

SCIENCE AFTER THE WAR

A CERTAIN judge, after trying a patent case in which scientific experts testified on both sides, said that there were three kinds of liars: liars, unmitigated liars, and experts. At present I am employed by the United States Navy as an "expert" on anti-submarine devices, so perhaps you had better not put too much faith in what I may have to say on "Science after the War," for it is really just as hard to know what is going to happen to science as to anything else.

A traveller once excited the curiosity of his fellow passengers by the extreme care which he took of a basket which he had with him. They began to ask him about it, but for a long time he refused to say what was in it. At last he said he would tell them what he had in it. He said he was going to visit his brother, who was in the habit of drinking too much and frequently saw snakes, so he was taking him a mongoose, which is an animal that lives on snakes. "But," said the passengers, "your brother's snakes are not real ones." "No," said the traveller, "and it isn't a real mongoose in this basket." I could tell you some interesting things about science during the war, especially about the new devices for catching submarines, but I have to follow the example of the traveller with the basket. A British naval officer, when asked what he did when he caught a submarine, said that, of course, he always put back the little ones.

Scientific activity during the war has been very largely

diverted into new channels—the solution of war problems. To meet the scientific barbarity of the Huns called forth the united efforts of the scientists on the other side. I think we can say that at the end of the war the scientific equipment of the Allies was certainly equal, and probably superior, to that of their enemies. The submarines did not prevent the American armies from getting across the Atlantic, which was due to the splendid work of the Allied and American sailors. Exactly to what extent scientific inventions helped to stop the submarines I cannot say; but if they saved a single American transport from being torpedoed, then they were worth far more than all the time and money which has been spent on them. After the war many of the new applications of science, made during the war, are going to be of great value for peaceful purposes. For example, some of the devices intended for locating submarines have already proved of great value for navigation in fogs. Only a few days ago a war-ship reported that it had been twice saved from collision in a fog by its anti-submarine devices, which located approaching vessels.

The war has made clear to all the practical power of scientific knowledge, and there has arisen a demand for more and better science in education. Most people manage to get along with little or no scientific knowledge, and they will probably continue to do so for a long time. Most people, fortunately perhaps, are not endowed with much aptitude or inclination for scientific thought. It is not worth while for them to devote much time to scientific subjects. Science, to be worth while, requires much time and hard work. What is wanted is opportunity for those endowed with scientific aptitude to get thorough scientific training and a more general understanding of where to go, and whom to go to, to get expert scientific advice. Politicians do not need

to know much science, but they ought to know enough to employ scientists to solve scientific problems. In this country, at any rate, I think it is fair to say the politicians, as a rule, do know enough to get scientists to solve scientific problems. Scientific knowledge is now so vast and complicated that scientists tend more and more to become specialists. It seems impossible to avoid this, and it is going to be the case in the future at least as much as now.

We need better schools and better universities. Do we need more science in schools? I say, not unless we can get good science teachers. My experience of school science, in England, was that it was often a farce, and we can do very well without such science. It seems probable that boys and girls are too young to get much advantage from the systematic study of science except when it is really well taught, and not always then. They merely acquire a jumble of facts, the relations of which they do not understand. Boys and girls should be encouraged to develop scientific hobbies outside school hours; *e.g.*, many boys amuse themselves with wireless telegraphy or dabble in chemistry. These hobbies should be encouraged; they often lead to a genuine interest in science very different from the contempt produced by farcical school lessons under incompetent teachers. Everything depends on the teacher. I am in favor of more science in schools if you can get first-rate science teachers, otherwise I would sooner have less science, not more. The only way to get better teachers is to pay them more.

