GENERAL SCIENCE

Progress Demands Basic Research

The creative scientist needs an insatiable desire to learn and a willingness to discard outdated concepts. He should feel at home in many fields as the sciences grow closer together.

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Excerpts from an address given at the awards banquet of the 19th Annual Science Talent Search in Washington, D. C., March 7.

MR. DAVIS, Mr. Kaltenborn, Dr. Carmichael, Science Talent Search judges, winners and distinguished guests. First I should like to convey greetings to each of the winners and congratulations from President Eisenhower. He regrets that it was not possible to meet you personally, as in previous years, and has asked me to extend to you his very best wishes for your continuing success.

May I thank you most sincerely for inviting me to address this Westinghouse Science Talent Search Awards Banquet. Congratulations to the Westinghouse Educational Foundation, to Science Service, and to the Science Clubs of America for their contributions to our scientific strength.

The other day I noted a news dispatch from the Florida spring training camps. It included some rather frank appraisals of another facet of American strength and a thought occurred to me. If that ultra-realist—Casey Stengel—were surveying the country's scientific talent, would he hesitate to conclude that we have got to build up our farm system if we want to keep winning pennants? In this sense we owe a special debt to Science Service and the Science Clubs. They have assumed the missionary task of carrying the message of science and technology to the far corners of America. In the vernacular of Casey, they are beating the bushes for the most talented rookies.

Many Math Majors

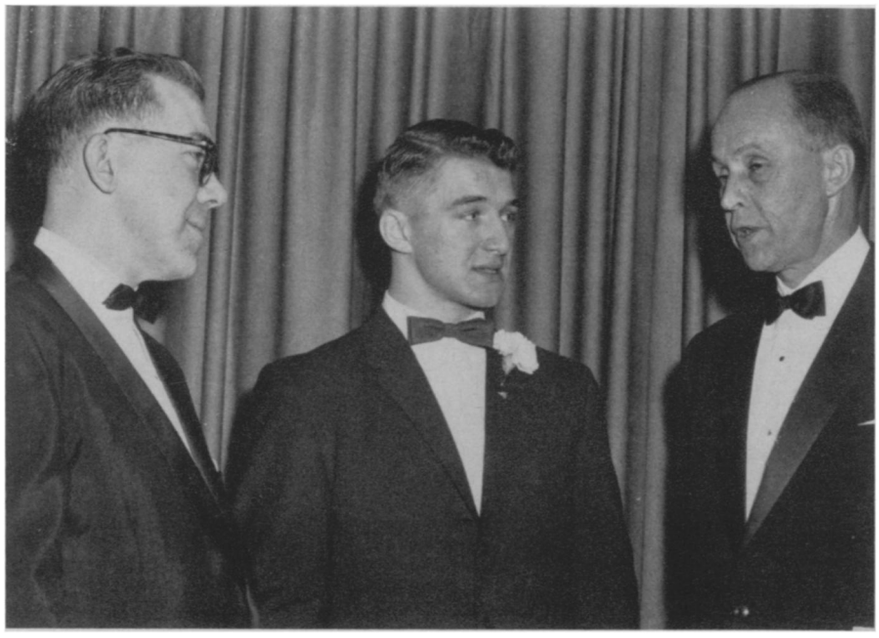
The other day, a colleague of mine was talking to one of our most respected younger mathematicians. They were discussing the reasons for the current sharp increase in mathematics majors in colleges and universities across the country. The mathematician observed that the rising interest in mathematics could possibly be traced to the glamour of high speed computers or to the excitement about outer space science and technology. But, he added, based on his own observations, it was unlikely that many of these new math majors understood why they have made this selection—regardless of what their explanation might be. He cited his own experience, shifting, while an undergraduate, from chemistry to mathematics. He could not explain his underlying motivations then or since. I am sure that similar intellectual migrations have been experienced by others of our foremost scientists and engineers. Thus, of the two Nobel Laureates in Physics who are members of the President's Science Advisory Committee, one earned his bachelor's degree in electrical engineering and the other in chemistry.

To become a creative scientist one needs good education, but one also needs something far more essential. It is the insatiable desire to learn, throughout one's professional life, a willingness to discard outdated concepts and to absorb new knowledge. Deficiencies in formal education can be overcome. Take my own case. Through the vicissitudes of the Russian revolution and civil war, I missed the last year of high school and had to compress my undergraduate and graduate university education into four and a half years. Leaving the University of Berlin, Germany, with a Doctorate of Philosophy degree, I had a store of knowledge certainly less than that of a Science Bachelor. In fact I knew very little outside the field of chemistry. But in those days sharp lines of demarcation existed between traditional disciplines, like chemistry and physics. One could be a researcher knowing little outside one's own little bailiwick. Those days are gone.

As we push back the frontiers of the unknown, the lines of demarcation between sciences fade away. The intellectual interests of a scientist have to be keyed to the unity of science, responding to the seamless web of nature that binds the physical and animate worlds. I could not stay in science unless I kept studying and filling out the frightful gaps of knowledge that my formal education—or lack of it—bequeathed me. Modern physics, math, biology, had to be learned almost from scratch. Then came the war. I was assigned to research on high explosives and rocket propellants and had to learn a lot about fluid mechanics. Since the war, electronics had to be studied, because one needs it nowadays to do research. And so, you see, I was in school not four but nearly forty years.

