A Plea for More Fundamental Research Effort[1]

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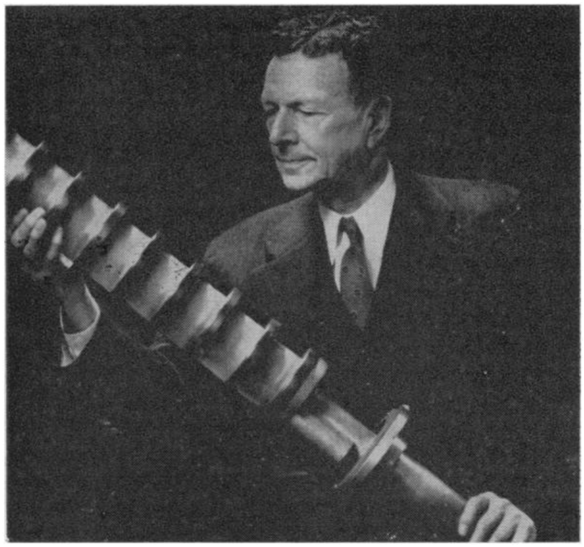
During our productive years, we all take ourselves pretty seriously, and if we did not, it would be bad for our work. When we retire, however, and get out of harness, we see ourselves and our achievements in truer perspective. We see how much of our success was due to our associates, and how much of it was due even to chance. To illustrate this last, I was given the privilege, and a very free hand, to work on tungsten at exactly the right time. In the same way, I had the privilege, at exactly the right time, of applying to the x-ray tube Dr. Langmuir's new knowledge of thermionic emission. I cannot take any credit for having been at the right place at just the right time, and had it not been for Dr. Whitney and E. W. Rice, I would not have been there at all.

There is another thing that makes one feel very humble, and that is seeing the accomplishments of people living in earlier civilizations and working with what we would consider entirely inadequate means. In Mexico and Central America, for example, you are astounded by the ruins of the Ancient Mayan civilization. Although living in their stone age, with no metal tools, no beasts of burden, and without the invention of the wheel, they still built large and beautiful and most impressive structures of stone—temple pyramids, palaces, and stone-paved roads. Without optical instruments, with nothing but lines of sight, as through holes in stone walls, they determined the number of days that it takes the earth to travel around the sun, with such precision that their value differs by only 0.0002 of a day from our latest value. In Egypt this past winter, we saw things made long before the Christian Era, involving such beautiful design and such exquisite workmanship that one was inclined to question whether these things could be duplicated today.

I suppose I am expected to indulge in reminiscence, or to tell what I can see for the future in the crystal ball. But age may have brought discretion—I shall do neither.

Cleveland has been the meeting place of scientists engaged in metallurgical research. They will, I am sure, have made intelligent predictions of things to come in their field. They will certainly have told you of recent strides made in getting a better understanding of the solid state, in general, and of the crystalline state in metals, in particular. You can safely predict that such new fundamental knowledge will lead to metals with more desirable physical properties than are attainable today. Cleveland has also been the meeting place of scientists and engineers actively interested in the nondestructive testing of the integrity of metals and other materials. The high standard of living which we, in this country, enjoy today is due in no small measure to the high quality of our metals and other structural materials, and to nondestructive tests used to maintain that quality.



Dr. W. D. Coolidge, director emeritus, General Electric Research Laboratory, studies the multisection 2,000,000-volt x-ray tube, one of the major developments with which he has been associated during his long and fruitful career.

There is one prediction which I will make. If, in the future, our present high standard of living is to be maintained in the face of foreign competition, we will find that the job is harder than it has been. The world has rapidly grown smaller, and this makes it easier for others to learn about and to adopt anything that is good in our methods. It is clear that the other fellow is learning very fast. It seems but a few years ago that we had a visit from an official of the International Harvester Company, who told us a little about their experience with the Russians. The Harvester Company had been selling its machines to the Russians, who were then starting to build their own. The Harvester man was quite unimpressed by this, however, for, he said, "The Russians have no mechanical sense." In support

[1] Based on Dr. Coolidge's talk at the dinner honoring his eightieth birthday at Nela Park Lighting Institute, Cleveland, October 20, 1953.

