DEFENSE

Knowledge Is Power

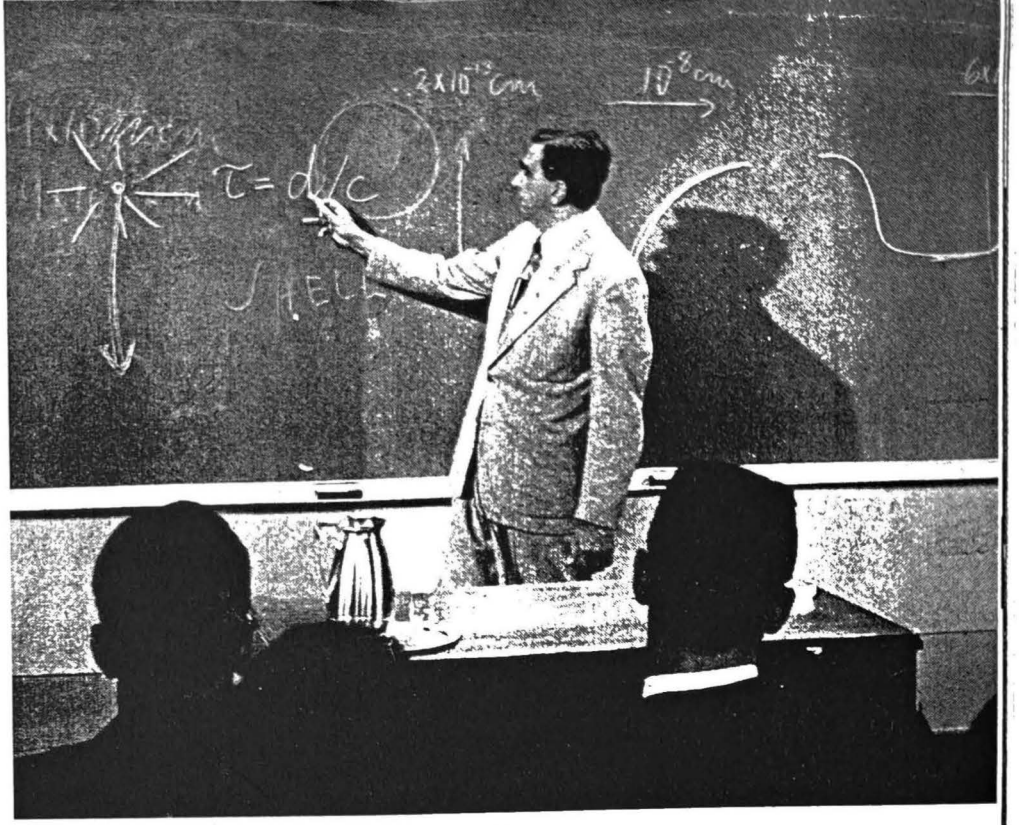
(See Cover)

In the uneasy autumn of 1957, the U.S. is reluctantly grasping the full, unwelcome meaning of Russian-made metal objects orbiting around the earth. Sputnik I and Sputnik II have painfully fractured the U.S.'s contented expectation that, behind an impenetrable shield of technological superiority, the nation could go on with the pursuit of happiness and business as usual this year and the next and the next. Now the U.S. has to live with the uncomfortable realization that Russia is racing with clenched-teeth determination to surpass the West in science—and is rapidly narrowing the West's shielding lead.

With the dizzying growth of science and technology in the 20th century, Philosopher Francis Bacon's 16th-century dictum that knowledge is power has come fully and prophetically true. Advances in abstract scientific theory can promise or threaten next year's breakthroughs in the technology of national power. And on the sidelines of the science-technology race, the backward nations, eager for progress and wary of winding up in the loser's camp, watch intently to see how Russia fares in competition with the West.

