Changes in Science: An Example

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We have lived through remarkable times. The period between the Second World War and the end of the Cold War has been one of the most creative periods of science and technology in the history of mankind. Propelled by the kind of enthusiasm expressed in Vannevar Bush's metaphor of the endless frontier, and building on earlier achievements, scientific and technological advances have created a novel world for us. The 50-year exploration of the endless frontier drew some of its strength from the premise that science in all its diversity contributed to the national security, a premise made more tenable by the collective social optimism about science engendered by successful construction of the first nuclear weapons during World War II. But, while national defense provided some of the motive for funding basic research, the real motivation for science has always been more fundamental: the sense of frontier, the sense of exploration, and the natural human curiosity that has led us to explore the corners of nature, from the vast reaches of the universe to the smallest building blocks of the atomic nucleus.

Particle physics at Fermilab has had an important part in this grand adventure, as the frontier of the structure of matter has moved from atoms to nuclei to nucleons, and still further to the intricacies of the interactions of quarks, leptons, vector bosons, and the not-yet-seen Higgs particle. As we look back to the Second World War, quarks and leptons seem far removed from that crisis of national defense. Nevertheless, many of those who worked in Los Alamos in the 1940s have served as leaders in these explorations: for example, Bob Wilson, who built Fermilab.

In the research territory between the extremes of the great universe and the tiny quark, there is also cause for excitement. Here occur

discoveries that often find their way to the marketplace on a rather short time line. Frontiers in biology, in chemistry and in many fields of physics have been pushed back significantly. In engineering and in industrial research, product improvements and increasing competitiveness have, in many respects, revolutionized the way we do business, from computing and the control of the flow of massive amounts of information to process control in manufacturing. Progress in biology continues at an unprecedented rate, and the systemization in biology promises even larger contributions to the health of mankind. Biotechnology, materials science and atomic physics all line the highway that leads from the frontier to the marketplace.

Until budget problems caught up with our country's economy, the nation seemed content to define the national defense interest broadly enough to include support for basic, frontier science. Now, however, we are in the midst of a transition that is far from over. The end of the Cold War and the ensuing political and economic instability are all major factors in this transition of scientific research. Forces acting in many directions make it difficult to predict the role of science in the world that will emerge. What is the reason for the problems now facing science and scientists? The root cause, in my opinion, is the decline of public trust in science and scientists.

Clearly, the Cold War is over. As a nation, we are rapidly forgetting any benefits that may have accrued to national security from winning the arms race. We have a new set of problems, and science is the scapegoat for the problems the arms race left behind. Science, after all, gave the world a gigantic nuclear arsenal. Why shouldn't science get the blame for the resulting environmental insult? Scientists and their products are not to be trusted.

Indeed, it would be easy to conclude that the nuclear age has left us with more problems than solutions. Some national laboratories are entirely devoted to dealing with the legacy of the arms race, and, even with no other activities, some of these laboratories have grown appre-

ciably. With something like 50,000 nuclear warheads in the world's stockpiles, we find the threat that a terrorist will seize one of them more fearful than the familiar stand-off of the two superpowers. Terror of terrorism has replaced the stability of the Cold War. Of course, some of this reflects the collective national anxiety that goes with change. Instead of the gigantic problems of the interactions of two superpowers, many see the insoluble problems of a fragmented new world.

The "evil scientist" has become more insidious than ever. We live in a culture of distrust. Science is accused of wasting the taxpayer's money and polluting the environment. Moreover, the snail's pace of most scientific progress is troublesome for people accustomed to wars that last only a few days. There are many rational defenses against this kind of negative image, but we cannot deny its existence. Even when people support science, they often have little sense of urgency for understanding new frontiers. The frontier can wait. And without the support of our society, scientists may begin to lose the commitment required for truly great advances in science.

I spent several years of my life pushing for the SSC, and I am a strong advocate for this project, so when people ask me "What will the Supercollider do?" I try to answer. What should I say? "Discover the Higgs?" Many would reply, "So what? We already know enough about mass or weight or whatever." Should I say the SSC will look for new phenomena beyond the standard model? What will this do for the man in the street, or for defense against terrorism, or to curb crime in the streets? Bob Wilson's reply, "It makes the country worth defending!" seems to be a nonstarter today. I might be able to explain why we need the SSC in a 30-minute discussion, but most people want a 30-second explanation. Nevertheless, I will keep trying, since I believe the diversity of the science we do is a strength in this country. It is important to understand what we are made of and how the building blocks of nature interact.

We must recognize that the role of science in our society has changed. We had better wake up if our commitments are to survive. It is time to pay attention to the society that supports us, and to re-prove our worth. Unless we do, we may come to be viewed as just another lobby, trying to extract as many dollars as possible from the government. For I believe we can say some positive things about the changes of science. The new definition of national security, for example has moved far beyond nuclear weapons, armaments, and military surveillance and communication. It includes counter-proliferation, counter-terrorism, economic competitiveness, and other important directions needed for survival in the post-Cold War world. More broadly for American science, the need to renew our social contract will require redirection, so that Americans will understand just how special our scientific heritage is in this country. Not everyone will hear the message, but we must start the pendulum of understanding swinging in the other direction. We must do our best to change the average attitude to one of greater understanding of the role of science in our society.

Science is changing, and science will have to rededicate itself to society if it is to continue to advance. In the new world, there is the opportunity for an even stronger union between the more broadly defined national defense and basic science. The old metaphor of the marriage of frontier science and national defense can have more meaning than ever. Of course, this marriage has problems to solve, both environmental and political. National security is taking on new challenges, including economic competitiveness, that will require an even broader commitment from science. To carry out this social contract, we must make clear the positive difference that science makes to our society. The issues of national security and the laws of man change, but they still require the advice and advances of science. ❖