

EARLY DAYS AT CALTECH

by Theodore von Kármán

In a chapter from his posthumously published autobiography, one of Caltech's great men recalls his first impressions of the Institute.

Theodore von Kármán's autobiography* was about three-quarters completed when he died on May 7, 1963, five days before his 82nd birthday. Lee Edson, his collaborator, finished the book, which was published this fall.

Their collaboration grew out of an article about Von Kármán that Edson had written for the *Saturday Evening Post* in 1957. "Von Kármán and I became friends," says Edson in his introduction to the book. "I visited the great house in Pasadena whenever I had a chance, occasionally to do another story, but mostly to sit around the long dining room table with Von Kármán and his friends, drink Jack Daniels bourbon, and laugh over anecdotes and reminiscences from Von Kármán's rich and colorful past. One day during one of these visits he asked me if I would be interested in helping to write his autobiography.

"This wasn't as easy a decision as it sounds. Some of Von Kármán's old associates felt that it was undignified for a scientist to write his life story, which stressed self instead of work, and that in any case it should be written by a professor of aerodynamics, not a science journalist. To my delight, Von Kármán refused to heed such advice. He thought that an academician would not be able to construct a humanized version of his life, but might place emphasis on matters not of interest to the general public. Von Kármán once told me with a smile that he had already created a vast body of work with the help of aerodynamicists, and very little of it was of interest to the general public."

"We have a fifty-fifty arrangement", is the way Von Kármán described this collaboration. "Lee writes and I read . . . (The book) is me in good English."

*THE WIND AND BEYOND: Theodore von Kármán with Lee Edson. Copyright © 1967 by Little, Brown and Company.

IN THE EARLY 1930's Caltech's reputation in scientific teaching and research was distinctly on the rise. This was due mainly to Millikan and his highly selective planning. In the four years that had elapsed since my first visit, this remarkably farsighted administrator-scientist had continued to seek out highly qualified and inspiring teachers.

Some of Millikan's methods were bold and unorthodox for universities of that day. In 1927, for instance, he brought in C. C. Lauritsen, a topnotch physicist, by offering him the facilities of a high-voltage laboratory which he had earlier persuaded Southern California Edison Company to set up on the Caltech campus. Such industry-university tie-ups were quite rare in the United States, and universities in any case never stooped to go to industry; they insisted industry come to them. But Millikan's approach paid off for Caltech. Lauritsen built in his lab the world's first million-volt x-ray tube, which became the father of all high-potential vacuum devices and brought the electric industry to Caltech.

Similarly in 1928 Millikan lured Thomas Hunt Morgan, then the leading geneticist in the United States, from Columbia University where he had spent 24 years. Morgan had hardly heard of the small engineering school in distant California, but Millikan persuaded the Rockefeller Foundation to furnish money for Caltech to build the nation's first laboratory devoted solely to the study of heredity. Morgan was offered the directorship. Unable to resist, he uprooted himself and his family from New York and settled in Pasadena.

Some faculty members questioned Millikan's judgment in hiring a biologist for the faculty of an "engineering school," but subsequent events showed that Millikan's decision was a wise one. Caltech contributed considerably to fundamental knowledge in genetics and developed a reputation as a scientific institution of the first rank. Morgan

himself received the Nobel Prize for Medicine in 1933, thus bringing further renown to the Institute.

In my first interview with Millikan when I arrived at Caltech, he told me with pride of Thomas Hunt Morgan's famous work with *Drosophila*, the fruit flies whose quick rate of reproduction enables scientists to study many generations in a few weeks and thus draw conclusions about human heredity that might otherwise take hundreds of years to develop. Millikan hoped to see similar fundamental developments in aeronautics and fluid mechanics.

"We do not have the funds to develop all the engineering sciences here," he explained, "but I am convinced the aircraft industry will be attracted to southern California. So with your help and the Guggenheim Foundation I think we can make Caltech the nation's center of aeronautics."

I liked this direct approach and his optimism, because I thought it would not only encourage the growth of aviation but would stimulate progress in aviation science as well. And because Caltech was very young as well as small and selective (only 160 freshmen were admitted each year), it would be an excellent place for me to establish and develop the ideas of education that I had brought from Europe.

