RESEARCH AND NATIONAL DEFENSE

Presidential Address
Alvin L. Moxon
South Dakota State College

Research and national defense is the timely topic which I have chosen for this address. Research is vital to national defense. I will also say something about the effect of wars upon scientific research because wars do have a tremendous effect upon research.

In the first place, wars are not brought about by scientific workers but by political regimes. Science knows no national or international boundaries. They are political. Scientists are cooperators and most of them do their part by serving humanity through their search for knowledge and truth.

The democratic way is a tradition of long standing in scientific research. Scientists have long held the policy that truth can be determined only by a direct appeal to nature rather than to authority.

The advancements made in science in this country are greatly dependent upon the advancements made in other countries. At present a large percentage of the laboratories of Europe are closed. In spite of many exceptions, however, there seems to be some effort in Europe to insulate important scientific research work from the shock of war and keep the scientists at their tasks. It has been said that Europe is perhaps profiting from the tragic example of the last war when such men as Henry Mosely, the physicist, and a number of new leaders in every field of science were killed at the front.

This attempt to keep scientists from the front meets only a small portion of the problem, because at best it can save for the future only those men whose promise is already indicated. No precaution can protect a country from the losses which war levies upon future scientists. R. B. Fosdick in the 1939 Review of Activities of the Rockefeller Foundation states, "The mortgage which war places upon the economic resources of a country is nothing compared with the mortgage levied upon its future intellectual and cultural life." In the same report Fosdick stated: "Scientific growth is almost invariably the result of cross-fertilization between laboratories and groups in widely separated parts of the world. Only rarely does one man or one group of men recite with clear, loud tones a whole important chapter, or even a whole important paragraph in the epic of science. Much more often the start comes from some isolated and perhaps timid voice, making an inspired suggestion, raising a stimulating question. This first whisper echoes about the world of science, the reverberation from each laboratory purifying and strengthening the message, until presently the voice of science is decisive and authoritative."

Science moves ahead year after year. It really doesn't move by leaps and bounds, even though we sometime think that it does; it just keeps moving steadily along. Each new development or discovery is based wholly or at least in part on fundamental observations and experiments which had been completed at an earlier date and recorded in a scientific publication, possibly in the **Proceedings of the South Dakota Academy of Science.**

One writer has recently compared the advancement of science with the phrase: "Ol' Man River, he just keeps rollin' along." The ever-widening stream of progress in science can be traced back to thousands of tributaries or contributions. Each of us as we come to our annual meeting can pour out our contribution and be quite certain that it will find its way to "Ol' Man River."

The development and application of sulfanilamide and other "sulfa" compounds illustrates the result of collaboration in research where flags and boundary lines have been non-existent. The first hint (or tributary) came from a German dye plant and the compound was called prontosil. In 1935 a German scientist, Dr. Gerhard Domagk, published the results of his experiments with this drug upon mice innoculated with streptococcus. The Pasteur Institute in Paris worked on the drug next, and found that only a part of the prontosil molecule—the sulfanilamide part—was the potent part. Next the Queen Charlotte's Hospital in London did its share of the work. Johns Hopkins School of Medicine was next in line to make a contribution and since then scores of laboratories and hospitals have made their contributions. Thus, achievements in science are often the result of many minds in many countries all driving toward a common goal. Each contribution is important when pieced together with other contributions, while when isolated from the others it may be of little significance.

Certainly no one can deny that the work on "sulfa" compounds and other compounds used in chemo-therapy is of great importance to our national defense even though the work started in other countries. These drugs are of great importance in protecting and maintaining the health, not only of our fighting force, but also our civilian population.

Many of the fundamental discoveries which have been made in the field of nutrition during the past 15 or 20 years have just recently been put to greater use. The restoration and fortification of such common foods as bread is a big step toward national defense. Certainly the present knowledge of the nutritive requirements of man should help avoid such catastrophies as happened in Denmark during the first World War. The eyes of many of the children in Denmark were damaged if not completely ruined by the exportation of butter and the use of butter substitutes which lacked Vitamin A.

