“We Knew That If We Succeeded, We Could at One Blow Destroy a City”

A final interview with the most controversial father of the atomic age, Edward Teller

By Michael Lennick

On October 31, 1952, Halloween was just getting rolling in California when, half a world away on the South Pacific island of Elugelab, the firing circuits closed on Ivy-Mike, the first practical test of the prototype hydrogen bomb. Ghosts and goblins roamed the Berkeley streets as Dr. Edward Teller, the driving force behind the new weapon, sat quietly in a darkened basement, patiently scanning for subtle, indirect evidence that he had irrevocably altered the world yet again. He had to squint to read the slowly moving lighted pen of the seismograph, a device normally used to record earthquakes. If the test shot was successful, Teller would see it here 15 to 20 minutes afterward, once the unprecedented shock wave had traversed thousands of miles to nudge the seismograph’s detector.

Teller in an officelike television studio in the late 1950s.
(LAWRENCE LIVERMORE NATIONAL LABORATORY)

It was already November 1, All Saints' Day, at the test site. the early-morning skies were clear over Enewetak Atoll. At T-Zero a radio signal from the control room aboard the USS *Estes* 30 miles away triggered 92 detonators to fire simultaneously, compressing an orange-size uranium/plutonium composite core to supercriticality. The resulting fission explosion, about the size of the Nagasaki blast, was only the first step. In a few millionths of a second it created the conditions, the necessary heat, pressure, and radiation, to enable nature's lightest, most plentiful elements to undergo fusion—to momentarily burn as a man-made star.

Down in Teller's borrowed basement lab the signal arrived exactly as anticipated, a tiny blip. He quickly sent word to his former colleagues at the Los Alamos nuclear-weapons laboratory in New Mexico. Ironically, the radio silence invoked by security concerns meant that the lab that had built the first atomic bombs as well as the new hydrogen test device would receive its initial hint of a successful detonation from its estranged and isolated co-inventor. The telegram read: "It's a boy."

Dr. Edward Teller—Manhattan Project physicist, father of the hydrogen bomb, and a man reputed to be the model for the title character in Stanley Kubrick's ***Dr. Strangelove***—was born in Hungary in 1908 and died in California in 2003. As a child he witnessed the horrors of Béla Kun's Red Terror and Miklós Horthy's far more brutal regime, events that go a long way toward explaining his lifelong distrust of the Soviet Union. In 1926 he went to college in Germany, and he stayed there through graduate school and the start of his research career before fleeing the Nazi menace in 1934.

Teller was a singular presence among his peers. Loud, aggressive, cock-sure, he could dominate any conversation with whatever agenda he was pushing that day. It was not entirely his choice to monitor the 1952 Ivy-Mike test from that Berkeley basement, but he had long ago antagonized and alienated the Los Alamos physicists who would build the device, and he had ultimately walked off the project, hardly a unique situation in his long career. His shadow looms over much of the twentieth century and reaches well into the twenty-first. An early member of J. Robert Oppenheimer's team at Los Alamos, he made key contributions throughout the Manhattan Project, though almost as an afterthought. As early as 1942 he had grown bored with the physics of atomic bombs. He had far bigger fish to fry.

"Szilard…told me about Werner Heisenberg and the letter he was carrying for Einstein….That was the beginning."

Although he was a brilliant visionary scientist, Teller never won a Nobel Prize. His great strength lay in his ability to seize upon an interesting idea and promote it doggedly, for years if necessary, long after its originators had lost interest and moved on. His primary claim to fame, the development of the hydrogen bomb in the early 1950s, is a perfect example. Hans Bethe's work on the carbon cycle, explaining for the first time how stars achieve fusion and thus create heavier elements, had laid the groundwork. In September 1941 Enrico Fermi suggested the possibility of using an atomic bomb to trigger a fusion reaction in hydrogen. Teller grasped the concept instantly and was unable to let it go. At a conference the following summer, called to consider the feasibility of the atomic bomb, he dominated the discussion with exotic schemes to design fusion bombs. It was only after Oppenheimer pointed out the need to achieve a working fission bomb before fusion could be contemplated that Teller agreed to concentrate on the task at hand, and throughout the war years he continued to view the atomic bomb as little more than a mundane engineering exercise. This infuriated his friend and immediate supervisor Hans Bethe, head of the Theoretical Division at Los Alamos—a posting Teller felt more rightfully belonged to him. After much cajoling, Oppenheimer finally gave Teller permission to pursue his fusion chimera, so long as he agreed to pitch in on fission problems as required.

