of the state. The large coal resources of the state are also of great importance. All these are of vital consequence to our standards of living. In certain phases of its work the Geological Survey cooperates with the Department of Ceramic Engineering and the Department of Mechanical Engineering of the Engineering Experiment Station and with the Department of Geology of the University of Illinois, and also with the Departments of Geology of the University of Chicago and of Northwestern University. To the Geological Survey is entrusted the topographic mapping of the state, and in this work it cooperates with the U. S. Geological Survey.

With national defense looming large, the mineral resources of Illinois, located in the interior of the continent, promise greater development. In 1938, the value of the mineral production was 160 million dollars, and in 1939, 283 million dollars, an increase of 123 million dollars. Significant is the fact that Illinois' new oil fields, in whose development the Geological Survey played an important part, produce three times as much oil as the fields of Rumania produced just before the opening of the present world war. With industry necessarily playing a vital part in the national defense program, the Geological Survey's contribution in research and advice will be of greater value and in greater demand.

The Natural History Survey is concerned with research in the state's great wealth of renewable natural resources, those resources that under adequate protection and wise utilization are inexhaustible. In certain phases of its work it cooperates intimately with the Agricultural Experiment Station of the University of Illinois.

Upon the results of the experiments of the Natural History Survey are based control measures for the destructive insects and diseases that threaten agricultural crops, income from which approximates annually a half billion dollars in value, the greenhouse industry with its annual crop value of fourteen million dollars and the forest industry with its six million dollar annual income. These figures do not include the income from nursery products, truck crops and numerous smaller but important industries associated with some phase of agriculture or with utilization of renewable natural resources. When the destruction of a large part of the corn crop was threatened by chinch bugs, a few years ago, it is estimated that through the advice of the Natural History Survey of the Agricultural Experiment Station a loss of three million dollars to the farmers of the state was prevented.

Upon the results of its studies are based management practices intended to preserve and increase the once abundant but long neglected wild life of the state, the fish, the furbearers, the waterfowl, the quail, the prairie chicken and other upland birds. The value to the people of Illinois of the wild-life resources transcends their estimated monetary value over a million dollars annually for furbearers, nearly half a million dollars annually for waterfowl, birds and small animals. The 400,000 Illinois citizens who annually purchase fishing licenses, the 280,000 who annually buy

hunting licenses find in their close association with the outdoors an esthetic value far above any monetary value they derive.

In times of international stress, the wild-life resources of the state become of increased value as a means of taking its citizens into the open and of preserving their mental balance and their collective sanity. In times of national emergency, the food resources of a country are its first line of defense. Protection of its agricultural crops from the ravages of insects and diseases is a primary objective in any effective defense program.

THE RESEARCH LABORATORY OF THE GENERAL ELECTRIC COMPANY[1]

By Dr. WILLIAM D. COOLIDGE
VICE-PRESIDENT OF THE COMPANY AND DIRECTOR OF THE LABORATORY

THE significance of our laboratory's work, in its three aspects—to our company, to the world of science and to industry—has been discussed by Mr. Wilson, Dr. Compton and Mr. Ferguson, respectively. They have been most generous in awarding us credit on all three counts, and those of us here, who are working, or have worked in the laboratory, have been heart-warmed and thrilled by their exceedingly kindly appreciation. We know each of them well enough to know his complete sincerity, so we accept their praise at its full value and acknowledge it with deeply sincere gratitude. Their mere presence here would be, were it needed, complete proof of their interest in our work, for, even in these busy and anxious days, it would be hard to select three men who are carrying heavier burdens and responsibilities than are, each in his own field, these three. For their taking time to come to this birthday party and for their most kindly contributions to it, we return our heartiest thanks.

We offer our thanks also to the civic leaders of cities where our plants are located, to the science editors and other representatives of the press, to the educational and industrial leaders of our own city and to our many friends in the General Electric Company who have graced this celebration by their welcome presence.

For me to add anything to what the preceding speakers have said about the laboratory's work would be in the nature of an anti-climax, but, since they have spoken, as it were, from the outside looking in, so perhaps I may say a few words from the inside looking out, in regard to the relations of the laboratory to science and industry, or rather perhaps on the aspect of the laboratory as a catalyzing agent which has helped to bring about a momentous reaction between the two.

Forty years ago the attitude of science toward industry was mostly one of aloofness, frequently tinged with contempt, while industry for the most part ignored the existence of science. To-day we find some 50,000 scientists contentedly domesticated in the 2,000 industrial research laboratories of this country, while industry, with considerable assiduity and often with generosity, caters to their peculiar needs.

In bringing about this startling change in four decades, I believe our laboratory, as a pioneer in industrial research, has been a contributing factor.

I think the hesitation which was manifested by both Dr. Whitney and myself on embarking on industrial research was symptomatic of the general attitude of scientific men. That hesitation in my case was caused not at all by any such feeling as was then entertained by many scientists that science would be soiled by close industrial contacts, but simply by my doubt that industry could present such fascinating problems as lay before me at M. I. T., or problems which would offer equal opportunity for worth-while work. The same was true with Dr. Whitney, I am sure. Indeed he had already made an application of his experimental work to profitable industrial ends. But he too evidently doubted if industry could offer enough problems of interest to occupy his full time to advantage, for he at first arranged to divide his time between Schenectady and Boston. It was not many months, however, before he realized that in the General Electric Company were enough interesting problems to keep himself and a growing staff of assistants busy for a lifetime and more, so he ended his connections with M. I. T. and devoted all his energies thereafter to building up the Research Laboratory here.

My own experience was similar. I was persuaded by Dr. Whitney to join him only by his invitation to bring with me the apparatus with which I was then working at M. I. T. and his assurance that I would be given all the time to devote to it that I desired. But I too soon found more engrossing problems here, so I shipped my apparatus back to Boston, leaving further experiments with it to other hands.

It was not long before the results of our laboratory's work began to appear in the products of the company, in new materials, more efficient processes and new devices, some of them opening up wholly new fields for electrical development. Other pioneer laboratories in their different fields were similarly demonstrating the utility of research in industrial problems,

[1] Address given on December 17 at a dinner on the occasion of the celebration of the fortieth anniversary of the founding of the laboratory.