Unique Endowment. That science has become the balance point between Communism and the rest of the world is no surprise to the Communists. Said Stalin in 1931: "The history of old Russia is the history of defeats due to backwardness . . . In ten years at most we must cover the distance which separates us from the advanced countries of capitalism . . . Look into everything, let nothing escape you, learn and learn more . . . We must study technology, master science." Today Russia graduates more than twice as many scientists and engineers per year as the U.S. So sophisticated was the approach of Communist bosses to science—particularly since World War II—that they freed scientists from the Communist system itself, set them up in a never-never land of unlimited funds, limousines, *dachas*, and even—in the last few years—freedom of thought. The Sputnik I that came as a shocking surprise to the U.S. public was no surprise to U.S. scientists. From keeping an eye on Russian research through scientific journals, from reports of colleagues who visited Russia, and from meeting their Russian opposite numbers at international scientific gatherings, U.S. scientists were well aware that Russia's scientific venture was accelerating fast.

In a very particular sense, the menacing Russian advance was no surprise to Edward Teller, 49, the rumpled, shaggy-browed, Hungarian-born nuclear physicist, the "father of the H-bomb" and now associate director of the University of California's Radiation Laboratory. Teller was uniquely endowed by his scientific talents, a first-hand familiarity with Middle European tyranny and his deep affection for his adopted U.S. to see what most of his fellow countrymen could not see. Of all the U.S. scientists on campus, in government, in industry, Teller worked hardest and most belligerently to send the warning that the Russians were coming. Looking beyond the obvious dangers of Russian advances in particular fields of military technology, *e.g.*, rocket engines, Teller finds a more worrisome menace in Russia's massive national program of science education and basic research.



TELLER AT WORK
Only one or two men in the world.

"The science of today," he says, "is the technology of tomorrow. Many people are afraid we will be attacked by Russia. I am not free of such worry. But I do not think this is the most probable way in which they will defeat us. They will advance so fast in science and leave us so far behind that their way of doing things will be *the* way, and there will be nothing we can do about it.

"Every year without war is a benefit for all mankind. But the Russians can conquer us without fighting, through a growing scientific and technological preponderance. Already today we are beginning to have some global control over the forces of nature. Throughout the world we already are beginning to change conditions. The planet will become smaller and smaller. What one country's technology is doing will obviously more and more affect other countries. If the Russians go ahead faster than we do in this direction, then we will be just helpless. If we are not able to use our freedom in the direction of accelerated progress, and if the Russians use their tyranny in this direction, they will win."

Two v. 35. The science race, says CalTech's President Lee DuBridge, is "not like a race of two horses. It's more like a race of 100 yachts. Some of their yachts are ahead, and some of them are way back. But their fleet is moving faster, and all their yachts could pull ahead." Top-flight physicists note that the Russians have an 8.3-billion electron-volt particle accelerator (atom smasher) more powerful than the University of California's Bevatron. Says U.C.L.A. Physicist Joseph Kaplan, scientific overseer of the U.S.'s International Geophysical Year effort: "In oceanography, meteorology and upper-atmosphere physics, the indications are that they are certainly as good as we are."

The record of U.S. science shows that a nation's scientific venture can move along fast when it gets up momentum. U.S. science lagged far behind Western Europe as recently as the 1920s. Then the contagious excitement of pure science hit the universities, and the U.S. spurted ahead. An enriching influx of dictator-fleeing European scientists, plus the pressure of World War II, accelerated scientific progress. Recalls Columbia University's Nobel-Prizewinning Physicist I. I. Rabi: "When I went to Europe a quarter of a century ago, I was provincial. When I went to Europe after the war, it was Europe that had become provincial." Adds CalTech's DuBridge: "It's a miracle that's happened in basic science in this country in the last 30 years." From 1901 until 1930, the U.S. won only five Nobel Prizes in science. Since then, the U.S. has won 30 Nobel awards in physics, chemistry, or medicine and physiology, far more than any other country.

By contrast, Russian scientists have won a grand total of two Nobel Prizes, one back in 1904, and the other last year for chain-reaction studies carried out in the 1920s. The lack of Nobel Prize quality in recent Russian research supports the opinion of leading U.S. scientists that most of the U.S. yachts in the scientific race are still well in front of their Rus-

sian counterparts. The U.S. still leads, the scientists think, in chemistry and most branches of engineering—and it is far ahead in the medical and biological sciences. Says the University of Colorado's pioneering, Russian-born Physicist George Gamow: "If you consider science as an instrument of the cold war, then maybe we are lagging a bit—but if you are talking about science itself, America is doing all right."