Know Many Fields

Today, a youngster with my lack of formal education is hopelessly lost. In fact, these days there is increasing need for scientists who feel at home in many fields of science, what might be called the true interdisciplinarians. For example, the oceanographic and atmospheric sciences require for their advance the application of principles and techniques from several scientific disciplines. Perhaps because of this they are undernourished fields, in terms of gifted scientists as well as in resources for their support.



CONGRATULATIONS—Jerome G. Spitzner (center), of St. James, Minn., who won the $7,500 Westinghouse scholarship, is congratulated by Dr. Howard S. Kaltenborn (left), Vice President of Westinghouse Electric Corporation, and Dr. George B. Kistiakowsky (right), Special Assistant to the President for Science and Technology, the speaker at the Awards Banquet.

Science and engineering have also grown closer together. The radical shortening of time between scientific discovery and its application has tended to bring scientists into more intimate contact with the engineers. In fact, many creative scientists have moved from their laboratory benches to the ranks of engineers. Fortunately, this has been a two-way flow. The engineers have undertaken to support basic scientific advance through the construction of great scientific instruments such as radio-telescopes, high energy particle accelerators of scientific satellites—marvels of engineering, indispensable for modern science.

Unfortunately, as a result of the narrowing of the boundary between science and technology, the work of the scientist has become confused with that of the engineer. They are not the same. The scientist searches for new knowledge, guided by his urge to learn more about the workings of nature. The engineer, on the other hand, is concerned with the achievement of practical goals which advance human welfare or national security. Basic scientific research is indispensable to provide the ever new tools for technology, but this is most often an unpredictable result of such research rather than its objective.

Take the case of the "Hertzian waves," the electromagnetic radiation. If Heinrich Hertz had been asked to devote his energies to producing a device for communicating over long distances without wires, he might very well have turned to semaphore and telescopes, or to light signals, or to some other application of already conventional principles. But he was interested in finding out if the electromagnetic waves predicted by Maxwell really existed, and so contributed something of fundamental importance to our understanding of the universe. It remained for a student of Hertz, named Marconi, to find the first practical application for his professor's discovery—radiotelegraphy.

Basic Research Is Key

You might ask, why lay stress on differentiating betwen science and engineering? Doesn't it run contrary to the intermingling of the disciplines and the erosion of traditional boundaries within and among scientific and technical fields?

The reason is this. The future growth and vitality of sciences in the United States depend upon public understanding of the nature and importance of the function of basic research. It depends on general appreciation that the difference between basic research and engineering is a fundamental difference in the intellectual processes and motivations involved. It requires an awareness that only some 27,000 scientists and engineers in this country are engaged in developing new scientific knowledge, about nine percent of our total number of scientists. On this little band of scientific explorers rests the burden of catalyzing our industrial and cultural progress.

As a result of the equating of science and technology, many have concluded that the $8 billion estimated to be obligated in fiscal year 1960 for Federal scientific research and development provides ample support for research.

Actually, ninety-four percent of this amount is in support of development and applied research—leaving less than $500 million for basic research. Still, this amount is a sign of major progress in gaining public acceptance of the need to support basic research.

Government Promotes Science

This year marks the tenth anniversary of the creation of the National Science Foundation—a remarkable innovation in the history of the United States Government. It was established by the Congress to promote the progress of science; and advance the national health, prosperity and welfare. It alone could initiate and support basic scientific research without relating it to any utilitarian mission. In ten years its annual budget has risen from $3.5 million to the $192 million proposed for the next fiscal year.

Although there are thus encouraging signs of increasing public support for basic scientific research, this support is sustained really only because of the admitted importance of science to our national security, economy and health. I doubt that scientific research is recognized and appreciated in its own right as a creative activity of the mind that enhances man's understanding.

To some, such recognition may seem to be unnecessary and unimportant. But basic research is a fragile flower that needs the nourishment of encouragement and understanding, as well as material sustenance.

Change of Attitude Needed

A change in public appreciation of basic research is, of course, difficult to accomplish and will take education and considerable time. Our present public attitude is a product of more than a century and a half of pragmatism born of the immediate necessity of developing and harnessing our national resources. It was a necessity more compelling than the tradition of scholarly pursuits.

We need both of these in our society: the unquenchable, free, probing into the unknown to expand the boundaries of knowledge; also the humanistic articulation of scientific knowledge that links it to the betterment of mankind.

Some of you will be inclined in one direction; some will be headed in the other. We shall need both—moreover, *you* will need both kinds of activities to insure for yourselves an almost limitless future that can be had if solidly grounded on the broad base of knowledge.

As I speak of the future, I am tempted to paraphrase Charles F. "Boss" Kettering, one of the greatest applied scientists of our age: the future is the main concern to our young people, because they are going to do all their living in it.