SCIENCE

EDITORIAL

Basic Research (I)

The good guys have gotten into an argument that should be settled quickly before damage is done. On the one side are the good guys in Congress who are looking out for the good of the country but are involved in the mechanics of how the country is governed. On the other side are the good guys in science who are looking out for the good of the country but are involved in the mechanics of how science is done. There is a problem in mutual communication that is not helped by terms such as "basic science," "applied science," "industrial policy," and "technology transfer," each of which can be interpreted in very different ways.

Basic research is not pure or unuseful or ivory tower research. It is undoubtedly the most useful and the biggest payoff—but it is also the biggest gamble and the least likely to produce an immediate predictable outcome. Basic research is like gambling on individual numbers in roulette where the chances of success are low but the payoff is big when it comes. Applied research is like gambling on the red or the black numbers where the successful outcome is more likely but the payoff is lower. The difference between research and gambling is that research provides a gain in knowledge even if an immediate practical application is not forthcoming. The difference between basic and applied research is the scope of the applicability, the time scale for the expected profit, and the predictability of the outcome. The discovery of Hertzian waves could not have predicted a world of radio, but it was the essential first step. The elucidation of enzyme specificity and enzyme pathways did not come from any desire for drug design, but it was the knowledge that allowed the development of the wonder drugs of today. Applied research has a narrower, more immediate goal than basic research. And if the applied research fails, it usually leads to new questions that give clues to new basic research horizons.

Basic research has brought us x-rays, penicillin, polio vaccines, light-weight polymers, computers, the green revolution, and recombinant DNA, to name a few of the discoveries that have changed the world in revolutionary ways. The investigators were never paid in advance to develop the industries that resulted from their discoveries but were rather looking into a phenomenon of nature and uncovered surprising new theories and other phenomena. Applied research has taken basic findings and provided the additional information needed to bring us vaccines, radio sets, television sets, the light-weight polymer wrappings that preserve our foods, and the heavier polymers that form our toys. Applied research has thus taken the basic research discoveries and converted them into practical products. Basic research is not necessarily more intellectually demanding than applied research, and indeed many of the discoveries of basic research have been revealed in the process of developing and exploiting new technologies. In applied research the successful application is expected; in basic research a successful application is astonishing.

Because of the unpredictability that any one basic project will succeed in giving a new product, it is unrealistic for Congress to expect, or for scientists to promise, immediate payoffs. On the other hand it would be a monstrous policy error to cut back on basic research if a significant increase in jobs or standard of living is wanted. The developed countries—the United States, France, Germany, England, Japan, and so on—are extraordinarily wealthy, and their citizens live extremely well compared to most of the people of the world. The investment in basic research is a small part of their total income; it is in their own interest to make that investment because they can retain their competitive advantage only if they are in the forefront of the new revolutionary industries. It is also their obligation because basic research in one country helps it in the short run and the entire world in the long run. Thus the developed nations have the expertise and money and are the immediate beneficiaries, but they also have a noblesse oblige to those less fortunate to carry on basic research—the long-range gamble that will ultimately dramatically change the living standard of the world.

So perhaps the debate should be reformulated in the terms of "revolutionary (for basic) research" and "evolutionary (for applied) research." The next question that arises is how to divide the organizational responsibilities, the funding levels, and the priorities of these two types of research. That question will be faced in my next editorial.

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