Too often we, or should I say the general public, are prone to criticize the scientist who is working on fundamental or pure science. We say: "Why does Jones work on that problem? Even if he does solve it, no one can make use of the information he is getting. It isn't practical. He is wasting his time. Why doesn't he work on a problem of importance to the people or to National Defense?" But wait. Weren't such men as Faraday criticized and ridiculed? At one time Faraday had demonstrated before a large audience that when a magnet is brought suddenly near a coil of wire a slight current of electricity is produced in the wire. A

lady in the audience asked, "But, Professor Faraday, even if the effect you explained is obtained, what is the use of it?" Faraday's reply was, "Madam, will you tell me the use of a new-born child?" Today I believe we all know at least some of the uses to which electricity has been put, and new uses are continually being found. At another time, Faraday was explaining an important new discovery and a statesman asked, "But, after all, what use is it?" "Why, sir," replied Faraday, "there is every probability that you will soon be able to tax it."

The practical man judges scientific research by its immediate practical application. This practical application of a fundamental piece of research is only incidental to the true scientist. To him, the practical applications are not the measure of the importance of the work done. He judges the importance by the fundamental contribution made to the stream of knowledge—facts upon which future investigation may be based. We will always need these facts. With the discovery of truth or facts as its single aim, science can pursue its inquiries in almost any direction it may please. However, if it permits itself to be entirely dominated by the productive or application spirit it becomes the slave of commerce. Commerce has in the past been more or less scientifically short-sighted as regards fundamental studies, and the tributary of "Ol' Man River" flows slower and slower. In other words, unless water flows into the well we will soon pump the well dry. During the past few years, however, more and more industries have come to realize this fact and today we find many industries supporting not only research with immediate practical application, but research of the most fundamental nature.

As industry has advanced, it has become more and more apparent that many of the investigations upon which modern industry has been built would never have been undertaken had all research been directed by administrators with a practical or production background. Thus, we find more and more men with some fundamental research in their background as directors of research.

There are instances in history in which we find a scientist doing some fundamental research as a sort of a hobby if his job is one of practical research. Williams, for example, worked on the isolation, structure and synthesis of Vitamin B_1 as sort of a hobby for 27 years. There is little research more fundamental in nature than the determination of the structure of a chemical compound. On the other hand we certainly can see the commercial applications of his research.

Certainly some sort of a balance is needed between practical and fundamental research. Possibly a certain percentage of the returns from the practical application of research should be turned back to fundamental or basic research. The Wisconsin Alumni Research Foundation was organized on some such basis. Discoveries are patented and the royalties, except for operating expenses and 15 per cent which goes to the discoverer, are turned back into research fellowships, equipment and supplies. This arrangement has been criticized by those who believe that the discoveries of scientists should be given free for the use of society. Maybe this is a short-sighted policy, however, because additional research certainly should be for the good of society.

Both practical and fundamental research is aiding the country in national defense. New and better products, short cuts in production, and elimination of bottlenecks in strategic industries—all are dependent upon research for information.

The National Association of Manufacturers has urged that American companies as a whole should spend 2 per cent of their gross incomes for research. The total expenditure for all basic production research in the United States in 1940 was less than one-half of one per cent of the gross incomes of the American companies. Some companies, however, do much better than the average. There are at least ten concerns which spend more than 10 per cent of their gross incomes for research.

In the case of agricultural research a very low percentage of the gross income has been used for research, and of

this approximately 95 per cent has been used to increase production, and only about 5 per cent has been used for research to find new uses for agricultural products. The four new regional laboratories of the U. S. Department of Agriculture will be engaged mainly in finding new uses for agricultural products. In case of emergency these four new laboratories can be used for research on problems vital to national defense.

Let me repeat again that research is vital to our national defense. As far as the general public is concerned, however, the appreciation of the value of scientific knowledge in national defense is probably much the same here as it is in England. Sir William Bragg, president of the Royal Society, in his address before the Society last November said: "It is true that in a vague way the nation is brought by the happenings of war to guess at the meaning of scientific research in every kind of enterprise. But still, it would be difficult for most people to grasp the significance, much less the meaning, of the description of a fact like this: that the R. A. F. could not carry out its operations without the knowledge resulting from the studies of cathode-rays and electrons made by our physicists."

Let me close with a quotation from Pasteur: "Two opposing laws seem today to be in combat—a law of blood and death which, daily devising new weapons of war, compels the people to be prepared always for the battle fields; and the law of peace, work and welfare, which is concerned only with the delivery of humanity from the scourges which beset it. The one seeks only violent conquests; the other the relief of mankind."