THE UNIVERSITY AND FUNDAMENTAL RESEARCH*

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The great advances in science have in general been the result of the research work of many individuals and in many instances arose from some apparently (at that time) insignificant but fundamental scientific observation.

The scientific genealogy of a research worker may be much more important than his blood genealogy.

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"What does chemistry mean to me?" said Mr. Averageman, as he looked at the page printed with ink made by a chemical process. As he pushed back his cuff, bleached by a chemical process, and laced his shoes, made of leather tanned by a chemical process, he glanced through a pane of glass, made by a chemical process, and saw a baker's cart full of bread, leavened by a chemical process, and a draper's wagon delivering a parcel of silk, made by a chemical process.

He pulled out his pencil, made by a chemical process, and wrote a reminder in his notebook bound in imitation morocco, made by a chemical process. Then he put on his hat, dyed by a chemical process, and stepped out upon the pavement of asphalt, compounded by a chemical process, bought a daily paper with a penny refined by a chemical process, and proceeded to the office where he dealt in a certain compound called coal.

"No," he added, "of course not, chemistry has nothing to do with me."

So wrote N. H. Casson, an editor, several years ago.

For a moment or two I wish to point out that the great modern chemical industries, the products of which contribute so much to our present comfort and well-being, did not spring suddenly into being but in most instances arose as the resultant of some apparently insignificant but fundamental discovery.

Only one hundred years ago, in 1828, Wöhler prepared for the first time in the chemical laboratory an organic chemical compound, urea. Prior to that time the "organic compounds," of which urea is a representative, were thought to be formed only by vital processes. A vital principle was necessary! Without a vital principle Wöhler prepared urea, and the modern age of synthetic organic chemistry began. Since Wöhler's discovery literally hundreds of thousands of organic compounds, many of which we now regard as indispensable to our well-being, have been prepared in the chemical laboratory.

In 1839, Charles Goodyear noted that when sulfur was added to crude rubber and the mixture was heated, a new product of unique properties was obtained, and that observation has made possible the entire rubber industry and the automobile industry of today.

In 1886, Charles Hall, then an under-graduate student at Oberlin, found a few metallic globules of aluminum in one of the experiments on electroly-

* An address delivered at University Convocation, University of Minnesota, October 31, 1929.

sis which he was conducting. Prior to that time, metallic aluminum was more rare than is platinum today. Hall at the time he made that experiment was filled with scientific curiosity. He had no thought that his experiment would create the enormous aluminum industry of today.

Perkin, in 1856, when he was eighteen years old, attempted an investigation of the chemical nature of quinine. He did not solve his problem; no one has completely solved it even today; but he did create mauve, the first of the so-called aniline dyes, and our entire dyestuff industry dates from Perkin's researches.

Pasteur, when he studied the disease of the silkworms and the reasons for abnormal and undesirable fermentations of beer, did not visualize the fact that he was creating not only the science of modern medicine, but likewise the modern industry of food preservation, the canning industry, the pasteurization of milk and fruit juices, and even our modern methods for insuring the purity of our water supply.

Osborne and Mendel, in 1911, when they attempted to test the old theories of Liebig that a certain amount of protein and a certain calorific value of the diet were all that was necessary for the maintenance and growth of animals, did not visualize that their experiments would change in a radical manner our conceptions of human and of animal nutrition and would point the way whereby a farmer, feeding a properly balanced diet, could secure greater gains and higher quality at a lower cost.

Eijkmann, when he undertook in 1890 his investigations of the disease beriberi which had decimated the Japanese navy, had no idea that this would lead to the discovery of an entirely new field in nutrition, but the fact remains that all vitamin research dates back to his pioneer work.

Babcock, at Wisconsin, searched for a simple and rapid method whereby he could analyze cream for its fat content. He found a technic which the average farmer could use, and the result was the "Babcock Test" and the saving of literally millions of dollars to the dairy farmers of America, since they could thus demand payment for their product in proportion to its content of butterfat.

Chandler, at Columbia, devised a special specific gravity spindle, and when he applied it to the study of milk he discovered that the milk which was being delivered in the city of New York had, almost without exception, been diluted with water. He refused to patent his "lactometer," for he said he wished it to be used everywhere so that the watering of milk could be readily detected.

The Curies investigated a rare mineral which even in the dark would leave a photographic image of itself upon a sensitized plate even though that photographic plate were wrapped in many layers of black paper, and their investigations resulted in the isolation of radium, a boon to medicine, and in a complete revolution of the mode of thought underlying the sciences of physics and chemistry.

The discovery of helium in the Frauenhöfer lines of the sun's spectrum is a far cry from the giant dirigibles which are now being constructed for the United States government.

Sir William Ramsay found fifteen parts of the rare gas, neon, in a million parts of the earth's atmosphere and today the neon signs give brilliance to our streets and bid fair to revolutionize the electric lighting industry.

And so one might continue adding name on name and accomplishment on accomplishment. In most instances the original observation was the product of a true scientist who had no other thought than to wrestle from nature the solution of some of the mysterious phenomena of the universe. No thought of gold or fame for himself, only the thought that the next generation of mankind would be wiser than his own!

It must not be thought that the persons I have mentioned completed their work. Hundreds of thousands of others added their mite of fundamental research before the present-day status was reached, and the end is not yet.

May I quote from President Hoover's recent address at the celebration of the fiftieth anniversay of Thomas A. Edison's invention of the incandescent electric lamp? He said,

> I may emphasize that both scientific discovery and its practical application are the products of long and arduous research. Discovery and invention do not spring full-grown from the brains of men. The labor of a host of men, great laboratories, long, patient, scientific experiment build up the structure of knowledge, not stone by stone, but particle by particle. This adding of fact to fact some day brings forth a revolutionary discovery, an illuminating hypothesis, a great generalization, or a practical invention.
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> Research both in pure science and in its application to the arts is one of the most potent impulses to progress. For it is organized research that gives daily improvement in machines and processes, in methods of agriculture, in the protection of health, and in understanding. From these we gain constantly in better standards of living, more stability of employment, lessened toil, lengthened human life, and decreased suffering. In the end our leisure expands, our interest in life enlarges, our vision stretches. There is more joy in life.

No institution is worthy of the name of a university unless it combines both teaching and research. Teaching without contributing to knowledge is at the best a parasitic existence. No stream will ever reach the ocean unless there is a never-failing inflow of water at its source. No university can accomplish its ultimate mission without contributing to the fund of the world's knowledge.

The highest, the ultimate reward of the true university professor is not reached when all of his students can write perfect examination papers, when they can all recite parrot-fashion all of the facts and theories enumerated in the textbook. The real joy comes when one, or two, or perhaps half a dozen students who have come under his guidance catch the fire of inspiration, become impatient with the meager fragments of knowledge which are handed out in the classroom, and start out for themselves to push back the barriers of the unknown. Then the professor can pass on to younger hands the torch which he has been carrying and can feel assured that his life and his teaching have not been in vain, that some one more gifted than he will carry on into succeeding generations.

I do not know the human genealogy of Faraday, I care not to know it, but I do know that Sir Humphry Davy said that his greatest discovery was Michael Faraday, and if we were to trace the scientific genealogy of our scientists, we would find that much more important than their blood genealogy. The teacher, the researcher, lives in his students and in their students in succeeding generations. That is the teacher's reward. That is true immortality.