Teller found little support for his fusion bomb in the postwar calm, but that period lasted only until the 1949 test of a Soviet fission device, built using plans stolen from Los Alamos by the wartime spy Klaus Fuchs. Teller and others had long argued that despite extraordinary security, the only real secret of the atomic bomb was whether or not it was possible. Hiroshima had answered that question. Successful nuclear programs in other countries were now inevitable.

Teller responded by lobbying for a crash program to develop his "Super bomb" as a response. Robert Oppenheimer, now a respected government adviser, led the Atomic Energy Commission committee asked to consider the proposal. After much discussion the committee correctly determined that Teller's initial design was undeliverable and recommended focusing instead on the creation of a moderate arsenal of "off the shelf" fission weapons as a deterrent to Soviet ambition. Beyond that, the hydrogen bomb's potential lack of an upper yield limit made it, in the opinion of Oppenheimer, Fermi, and others, an obscene weapon, as well as one without a target in the Soviet Union that couldn't be adequately devastated by one or more Nagasaki-size fission bombs. Only the United States had any cities large enough to provide tempting fusion targets. Finally, the suggestion was made that by turning away from H-bomb research the United States might actually inspire the Soviet Union to do likewise.

Oppenheimer's recommendations appalled Teller, who thought his old friend utterly misunderstood Stalin's dangerous ambitions. Among many in Congress and the Air Force the report was seen as openly treasonous, a belief Teller was able to exploit very effectively in his quest for backing. Teller got his go-ahead for a crash program on the hydrogen bomb, which, thanks to an insight by the

mathematician Stanislaw Ulam, had now been completely redesigned. The new configuration was so elegant and logical that even Oppenheimer called it “sweet.”

The prototype H-bomb, “Mike,” at left, 1952. The horizontal tubes will carry its light to special cameras two miles away for later analysis.
(COURTESY OF LOS ALAMOS NATIONAL LABORATORY)

Shortly after the Ivy-Mike shot, Robert Oppenheimer found himself removed from government service. In subsequent months, as Cold War hawks assumed higher positions of power, Oppenheimer’s top-secret “Q” clearance was revoked amidst charges of disloyalty, stemming largely from his pre-war Communist associations, as well as his more recent attitudes toward the hydrogen bomb. To salvage his reputation, Oppenheimer chose to fight back and requested a hearing before the Atomic Energy Commission. At the 1954 closed-door sessions a stream of scientists and colleagues testified on his behalf, including, rather lukewarmly, Gen. Leslie R. Groves, who had been the military leader of the Manhattan Project. To the astonishment of Oppenheimer and the rest of the scientific community, Edward Teller was recruited by the prosecution. Asked if Oppenheimer was a security risk, he testified: “In a great number of cases I have seen Dr. Oppenheimer act … in a way which for me was exceedingly hard to understand. I thoroughly disagreed with him in numerous issues and his actions frankly appeared to me confused and complicated. To this extent I feel that I would like to see the vital interests of this country in hands which I understand better, and therefore trust more.”

Teller paid mightily for those words. Most of his friends in the scientific community turned their backs on him. For the remainder of his life he insisted

that his testimony had not harmed Oppenheimer significantly. More recently, and very specifically in the interview that follows, Teller claimed his words were a one-time overreaction, the impetuous result of his learning only the day before of Oppenheimer's failure years earlier to fully and promptly disclose an approach by an old Berkeley friend, Haakon Chevalier, a professor of French literature and a longtime Communist. In 1942 Chevalier hoped his friend Oppie might agree to help the Russians, then imperiled by the German invasion, by sharing nuclear secrets—a position that, ironically enough, Oppenheimer would come to advocate after the war. Oppenheimer turned Chevalier down flat but did not report the approach, as he was required to do. Later, when questioned about the incident, in a mixture of panic and an attempt to protect friends of questionable background (including his own brother), he exaggerated the extent of Chevalier's involvement in the espionage scheme. To his enemies in the military and the FBI, it looked as though Oppenheimer might be embroiled in a nest of spies. He would pay dearly for his misjudgment a decade later. Devastated by the outcome of the AEC hearing, his security clearance never restored, Oppenheimer spent the rest of his career at the Institute for Advanced Study in Princeton, New Jersey (he was the director from 1947 until his death), before dying of cancer at 62.