of this statement, he said that crates of ball-bearings sent to Russia had been allowed to stand out in the rain there until ruined. When I visited a few laboratories and factories in Moscow and Leningrad in 1933, I found the Russians very much alive to their technical backwardness, and doing something about it. As an illustration, their arrangement with Mr. Ford had brought them Ford and Lincoln cars and Ford engineers to teach them how to build cars. We had lent them our Mr. Lenox from Pittsfield, who had been with them for three years teaching them how to build transformers. In an incandescent lamp factory, I saw them making tungsten lamps with American lamp-making machinery. Since then, they must have got great help from the German engineers they acquired after the war. I cite this Russian case only as an illustration of the fact that, in this small world, a backward nation can, under pressure, make very rapid headway.

In Japan, in 1947, I had, for forty days, the privilege of visiting laboratories and factories. Two things that impressed me very strongly were these: in the first place, for several reasons, science had entered very little into Japanese industry, and, in the second place, inspection at various stages of manufacture seemed to have been quite inadequate. But these deficiencies could, of course, be corrected, and today I find some recent Japanese accomplishments in the optical field very impressive. In this field we see them selling binoculars, microscopes, and telescopes in this country, in competition with those of U.S. manufacture. We also see them selling cameras with very superior high-speed lenses.

When the foreign-made product becomes as attractive as that made here, and when equipment and methods become such that the productivity of the worker in a foreign country is as great as that here, and this while he has a very low standard of living, his competition will be more to be reckoned with than we have had in the past. I think that if our present standard of living is to be maintained and, as we hope, improved, the only real answer to such competition is continuous effort on our part to improve old devices and develop radically new ones.

The thought of radically new devices should take us back to the time, prior to 1900, when E. W. Rice, supported sympathetically by Professor Elihu Thomson, A. G. Davis, and Dr. Steinmetz, decided, as an experiment, to establish a General Electric research laboratory. The impelling motive was the thought that the firm's manufactured products were, at the time, practically all based on the fundamental researches of Michael Faraday and Joseph Henry. The hope was that a General Electric basic research laboratory could establish further new scientific facts and principles that could serve as a basis for new devices. This hope has, I am sure, been realized, and our management continues sympathetically and enthusiastically to support basic research.

One of the best examples that I can give, showing how fundamental research can be made to pay, is that of Dr. Langmuir's work in the two fields of thermionic emission and gaseous heat conduction. From one, we have our whole family of high-vacuum tubes, and from the other, the gas-filled incandescent lamp.

The idea of applied research seems to have been adequately sold, but, speaking for the country as a whole, far too little effort is going into basic research. Most of our colleges are pinched for money and will today certainly find it easier to sell the services of their staffs for work in applied science, directed to some specific end, rather than for work in basic research, which may or may not lead to useful applications. Not only this, but even the field in which its applications might lead is unpredictable.

Everybody can see tangible results, but they can easily forget the basic research that established the new facts or principles and made these results possible. It is most desirable that our educational institutions, our scientific societies, our industrial organizations, our labor organizations, and our government encourage and support basic scientific research. With sufficient basic and applied research, we can confidently hope to maintain and even raise our present high standard of living.

Looking still further into the future, may not a continuous supply of new frontiers, provided by basic research, prevent the stagnation that might otherwise develop in our Western civilization? It is very impressive, and almost frightening, to see some of the remaining evidence of the wonderful achievements of the Mayan civilization in Central America and the Egyptian in Africa, and then to read of the rise and fall of other civilizations, and finally to note the shortness of time involved in each case. It is clear that there have been various causes contributing to the decline of different civilizations. It seems equally clear that a constant supply of new horizons would not of itself guarantee the continued existence of a civilization. It might well prolong it, however, and would certainly add zest to living.

In closing, let me recommend to each of you, on the chance that you may sometime retire, that you then see for yourself something of older civilizations, starting perhaps with the Mayan. Go to Yucatan and spend at least four days seeing Chichen Itza and Uxmal. They will be four of the most thrilling days of your life. One of the greatest advantages of travel, after retirement, when your mind is free of business cares, is the rosy light it throws on your home—on the place where your friends are.