As to science in universities, the war in this country has brought many university teachers into close contact with manufacturers and users of scientific devices. This is going to increase the tendency for the best scientists here to leave the universities and devote themselves to commercial work. Science is beginning to have a commercial value. Several

large companies in the United States maintain large research laboratories and employ many highly trained scientists. They are finding that it pays to do so, and that it pays them to get the best scientists. They even allow these scientists to work on lines of purely scientific research and to publish the results in scientific journals. Science is becoming almost respectable. The days of the traditional scientific professor with long hair and shabby clothes are almost past. The title of "professor" is out of date and may mean anything, from a great savant to a piano-tuner. A certain Southern gentleman was once talking to Booker Washington, and did not quite know how to address him. He did not care to call a colored gentleman "Mr. Washington" or to address him as "Sir," so, as he said, he just compromised and called him "Professor."

The increasing commercial importance of science is going to raise its status in this country, but in American universities science has long occupied a satisfactory position. Magnificent laboratories are provided and research work is encouraged. On the whole, university scientists in the United States have good reason to be satisfied.

Will the teaching of pure science in universities have to be modified as a result of war experience? I do not think any serious modification of the teaching of pure science in universities is indicated. Engineering teaching may need change, but of this I am not competent to speak. There is a growing opinion among university teachers in America that more should be done to care for the needs of the best students. There has been far too much attention paid to the average student and too little to the best. The few students who are endowed with exceptional abilities should not be kept down to the average level, but special courses should be provided for them and a large part of the energy of the

university should be devoted to developing their special capacity to the highest possible level. Such students are worth while for a real university to educate. They are the nation's greatest asset, and money spent on their education will be repaid many times over.

Purely scientific research, as distinguished from research in applied science, depends greatly on the interests of particular scientists. It will go on as before. There is no reason to suppose that the progress of pure science, after the war, will differ essentially from that before the war in universities or elsewhere. An Irish captain was once marching with his regiment on a road leading to Dublin. He asked an old man how far it was to Dublin. "Eight miles, yer honor," was the answer. "Come along, boys," said the captain. About an hour later he met another man and asked again. "Eight miles," was the answer. "Come along, boys; we must get a move on," said the captain. After another hour he again asked how far it was to Dublin. "About eight miles, yer honor," was the answer once more. "Come along, boys; we are holding our own, anyway," said the captain. The march of science goes on, always covering new ground but never reaching the end of the journey.

During the war several important war problems have been solved by making use of scientific discoveries which, when made, had apparently no practical value. Many years ago an English physicist named Guthrie discovered that electricity escapes slowly from a red-hot body into the surrounding space. This result is now of great practical importance in wireless telephony and telegraphy and has had many other uses during the war. That the results of pure science may possibly in the future find useful application is not the only reason for research in pure science. It is not even the most important reason. Research in pure science

helps to satisfy certain fundamental desires of the human mind, such as the desire to know and to understand the nature of things. The pleasure and interest obtained by the satisfaction of such desires serve to enrich life just as do music and art and literature. Let us not judge the relative values of the humanities and of science by their practical usefulness.

Before the war very many graduate students from American universities went to Germany for study and research. To-day Germany is defeated and despicable, and we do not expect any more American graduates to go there. As a graduate student I went first to Cambridge in England and then to Berlin. However, as a place for graduate study and research I did not find Berlin anything like as good as Cambridge, so I very soon went back. I have known several American graduate students who have been at both English and German universities, and I think they all found that English universities satisfied their needs quite as well as German ones. Then there are French and Italian universities at least equal to anything in Germany, and, last but not least, there are American universities in America as good as any. American universities should not be regarded merely as preparatory schools for European colleges. American graduates are not advised to go to foreign universities because there are not great universities in America, but because it is considered advantageous to get first-hand knowledge of thought and methods in other countries. It is also desirable to see something of the world outside one's own country. Germany is now ruled out, so where shall American graduates go? They can go to England, France, and Italy, where they will be warmly welcomed. Of course, if they go to England they do not have the advantage of learning a foreign language. They may, however, learn

something about the English language. An old friend of mine came to Cambridge, England, from America as a graduate student about twenty years ago. He went to a post-office to buy a five-cent stamp for a letter to America. Two cents are equal to one English penny, and a stamp for foreign letters is a "twopence halfpenny stamp" and is called a "tuppence hapenny stamp." My friend asked for "a two and a halfpenny stamp," and the clerk told him that they did not sell half stamps. Then he remembered hearing some one refer to something as a "tuppenny hapenny thing," so he thought that must be it and asked for a "tuppenny hapenny stamp," whereupon he was asked if he was trying to be funny. Then he tried asking for a "two-point-five penny stamp," and finally an English friend turned up and bought the stamp for him. So you see even in England American students have an opportunity to learn something about the language.