Edward Teller viewed himself as one of the heroes of the Cold War. He believed with all his heart that the hard-line positions he urged against Soviet expansion, his insistence on overwhelming nuclear deterrence, and his advocacy of strategic missile defense were all instrumental in the prevention of nuclear war, not to mention the eventual fall of the Soviet Union. His great blind spot lay not in his comprehension of science or in his soaring imagination and curiosity but in his understanding of the people he shared this fragile planet with (as he freely admitted in his appraisal of Oppenheimer's motives during the AEC hearings). His perpetual disputes with colleagues were a minor issue compared with the dangerous trust he placed in government officials until quite late in life. Buoyed by Oppenheimer's wartime counsel to leave politics to the politicians, Teller failed to see the hidden depths of the Faustian bargain he had so eagerly made with the ambitious generals then running the Air Force and the Strategic Air Command (SAC). The true miracle may be not that we survived the years of nuclear testing and saber rattling but that wiser minds prevailed over the opinions of men like Gen. James Doolittle, the World War II hero whose 1953 advisory committee recommended that the Soviet Union be given two years to come to terms—and then be attacked with nuclear weapons if it failed to do so (a recommendation that President Dwight D. Eisenhower swiftly rejected). Far more dangerous was the SAC commander and later Air Force chief of staff Gen. Curtis LeMay, who sent spy planes over the Soviet Union and maintained an SAC policy (with details hidden even from government officials) that in response to a severe Soviet attack would have launched his "Sunday Punch," a simultaneous attack on Soviet dams, military installations, cities, and towns using everything in the arsenal. He died regarding Presidents Truman, Eisenhower, and Kennedy as

rank cowards for not crushing the Soviets by threatening a nuclear attack while their country held the means to do so.

“Heisenberg worked on it as a German citizen….He had to work on it because he couldn’t leave his country.”

I was finally able to set up a meeting with dr. Teller, for what would turn out to be his final interview, in late 2002. It wasn’t easy. What follows came about only after months of very difficult “auditioning” on my part. Teller wanted to be sure that his interviewer knew what he was talking about. I was required to submit a series of essay-style answers to questions he posed to establish my position and knowledge on a number of topics, not all of them nuclear-based. This process continued even as I was setting up the lights to videotape the interview in his Berkeley study. He would regularly call me over to ask my opinion of, say, recent political developments in Hungary or to quiz me on something he had included in his just-published autobiography. Apparently I passed his many tests, although it wasn’t until we had been talking freely for half an hour that I began to lose the apprehension that he might yank off his mike at any moment and wheel himself from the room. Although we had conversed by letter, telephone, and fax, I had no idea what to expect from him in person. What I found was a brilliant scientist and thinker still vibrant at the end of his days. His thoughts on free will relate to the unpredictable actions of subatomic particles as revealed in work only now being reported, nearly two years after his death.

Edward Teller remained ever childlike, in both the best and worst senses of that word. The long-term consequences of his work are still playing themselves out, and they will determine whether future historians regard him as a genuine titan or the ultimate terminator.

Dr. Teller, I wonder if we could begin with your good friend Leo Szilard, and specifically your involvement with him in encouraging Albert Einstein to write his 1939 letter to President Roosevelt warning that the Germans might be working on a bomb.

Szilard was a very ingenious and interesting person, almost 10 years my senior, whom I met when I was a high school student in Hungary. We kept up our friendship, and one day he came to me and told me about Werner Heisenberg and the letter he was carrying for Einstein. I was superior to Szilard in one respect. I drove a car. He did not have a driver’s license. He needed a chauffeur. He told me what it was about, but I would have been glad to help him in any case. I agreed to drive him wherever he needed to go, which was near the end of Long Island, where Einstein took his summer vacation. That was the beginning.

The beginning of the Manhattan Project?
The beginning of everything.