Einstein Complex. It is the sense of adventure in science that catches the imagination of the American and makes him good. Asked what he is doing, the scientist is likely to reply, disconcertingly, that he is having "fun"—a word that recurs again and again, along with "adventure," when scientists talk about their work. This sense of joy and excitement that scientists find in their work flatly contradicts the layman's image of science as a grey, austere calling, suited only to eccentrics. University of California Physicist Luis Alvarez blames this image largely on what he calls "the Einstein complex." For years the only scientist known to the U.S. public at large was the late Albert Einstein. He perfectly fitted the image of the scientist as an unkempt eccentric, to be applauded from a distance, but not imitated.

Tests designed to measure high-school students' attitudes toward scientists show that, along with considering scientists eccentric, they think of them as being 1) underpaid, and 2) elderly. Neither notion fits flesh-and-blood U.S. scientists of 1957 (*see box, p. 24*). Along with his fun and adventure, a university-based scientist can make, with consultant fees from industry added to his faculty salary, from $10,000 to $20,000 a year. Scientists in industry can do a lot better than that. As for age, middle-aged scientists complain that in science the most brilliant ideas come to men in their 20s and 30s. "The best years are when you are young," says Alvarez. "Your legs give out at 35. It's like baseball. If you can't be a manager by the time you're 35, you'd better run a filling station."

To the Cosmos Club. There is still another path for any modern scientist who has acquired a reputation: it leads toward Washington, the affairs of state, national secrets, and the unscientific intricacies of government. In and out of the intellectuals' Cosmos Club on Washington's Massachusetts Avenue hurry physicists, chemists and mathematicians newly arrived to huddle with generals, admirals, high officials of the Federal Government, even, occasionally, the President himself. "There are three kinds of physicists," says AEC Chairman Lewis Strauss, "theoretical, applied and political." Edward Teller is all three.

At the Atomic Energy Commission's Livermore, Calif. fusion laboratory, Teller turns his mind to development of tactical-size, low-fallout thermonuclear weapons. In addition, he serves on the AEC's General Advisory Committee and the Air Force's Scientific Advisory Board, carries on his own strenuous public-education campaign in media as far afield from pure science as the *This Week* Sunday supplement. Main topics: the survival value of underground bomb shelters, the need for continued nuclear-weapons tests, and, above all, the urgency of keeping ahead of Russia in science.

Multiple Monomania. With all this, plus university duties as an associate director of the Radiation Laboratory and a teacher of postgraduate physics, Teller's life shows scant resemblance to the stereotype of the scientist at work, insulated from the clamors and interruptions of the outside world. Even before Teller leaves his garden-girdled house in Berkeley in the morning, his harried secretary usually puts through two or three long-distance calls. After he gets to his office, a train of thought about some theoretical problem in nuclear physics is likely to be interrupted by a query from the Pentagon or a reminder that it is time to leave for the San Francisco airport to catch an outgoing plane. On his trips to the AEC's Livermore lab, 45 miles from Berkeley, Teller dictates letters to his secretary while driving. It is no wonder that Teller has not found time to finish the atomic alphabet (*see box*) that he started writing for his two youngsters.

Teller's hectic schedule has damaged his health: suffering from ulcerative colitis, he takes daily doses of atropine and phenobarbital, sticks to a doctor-ordered diet, painful for a man who devours food with Hungarian gusto. But a damaged constitution has not damped his crusader's fervor. The late great Nuclear Physicist Enrico Fermi once said to him, with affectionate exasperation: "In my acquaintance, you are the only monomaniac with several manias." Princeton Physicist John Wheeler, who worked on both the A-bomb and the H-bomb, put it more truly. The essence of Teller's character, Wheeler said recently, is that he "cares very much."