I am afraid that the high cost of living, or rather the cost of high living, at Oxford and Cambridge in England may make it difficult for some American graduates to go there. One American said that a dollar in America went about as far as a pound in Cambridge or as a mark in Berlin. When a graduate student arrives in Cambridge and joins one of the colleges the first thing he has to do is to pay about \$100 "caution money" to cover possible damage he may do, and then he has to have a so-called tutor to whom he must pay about \$150 per year, in return for which he gets nothing but a few words of advice and perhaps a couple of invitations to dinner or breakfast. I would suggest to Dr. Shipley that such charges might be omitted in the case of graduate students. At Cambridge, after two years of graduate study and research, a graduate student may obtain the degree of B.A.—at least this was the case very recently. Since Ameri-

can graduates all have such a degree already, this degree is not very satisfactory to them. It is to be hoped that some way of removing this serious objection to Cambridge, England, as a university for American graduates will be found promptly. The same difficulty also existed very recently at Oxford. Most American graduate students who go to Europe intend to become university teachers, and it is important for them to obtain a satisfactory degree. The degree is not the main object of graduate study, but it is nevertheless desirable for American graduate students to go where they can get a suitable one. The diversion of American graduate students from Germany to the countries of the Allies is going to have an important effect on the progress of scientific research and education after the war. This effect will, I believe, be good not only for science but also for the students as men, and for America and the Allied countries. A German university never was a very good place to send a young man to.

English universities will welcome American graduate students, and both parties will benefit by it. A Western farmer once caught a moose, and to make a few dollars put it in a tent with a notice up: "Admission, five cents, to see the moose. Family tickets, ten cents." A man came along with his wife and about fifteen children and asked for a family ticket. "Is all this crowd your family?" said the farmer. "Yes," said the man. "Well, then, you come right in free; it's just as important for my moose to see your family as it is for your family to see my moose," said the farmer. I hope the English universities will let in the big family of American graduate students in the same way.

Let us consider "Science after the War" in Texas and at the Rice Institute. So far science in Texas has been almost entirely applied science. As the State develops, we may

hope that it will take some part in the progress of pure science. Research in pure science in America and elsewhere is carried on almost exclusively in universities. Science owes a great debt to modern universities for the way in which they have encouraged scientific research. In America nearly all the great universities are very liberally supported by the public or by their State governments. While in England it is generally extremely difficult to get any money for a university, in America many universities get almost more than they can spend. For example, Yale University has recently been left about twenty million dollars. I should say that it is about as hard to get ten thousand dollars for an English university as it is to get a million dollars for an American university. The great universities of Europe had a long start, but they will be left behind in the race by American universities unless the public in Europe begins to support their universities as the public in America is doing. In Texas the universities are very young, and unfortunately the State university has not so far been supported by the Government with American liberality, but we understand that Governor Hobby is going to right that immediately. The Rice Institute as a university is a mere infant, but it has the advantage of a considerable endowment. The endowment of the Rice Institute is about enough for a small university of, say, six hundred students, for the students at Rice pay no fees and half the income is reserved for buildings. We hope that the people of Texas will, in the future, support their universities like the people of the older States. If they do—and I believe they will—then the University of Texas and the Rice Institute will develop into great universities and will take an honorable part in the progress of pure and applied science. But the people of Texas, if they want to have, right here in Texas, first-class schools and universi-

ties for their sons and daughters, must do their part. They must see to it that their representatives in the Government are pledged to give the State university more than adequate support, and they must not forget the Rice Institute when they make their wills. We want to get right away from the idea that anything but the best is good enough for Texas. There is nothing wrong with the sons and daughters of Texas. They are of the best, and they ought to have schools and universities of the best. It is up to the people of Texas to see that they get them.