Your work in nuclear physics will certainly form a large part of your legacy, but your writings suggest that you were heading in a different direction as a young man.
An entirely different one. The most important part of my education was my study with a great man whom I admired and whom I continued to consider a wonderful person, and not only a wonderful scientist, Werner Heisenberg. I learned from him the amazing new story of quantum mechanics, something that says that the future is truly unpredictable and that we may well have something like a free personal will. I worked on molecular spectra, a big area in this new science. I was happy doing that, I was happy teaching it, and had fission not come along, I would have continued to do it happily ever after.

What are your thoughts about Dr. Heisenberg's involvement in the German nuclear effort and in Germany's failure to produce a viable weapon?
Heisenberg worked on it as a German citizen, but he was not a Nazi. He was almost sent to a concentration camp. He had to work on it because he couldn't leave his country. His attitude normally would have been: "This thing, let's get it done." In this case his attitude was different, thank God. He wanted to do it, yes, but not in his heart. He had an obligation to do it, but I believe he did not succeed because he was not really convinced that he must succeed. During the war of course I did not know that, though I knew always that Heisenberg was a very decent person.

For the Germans, the British, or the Americans, the engineering problems in 1939 must have seemed overwhelming.
We did not know how difficult it would be. That there would be people in Germany who would want to use it to help Hitler rule the world, I have no doubt. All Heisenberg wanted was for the war to be over and for his country, Germany, not to suffer very badly.

Did you know intuitively that if a way could be found to purify enough U-235, a crude but deliverable weapon was a certainty?
I am tempted to say yes. We knew that if we succeeded, we could at one blow destroy a city.

Germany surrendered shortly before your final push toward the Trinity test. What effect, if any, did the loss of the original threat have on the pace of work at the lab?
The matter was hardly discussed. We were close to the end, and there was no doubt in people's minds about demonstrating the explosion, which happened in the middle of July. I remember driving away from that knowing that next time it would not be a demonstration, and I felt very worried. So did many other people in Los Alamos. After the Japanese missions we received the news that the war

was over, and most doubts ended. There was a feeling of joy and celebration at the lab. We had made a big contribution to ending the war. Some celebration was justified, but I did not wholeheartedly participate.

“I took off the glasses and looked at it, and there was a fireball rising, illuminating the whole world.”

May I ask you to recall the morning of the Trinity test, July 16?
That is a very sharp memory. I was with a group of people, I don’t know how far, maybe 20 miles from the point of explosion. We were told to lie down with our backs to the explosion. I obeyed and did lie down, but I did not turn my back to the explosion. I looked straight at it. We were given welding glasses to put before our eyes to shield them from possible radiation. At our distant observing station we had reports from time to time, but then before the shot the reports stopped and we did not know what had happened. Maybe the shot was called off. Then came the time, the actual time. I was, as I told you, looking straight at the object. It was early in the morning, the sun wasn’t up yet. There was a little light—and the first seconds, a disappointment. Is that all? So I tipped the welding glasses and looked down at the sand next to me, and that gave an effect as when it’s midday and a heavy curtain moves on your window and the sunlight is streaming in. And that was only reflected light. Then I was impressed. I took off the glasses and looked at it, and there was a fireball rising, illuminating the whole world. Then after maybe 10 minutes, 15 minutes, we got up and started to walk away. Things were different. There was a strong feeling that whatever came next, it would be much more than a fireball.

Your primary working relationship at Los Alamos was with Robert Oppenheimer, who recruited most of the scientists for the lab. What are your memories of him?
Plenty, and not easy to tell. I want people to hear the story. To many of the people Oppenheimer was a motivator. He understood what people said, he understood what made them tick, and he encouraged them. He was, once he undertook the job, very anxious that he should succeed. He would say of Japan that it’s a terrible thing, they have no weapons, the war is over, but let’s do it. Oppenheimer was not a person without contradictions.

With all the dossiers compiled on Oppenheimer and his family and friends, the FBI actually managed to miss the two Soviet spies who really were working at the lab. Were you surprised by the Soviet detonation in 1949 or the revelations of how close their agents actually got to your work? I’m thinking, of course, of Klaus Fuchs.
They had a very effective spy in Klaus Fuchs. He was a German and a very nice person, a highly intelligent person. I don’t know what the Nazis did to his family,

but they did terrible things. He was actually informing the Soviets about the essential things we did. He got money for it, but I'm absolutely certain that he did not do it for money. I could not disagree with his actions more than I do, yet he behaved as a friend, and somehow I cannot think about it in very different terms.

