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SCIENCE AND MORALITY

ILLUSTRATION: ALLAN M. BURCH

EDWARD TELLER *is a Senior Research Fellow at the Hoover Institution. A physicist born in Hungary, he is most widely known for his contributions to the first demonstration of thermonuclear energy; in addition, he has furthered our knowledge about quantum theory, molecular physics, and astrophysics.*

What is true? What is right? What is beautiful? Science considers what is true, starting out with almost unimaginable ideas (The earth is moving! The future is unpredictable!). The job is to understand these ideas and fit them into a broad and logical picture of the universe. Politics considers what is right. This requires broad understanding and eventual consensus of points of view that often appear incompatible. Art is the development of what is beautiful—whether through words, a musical note, or architecture.

Truth, morality, beauty. It has been humanity's persistent hope that these three ideals should be consistent with each other. Yet successful activities in science, politics, and art diverge greatly, and I believe the three activities can be pursued initially without regard to each other, or without reconciling the possible conflicts that may arise. Today there is perceived to be a strong contradiction between the results of science and the requirements of morality; for instance, the application of science has led to the development of nuclear weapons, while international morality seems to demand that such results never be applied—and that research leading to them should be stopped. I hold a position radically different from the general point of view, believing that contradiction and uncertainty should be embraced.

Contradiction and uncertainty. Niels Bohr loved contradictions. He would not tolerate the idea that quantum mechanics might some day supersede classical physics. For Bohr, classical physics had to remain in permanent contradiction to quantum mechanics and the tensions between them retained as a part of science. In the same way, the impacts of science, politics, and art must remain independent. We must learn to live with contradictions, because they lead to deeper and more effective understanding. The same applies to uncertainty.

According to Heisenberg's uncertainty principle, only probabilistic predictions can be made about the future. Furthermore, small events can have important consequences. An everyday example is weather forecasting. It is fairly successful for predictions up to 5 days ahead, but if you double that period the predictions are no longer accurate. It is not clear whether long-range predictions are forever excluded, but the example does illustrate that small causes can have significant effects.

This situation has an obvious analogy in free will. In a completely deterministic world, what we know as free will in humans is reduced to a mere illusion. I may not know that my actions are predetermined in some complicated configuration of my molecules, and that my decisions are nothing more than the realization of what has been inherent in the configuration of electrons. According to quantum mechanics, we cannot exclude the possibility that free will is a part of the process by which the future is created. We can think about the creation of the world as incomplete and human beings, indeed all living beings, as making choices left open to probability.

One may argue that this notion is fantastic. Indeed, Einstein firmly believed in causality, and rejected the relevant part of quantum mechanics. (His famous statement is that, while God can rule the world by any set of laws, "God does not play dice with the universe.") Attempts have been made to add laws to quantum mechanics to eliminate uncertainty. Such attempts have not only been unsuccessful; they have not even appeared to lead to any interesting results.

Personal history. Looking back at my own work, my major activities have been suspended between science and politics. This was not premeditated—my actions and answers developed from the unavoidable situations in which American science obtained an important influence on world politics. But, upon thinking back, I find that I acted as though I had been convinced from the very beginning of the unavoidable separation of scientific and political decisions.

There was one major decision in my life that seems to have made a difference on a large scale. That was the advice I gave in 1949 about pursuing work on the hydrogen bomb. In August 1949 the Soviets tested their first atomic bomb. Four years earlier, work in the United States on the hydrogen bomb had been discontinued. I had been engaged in one aspect of that project—the problem of how the energy of an atomic bomb could be used to produce nuclear reactions involving the simplest atoms, that is, hydrogen atoms, to release energy in a way analogous to what happens in the sun and stars. What a person works on with some diligence he does not like to discontinue, and I had two reasons to feel disappointment on leaving the work incomplete. One was my firm belief that the pursuit of knowledge and the expansion of human capabilities are intrinsically worthwhile. I could provide valid arguments to support this conviction,

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yet they would fail to explain the devotion I felt for scientific and technical progress. The second reason was my worry of what might result if the Soviets got too far ahead of us in military technology.