A Lost War. Edward Teller's intense concern with the menace of tyranny traces back to his Hungarian childhood. When Teller was born, in 1908, into a Jewish family with culture and money, citizens of gay, well-fed Budapest could believe that the world was solid, dependable. But Austria-Hungary got into World War I on the losing side, and the seemingly solid world crumbled. Defeated Hungary lost two-thirds of its prewar territory, and the country's economy collapsed in wild inflation. With the nation's life disrupted and anti-Semitism rampant, Teller's father dinned into his son two grim lessons: 1) he would have to emigrate to some more favorable country when he grew up and 2) as a member of a disliked minority he would have to excel the average just to stay even.

"All this has great relevance to me," says Teller. "I have seen, in Hungary, at least one society that was once healthy go completely to the dogs. I have seen the consequences of a lost war. I have also seen very many people, with all the evidence before them, refuse to believe what they saw."

The Square. It was easy enough for young Edward to excel the average. In early childhood he showed a gift for mathematics. "One of my earliest memories," he recalls, "is that I was put to bed earlier than I liked and then lay awake in the dark, amusing myself by figuring how many seconds there were in a minute, an hour, a day."

In his high-school days in Budapest Teller was, as he puts it today, a "square" (pronounced, in his thick accent "skvare"). Favorite amusements were chess, hiking, poetry and music. Among the subjects of his poems was a chum's brainy, grey-eyed younger sister, Mici (pronounced Mitzi), who shared young Teller's enthusiasm for mathematics and that special Hungarian passion, pingpong. Eventually they were married.

Like all young Hungarian scientists in those days, Teller took his Ph.D. in Germany (University of Leipzig). When Hitler took power in 1933, Teller was at Göttingen, pursuing research in the molecular structure of matter. With the anti-Semitism that darkened his childhood raging about him again, he eagerly grabbed at a British rescue mission's offer of a lecturer's post at London University. Two years later he moved on to the U.S. to take up a physics professor's duties at the District of Columbia's George Washington University.

Mici Teller recalls the stretch in Washington before World War II as the best years of their lives. "We had time to go to the movies and give parties," she says wistfully. "We do not have much time for that kind of thing now." Working with

DR. TELLER'S ATOMIC ALPHABET

A stands for atom; it is so small
No one has ever seen it at all.

B stands for bombs; the bombs are much bigger.
So, brother, do not be too fast on the trigger.

F stands for fission; that is what things do
When they get wobbly and big and must split in two.
And just to confound the atomic confusion,
What fission has done may be undone by fusion.

H has become a most ominous letter;
It means something bigger, if not something better.

S stands for secret; you can keep it forever—
Provided there's no one abroad who is clever.

Professor Gamow at George Washington. Teller studied thermonuclear reactions (fusion of hydrogen nuclei) in the stars. That pure-science undertaking was to have momentous consequences: it led to the development of the H-bomb.

Snarled Threads. Seven months before the outbreak of World War II, scientists in the U.S. learned with alarm that physicists in Germany had succeeded in bringing about atomic fission. Shortly afterward, the U.S. incurred the first major installment of its massive debt to Hungarian-born scientists. Physicist Leo Szilard, leaping in thought from laboratory fission to atomic bomb, set out to urge the U.S. Government to get an atomic-research project going. Reasoning that a letter to President Roosevelt would have maximum impact if signed by Einstein, Szilard recruited his fellow Hungarian Edward Teller to chauffeur him out to Peconic Bay, N.Y., where Einstein was vacationing. Einstein signed, and the eventual result was the Manhattan Engineer District project that produced history's first atomic bomb.

Teller did not know it then, but the trip to Peconic Bay was a turning point in his life—the start of his deep involvement in weaponry, war and politics. When he went to Columbia to work with Szilard on an atomic-energy project, Teller intended to go back to George Washington some day and resume his pure-science investigations into the minute structure of matter. That day never came. In 1943 he found himself heading to New Mexico to work at the Los Alamos A-bomb lab. Recalls Teller: "I was then on leave of absence from the Chicago Metallurgical Laboratory [another atomic project], where I was on leave from Columbia, where I was on leave from George Washington." The snarled threads of his life were never to be straightened.