The progress of science is so intimately bound up with the progress of education that a discussion of the future of science is liable to become a discussion of the future of education. Modern science requires highly educated students, and the study of science serves as part of an education. The education of scientists has sometimes been defective on the literary side, and science has suffered in consequence. It is to be hoped that the serious dangers of too early specialization will be avoided in the future. The point which I wish to emphasize is that in order to have scientific progress you must have good schools and good universities. Good schools and good universities are also necessary for all other kinds of progress—*e.g.*, commercial progress. You cannot develop manufacturing industries to a high level except in a well educated community. You cannot develop scientific agriculture except in a well educated community. It would pay the business enterprises of Texas to take a serious interest in the schools and universities. How can the people of Texas tell if their schools and universities are good? There are many business men in Texas with sons and daughters to be educated. They want their sons and daughters to be well educated. Therefore they want to know if the schools and colleges of Texas are really good.

But how can they tell? Suppose you want to know if a commercial company is successful. You find out what dividends it is paying and you examine its balance sheet. You find out about the equipment of its plant and so forth. A business man can easily find out if a company is doing a good business. It is not so easy to find out about educational institutions. They do not pay dividends, and if their graduates are successful it is hard to know whether the success is in spite of or because of the education they received. Besides, it takes too long to wait and see if the graduates are successful. One way of judging a university is to follow the careers of its football and baseball teams. This is the usual method, I believe; and while it might be worse, it is not really satisfactory. The great universities in the United States, like Harvard, Yale, and Princeton, usually have first-class football teams, but it does not follow that because a university has a fairly good team it is therefore a fairly good university. Another way is to find out what the students at a school think about the education they are getting. This method is of some value, but not very much. The students do not know what a school ought to be like. They may think it is good merely because they have never seen anything better. Of course you can ask the President if he thinks his university is a good one for you to send your son to, but that is like asking a banker if he thinks his bank is a good one for you to put your money into. The problem is really not a very easy one, but I think a useful practical solution can be found. There are in the United States many good schools and universities which have well established reputations. They are undoubtedly good. We may take, for example, the public schools of Chicago and the University of Princeton. The solution which I suggest is to make a detailed comparison between some such admittedly first-

class schools and universities and the schools and universities of Texas.

Ladies and gentlemen, comparisons are odious, and I do not propose to make any. I hope that if you make for yourselves any such comparisons you will find that some, at any rate, of the schools and universities of Texas compare well with those in the other States.

I feel sure that if the people of Texas would take a lively interest in their schools and find out for themselves how they compare with the best elsewhere, it would be a great help to Texas educators. There is nothing like public interest in a question to produce progress, and educational progress is necessary for progress in anything else.

The opportunities for education in Texas and Houston have greatly improved in recent years, important progress has been made, and the outlook for the future is good. There is perhaps a tendency to attach too much importance to buildings and too little to the teachers. What is most required is better pay for school-teachers and employment for them during the whole year. You must attract good men into the teaching profession if you want to improve education. I suggest that a good school-teacher ought to be as well paid as a good carpenter or a good plumber. At any rate, that might be taken as an ideal to be attained some day when the country has become rich enough. If the laws of the State limit the money available for schools and universities, then the laws must be changed.

The progress of pure science centers round great discoveries—for example, the discovery of radioactivity. Such epoch-making discoveries are, comparatively speaking, rare. Each such discovery leads to an immense amount of research work by which its meaning is made out, and in the course of which many new minor discoveries are made. We cannot

tell what the great discoveries of the future will be, but we may feel sure that they will be many and wonderful and that the splendid public support of science in America will result in this country having an honorable part in the making of them. Now that the war is over, we may expect that the Rice Institute will continue to develop, and we may hope that in the future Houston will come to be regarded as a center of scientific progress. For this we should have to thank our generous founder, and our trustees who are carrying on the work he made possible.

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