I have long been accused of criticizing communism. By age 11 I had had a none-too-sweet taste of communism in Hungary. This left me with a dislike for it but with no firm conviction that communism was wrong—or that the specific Russian brand had to be opposed. Indeed, Hungary's fascist government of the 1920s was much more than disagreeable. I left Hungary to study in Germany, and around 1930 I had discussions with two close friends. One was Carl Frederick von Weizsäcker, elder brother of a later president of West Germany and a most determined opponent of communism. The other was an excellent Russian physicist and Nobel Prize winner, Lev Landau. He could not imagine anything more ridiculous than a capitalist government. I listened to both, but my final decision was influenced by something more important than words.

My second published paper in physics was a joint undertaking with my good Hungarian friend, L. Tisza. Shortly after our collaboration in Leipzig he was arrested as a communist by the Hungarian fascist government. He had lost his chance of obtaining an academic position and I referred him, with my strong recommendation, to my friend Lev Landau in Kharkov, Ukraine. A few years later Tisza visited me in the United States. He no longer had any sympathy with communism. Lev Landau had been arrested in the Soviet Union as a capitalist spy! The implication of this event was for me even more defining than the Hitler-Stalin Pact. By 1940, I had every reason to dislike and distrust the Soviets.

With the advent of the Soviet atomic bomb in 1949, it become clear that the communists were catching up in nuclear technology. Would they develop the hydrogen bomb and become unbeatable in every military respect? Ernest Lawrence, the pioneer in nuclear energy and its applications, visited me in Los Alamos, New Mexico. He wanted to know about the hydrogen bomb and then invited me to accompany him to his plane that left the next morning from Albuquerque. Preparing for bed that evening, he washed his shirt (the newly invented drip-dry shirt) and told me, "In order to use your arguments, you will have to do a lot of traveling. This is now much easier, because as you see, you don't have to take so many shirts along." This was, perhaps, not the most logical argument he could have used to encourage my entrance into politics, but it was most effective in convincing me that he meant what he said.

Even so, I did not proceed to argue for the hydrogen bomb in Washington. I was a physicist, not a politician. I was not a member of the advisory body that had told the president not to proceed with the development of the hydrogen weapons. That unanimous recommendation came from great scientists such as Robert Oppenheimer and my very good friend Enrico Fermi. Not much later, in a private conversation, Enrico told me, "Go ahead with the work on the hydrogen bomb, if you must. I hope you will not succeed."

In the end, I did give my advice to two important people. One was the Democratic senator Brian McMahon to whom the Atomic Energy Commission (AEC) reported. The other was Admiral Lewis Strauss who subsequently became AEC chairman. When asked my opinion, I told them, "I believe that the hydrogen bomb is feasible, may be effective, and the Soviets may soon develop it."

My advice reached President Truman, who decided to proceed with the development of the hydrogen bomb. He did so even though only one of those familiar with the hydrogen project made this recommendation. Whether he would have come to the same conclusion in the face of unanimous opposition by the experts, I, of course, do not know. What I do know is that I ended up with an obligation to work on the hydrogen bomb, which I did with half my heart—the smaller half. I wanted to do it, but my heart's bigger half was with pure science, which I was far too busy to pursue in what was then the prime of my life.

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Several decades later the cold war ended with an American victory. It is possible, perhaps even probable, that my advice to give a positive answer to the question of the hydrogen bomb played a significant role in determining this outcome. Would I have behaved the same way if purely scientific interests had not led me to make calculations about the energy production in the sun? Would I have given the same answer if my friend Tisza had not told me about the persecution of Lev Landau in the Soviet Union? At any rate, my decision was not a momentary exercise of free will, but a combination of many reasons and many choices, some of which were an expression of my "free will."

I am still asked on occasion whether I am not sorry for having invented such a terrible thing as the hydrogen bomb. The answer is, I am not. On the occasion of my 90th birthday, I received a letter signed by four Russian colleagues whom I had visited in their weapons laboratory Chelyabinsk.* The letter contains a paragraph obviously referring to the hydrogen bomb. Their remarks make me very happy.

> The developed nations have paid a great price in terms of their national resources in their strenuous effort to protect life, to safeguard peace. They displayed sufficient wisdom to overcome the traditional inclinations toward military solutions of world problems. This has happened for the first time. And it has provided an abiding pattern to apply new, peaceful and joint approaches to solving the most acute world problems. For the first time in world history, the most powerful weapons ever created were not used. Instead, they became an instrument of human experience, the means of great discoveries, the tool of deep penetration into the secrets of Nature. We trust, it will henceforth and forever take its deserved place among the sophisticated tools of enlightened generations.

ILLUSTRATION: TERESE WINSLOW