Work on the hydrogen bomb must have seemed impossibly more complex than implosion, if only because of the vast number of events that had to take place within milliseconds of the triggering blast to ignite the fusion fuel and keep it burning. How were you able to address those problems in the age of desktop adding machines?

Among my Hungarian friends there was one who was particularly ingenious, John Von Neumann. He changed the thinking about computing machines. Instead of a hard-wired machine that was good for one job, he invented something flexible that could be instructed and could work not only on things that you told it to work on but on alternatives that the machine itself formed. A tremendous piece of progress that now plays a considerable role in day-to-day life and commercial life. The early calculations on the Super were done by his method, and our success relied to a great extent on his computing machines.

Which leads me to the disproportionate Hungarian connection to physics in the twentieth century. There's an old theory that coming from Hungary, a mountain-rung country with no linguistic connection to its neighbors, you were clearly aliens using your superior intellect to help the rest of us along. What are your thoughts?

I had four Hungarian friends. One was much older, Theodore von Kármán. The second was Leo Szilard. He was responsible for early work on atomic energy. The third one was Eugene Wigner, a very modest, incredibly ingenious man who played a huge role in designing nuclear reactors. The fourth was John Von Neumann. To my mind he was most ingenious of the whole group, except possibly for me, who is sometimes given the honor of being mentioned with the others. All of us together were mentioned by the older Theodore von Kármán. He denied that we were Hungarians; since we could not talk English without an accent, we had to pretend to come from someplace, because no one would believe in a Martian. So we settled on Hungary, and that was where we came from.

I've always been amazed by the widespread acceptance of the Martian theory.

It's as nice a theory as I've ever heard, and Theodore von Kármán was famous for his true statements. He always insisted on never being too confined by actual events, and he never told a good story twice without improving it.

You're not widely known for actively espousing the Martian theory.

Not necessary, it's a simple fact.

Looking back, how do you view your role in America's deployment of a thermonuclear defense strategy?
I absolutely accomplished it. I saw, and I saw correctly, that both atomic weapons and hydrogen bombs, Super bombs, would become important. I saw correctly that the Soviets would have both in a short time. I did two things with conviction, develop our bomb first and act in a way that we should never use it except to deter its use by others. In that we succeeded. The Soviet leaders after Stalin, who were not complete fanatics, realized that they could not possibly win without terrific losses, and in the end they resigned. That they resigned was the triumph and success of the Russian people, but had they had the power of the hydrogen bomb before we did, I don't know what would have happened.

But we did build both bombs well before them.
Due to the excellent work of the people who came to Los Alamos. These were Americans, but to a not small extent they were refugees from Hitler's regime. There were also inspirational American leaders, and among those, Oppenheimer was most outstanding. His efforts inspired us to success before the entire world. Even so, we were ahead of the Soviets by only a few years, and not more.

Yet Oppenheimer was ultimately destroyed over his postwar leadership of the Atomic Energy Commission's General Advisory Committee, especially in its recommendations against the development of the hydrogen bomb and what he saw as a costly and ultimately futile arms race with the Soviet Union.
What you said is believed by many and is completely wrong. Oppenheimer was not destroyed. Oppenheimer was deprived of his security clearance. He was no longer asked to assist in policy matters. He was already the scientific leader of a group in Princeton, the Institute for Advanced Study, the most outstanding theoretical group in the world. To be the head of that and be destroyed is quite a combination. But he was extremely ambitious, and he was deeply hurt. And then he died, to what extent due to these events I don't know.

I take your point. Yet history views your testimony at the 1954 hearings as a factor, perhaps the primary factor, in the decision to deny the renewal of Dr. Oppenheimer's clearance. Your life in the aftermath of that hearing was affected to almost the same degree as his. In hindsight, would you testify any differently today?
[Long pause.] I can now say yes. I have thought about this a great deal in recent years. In my testimony in the Oppenheimer matter I was prepared to say he was a loyal citizen. I did say that. But immediately before my testimony I received information that he had accused one of his friends of espionage, for which there had been no evidence. I received that information, and it induced me to be a little more open about the point that I did not agree with him in many details of what he was doing. I should have told the meeting that I had been influenced by that information I had gotten concerning the statements of Oppenheimer on his friend Chevalier. I wish I had.