Sin & the Super. In the Manhattan Engineer District days, while the first A-bomb was still in the making, Teller's mind leaped ahead to the possibilities of a thermonuclear bomb repeating on earth the fusion that makes the stars glow. But at war's end he found most of his fellow scientists unwilling to work toward the "super." The deadly success of their A-bombs at Hiroshima and Nagasaki had rocked the consciences of the atomic scientists. "The physicists have known sin," said Physicist J. Robert Oppenheimer, Los Alamos' wartime director, and most of his colleagues agreed with him.

When the Los Alamos bombmakers scattered, Teller accepted an invitation to work with Enrico Fermi at Chicago's Institute for Nuclear Studies. Teller kept urging an H-bomb program, but nobody seemed interested.

In August, 1949, years ahead of the most pessimistic U.S. predictions, the Russians achieved their first atomic explosion. Far from urging a crash program to produce an H-bomb, the Atomic Energy Commission's influential General Advisory Committee of scientists, chaired by Oppenheimer, voted flatly and unanimously against any H-bomb program.

Teller had to make an agonizing decision: either accept the G.A.C. verdict against his own passionate conviction that it endangered the nation, or fight the decision, with little chance of winning, and at the cost of ostracism by many of his fellow scientists. He chose to fight, joined forces with Atomic Energy Commissioner Lewis Strauss in the struggle that pitted them against popular Robert Oppenheimer and split the ranks of U.S. scientists for years afterward.

The Missing Idea. The behind-doors debate dragged on for half a year after the Russians exploded "Joe One." Then, in late January 1950, a shocking bit of intelligence decided the issue: German-born British Physicist Klaus Fuchs confessed that he had passed atomic secrets to Communist agents. Fuchs had been present at Los Alamos when Teller & Co. reviewed all that was known about thermonuclear reactions. Four days after Fuchs's confession, Harry Truman directed AEC to go ahead with the H-bomb.

In November 1952, history's first thermonuclear explosion wiped the South Pacific islet of Elugelab off the face of the earth. What exploded was not a bomb, but an unwieldly device made monstrous by the refrigerating equipment needed to keep heavy hydrogen liquified. History's first real H-bomb (using lithium instead of heavy hydrogen) was exploded by Russia in August 1953. Fortunately for the U.S., Edward Teller had by then come up with the missing idea (still top-secret) that the U.S. needed to make a practical H-bomb. It was an idea so ingenious, says a U.S. physicist who is no friend of Teller's, that "only one or two men in the world could have thought of it." (The other was a Russian.)

The Monster. One of Teller's sturdiest allies in the 1949 H-bomb struggle was the University of California's Nobel-Prizewinning (1939) Physicist Ernest Orlando Lawrence, inventor of the cyclotron and head of the Radiation Laboratory. In 1953 Lawrence invited Teller to join the university's topnotch physics faculty.

For Teller, the move to California meant an opportunity to work in the famed Rad Lab, whose star performer, the 6 billion electron-volt Bevatron, was then the world's most powerful atom-smasher. For Housewife Mici, the move brought fulfillment of a long-cherished dream: a living room big enough to hold both family and "the monster," as she calls her husband's piano, an 1879 Steinway that he bought in Manhattan in 1941. Teller (favorites: Bach, Beethoven, Mozart) calls the piano "my only possession that I really like," but Mici's voice takes on a steely tone when she recalls the logistics of getting "the monster" hauled back and forth across the U.S.

What with the big living room, the Bevatron and Berkeley's balmy climate, life in California should have proved pleasant. But Edward Teller is no man to pursue either happiness or pure science in the midst of the cold war. Nagged by new signs that Russia was catching up in the science race, he set out on a crusade to warn the U.S. to run faster.

Jon Brenneis

THE TELLERS AT HOME*
How to live with each other on a greatly contracted globe.

What Makes Grass Green. What does the U.S. have to do to run faster? On two basic points, just about all U.S. scientists agree: the U.S. needs 1) more basic research, and 2) more and better science education in the high schools.

At present, the U.S. channels about $450 million a year, only one-tenth of 1% of its income, into basic scientific research—the kind that former Defense Secretary Charlie Wilson scornfully dismissed as finding out "what makes grass green and fried potatoes brown." Among scientists, Wilson's remark is quoted again and again as an example of the nonscien-

* Son Paul, 14; wife Mici; daughter Wendi, 11; Teller.