“I see now I should have given my source of information….The result was pain for Oppenheimer and for me.”

Are you saying it was only momentary anger over what Oppenheimer had said about Haakon Chevalier that led you to speak as you did?
Not anger, more of a feeling of responsibility. I could not ignore such responsibility. I see now I should have given my source of information. I had been told not to repeat the source, but I should have ignored that and told it. The result was pain for Oppenheimer and for me. But it was not anger; it was worry and more worry. I was not alone in this. Oppenheimer was a good friend, a great and wise man who saw the world in a foolish way. Sadly, history has proven this to be so.

You stood practically alone in the scientific community after the hearings, especially among your fellow physicists from Los Alamos. How were you able to re-establish relationships with your colleagues?
Not easily, and with some not ever, but with the help of some of my friends, most particularly Hungarian friends. For instance, Szilard and I were in sharp disagreement, yet he did not leave me in the slightest. Among the others, I lost far too many.

Well before the AEC hearings, you had already broken off from the Los Alamos group, going so far as to lobby the government for a new lab here at Berkeley to work on the hydrogen bomb following the breakthrough you shared with Stanislaw Ulam.
My work at Los Alamos was over. I had recommended we build a new laboratory, which most fortunately became a reality in Livermore. This became my new home. I’m still consulting there two days practically every week.

Yet the first full fusion test, the Mike shot, was a Los Alamos device. You’ve described sitting in a darkened room in the basement at Berkeley and watching the shot on a seismograph printout. Why were you not present for the birth of this child?
It was not yet the Super. It was a test of certain theories, mine and Ulam’s. We were at the very beginning of the project. The head of Los Alamos, Norris Bradbury, kindly invited me to attend. I had to stay in Livermore, but on the advice of a very excellent seismologist friend I had the seismograph set up and all the seismologists in Berkeley watching. I was indeed watching in the basement. The time came and went, and nothing was seen. It couldn’t have been. The shock that came through the earth, moving at sound velocity, took a quarter of an hour or more to arrive. The shock wave arrived precisely at the time when it should and had roughly the right shape. We found that what was seen

was precisely what should have been seen. At that time I knew it was a success. Remarkably enough the people in Los Alamos did not know that because their representatives in the Pacific, where the shot actually took place, were not allowed to tell home until Washington made up its mind that it was clear. I was not allowed to wire anything classified, so I made up my own code. I did not mention any explosion, only that it was a boy. I'm glad to say the message was received, understood, and it was their first news that the shot was a success, though I have to apologize for its sexist character.

Have you been surprised by the growth of public interest in science since the end of the Second World War?
That is a very complicated question. My branch of science became public policy the moment the world knew of Hiroshima. Unfortunately, a proper discussion requires a background and education that for a nonscientist in particular is not an easy matter.

Are you saying a lack of grounding in physics or mathematics disqualifies citizens from participating in discussions of scientific matters that might affect them?
No. From the beginning of the twentieth century there has been great interest in science. Very particularly there were two pieces of enormous progress: Einstein's relativity and quantum mechanics. These two ideas resulted in great understandings that in many respects contradicted common sense. The idea of limited light velocity, the idea that if two events are simultaneous or not, you cannot properly judge without saying how fast you are moving—these are completely foreign to common understanding. Quantum mechanics even more.

Yes, but lately it would seem that international commerce or even religion has had more impact than scientific knowledge on scientific policy. Does this concern you?
Yes. But in the nineteenth century if a physicist believed in God, he had to admit that God was unemployed. Unemployed because the world was created billions of years ago with a law that at that time physicists believed in, of cause and effect, according to which the whole future is absolutely determined by what we can see today. Quantum mechanics says that the future is not determined. We can't find out about the future. Probabilities, perhaps, but not certainties. If quantum mechanics is right, and if you happen to believe in God, there is plenty for God to do. He is anything but unemployed. That should give you a bit of a feeling how important, for the general way of thinking, science has been. On top of that there came all the practical applications of which the nuclear explosions are a symbol. The result was a growing interest in science in the last half of the twentieth century. But there is a limit. The more we know, the more seems unknowable, certainly to laymen or those of religious intent. Those of the public who are interested are only beginning to understand how enormous the universe really is. I say enormous, and secretly I believe perhaps infinite.

How do you respond to the new reality that small, unaligned nations and even individual groups are attempting to get nuclear weapons and other means of mass destruction?
With extreme dismay, but not without hope and optimism. The danger is there, but these things are not easy to do. We found this out. For a small group nuclear weapons are very probably more trouble than they are worth. You can do more damage for much less cost with biological weapons. To my mind the danger is there for such weapons to start something like the great diseases that killed millions of people, yet this has not happened. Why not? These compounds are cheap, and there have been attempts, but the number of people killed were about a dozen or two. Why? I will give you two answers, one honest, one hopeful. The honest one is: I really don't know. The hopeful one is: Our research in counteracting contagion has gone so far that for the terrorists to overcome it is not easy. You will see this is the case with nuclear weapons as well. Always there is a balance.

As you look back on an extraordinary career across most of a century, if you could write your own epitaph, what would you emphasize?
The love of science. I used to be a simple advocate for our government. I have changed. By being a little more curious about the world, I have learned that the difference between cultures is a varying thing, which can and should be reduced by emphasizing positive cooperation.

Dr. Teller, for my final question may I ask you if there is anything you regret?
Yes. *[Long pause.]* Concerning Oppenheimer, I should have been more careful. I wish I was. But as far as people getting angry with me, I wish the outcome had been a little more gentle.

Michael Lennick has written and directed films and television series on space travel and technology for the past 25 years. His latest project, "Dr. Teller's Very Large Bomb," will air in late 2005.

The Cast

HANS BETHE (1906–2005) Physicist, Nobel laureate, head of the Theoretical Division at wartime Los Alamos. His solar research led to speculations on the feasibility of a hydrogen bomb.

HAAKON CHEVALIER (1901–1985) Professor of French literature at the University of California, Berkeley, Communist, and close friend of Oppenheimer. In 1942

Chevalier asked Oppenheimer to help transfer information about the bomb to the Soviet Union. Oppenheimer refused, but the incident caused him much trouble later.

ALBERT EINSTEIN (1879–1955) The letter he addressed to President Roosevelt in 1939 (initiated by Szilard and Teller) ultimately led to the Manhattan Project and the first atomic bombs.

ENRICO FERMI (1901–1954) Physicist, Nobel laureate, key member of the Manhattan Project, first man to build a nuclear reactor (1942). He first proposed the possibility of a hydrogen bomb to Teller in 1941.

KLAUS FUCHS (1911–1988) German-born physicist who joined the Manhattan Project with the British contingent, later revealed as a spy for the Soviet Union.

WERNER HEISENBERG (1901–1976) Nobel laureate best known for his uncertainty principle, Teller's mentor, and head of the unsuccessful Nazi atomic-bomb project.

J. ROBERT OPPENHEIMER (1904–1967) Physicist, director of scientific programs at the Manhattan Project's Los Alamos laboratory, "father of the atomic bomb," Teller's close friend and supervisor at Los Alamos. Although Oppenheimer supported dropping the first bombs on Japan, he spent the rest of his life arguing against nuclear proliferation.

LEO SZILARD (1898–1964) Hungarian-American physicist and biologist. Szilard co-wrote and instigated the famous Einstein letter, which urged President Roosevelt to consider development of the atomic bomb.

THEODORE VON KÁRMÁN (1881–1963) One of Teller's fellow Hungarians and cofounder of Caltech's (now NASA's) Jet Propulsion Laboratory in Pasadena.

JOHN VON NEUMANN (1903–1957) Mathematician, chief designer of first programmable, general-purpose electronic computer and permanent data storage techniques. Another of Teller's fellow "Martians."

STANISLAW ULAM (1909–1984) Mathematician,

Manhattan Project veteran. His calculations proved Teller's initial design for the H-bomb would not succeed.

EUGENE WIGNER (1902–1995) Physicist, Nobel laureate, Manhattan Project veteran, and the fourth of Teller's "Martians."

Reference

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