This proved to be the case. I remember that one of the things I noticed first in the United States was the lack of reverence for the teacher and the very few teachers who commanded real respect. A student came to me one day and said he had studied mathematics at the University of Chicago. When I asked him who his teacher was, he said he didn't remember. I found this response shocking. Who could forget the great Felix Klein or David Hilbert of Göttingen? I felt that if this were typical, it represented a real deficiency in American education. To what extent it might be remedied I wasn't sure.

Another characteristic of education I noticed when I arrived at Caltech was that the teaching plan was somewhat conventional. Each day so many pages of study were assigned from a textbook.

The teacher wrote equations on the blackboard. The student copied them fervently in his notebook while he tried to understand as much of the reasoning as he could. There were frequent examinations in some courses. Therefore it was the memory, not creative impulses of the mind, that was being trained. Of course under such circumstances the teacher would be barely remembered.

My years of teaching had given me a different view of the art. In Germany, as I've indicated earlier, my courses began with the basic concepts, so the students would quickly develop a feeling for the principle at work. For me the principle was most important, not the detail, and I subsequently emphasized this in class at Caltech. How does the electron "feel" in its environment? What makes it behave as it does? What makes the wing lift in the air? First in each case came the physical "picture" with only the essentials, like a caricature. Then came the mathematics.

I seldom had used tests as drills in Aachen, and I saw no reason to change this approach at Caltech. Some of the students didn't like this. In fact, I was surprised to learn that the students in one of my classes were actually worried because I had not given them any tests during the semester. They didn't know how they stood in my estimation and were afraid to have me judge them on the basis of just one end-of-term examination. Faced with this insecurity, a delegation of students approached me with a request. Could I furnish a hint of the topics that would be covered in the final examination?

"Why just a hint?" I said. "I will be glad to give you the entire examination."

They must have thought I was fooling or playing a trick. They stood in front of me speechless. I wrote out the questions and handed over the list, but I could see that the men were still worried.

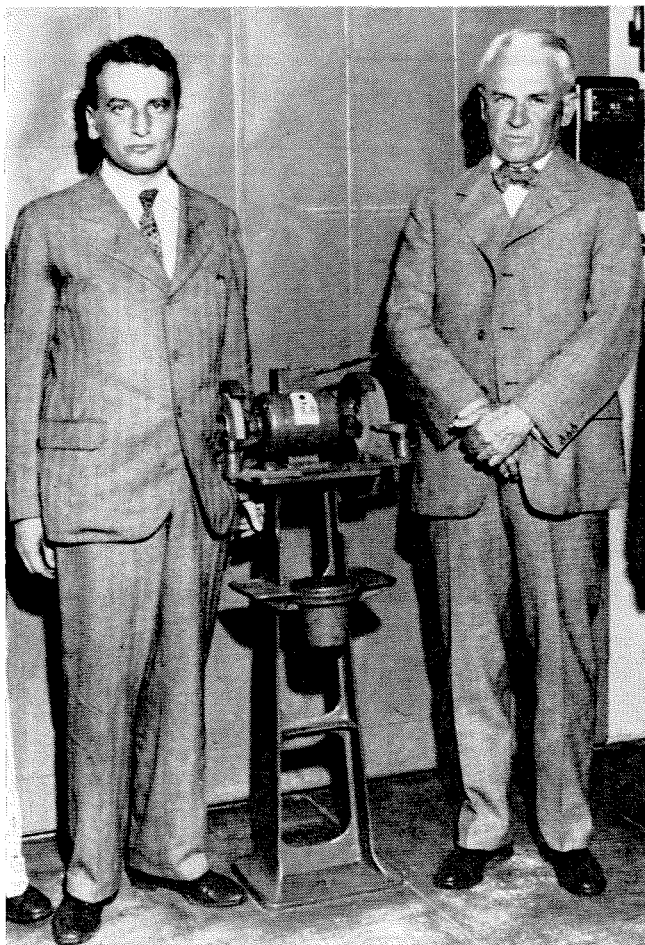
"This isn't fair," one of the students spoke up finally, expressing what was in everyone's mind. "If we all know the answers, everyone will get 100."



THEODORE VON KÁRMÁN 1881–1963

Theodore von Kármán, professor of aeronautics and director of Caltech's Guggenheim Aeronautical Laboratory from 1930 to 1949, was born in Hungary in 1881. His childhood, his student and teaching years at the University of Göttingen, and his early work in fluid mechanics were marked by his brilliance as a mathematician and scientist. At age 31 he was invited to head the new Aeronautical Institute at the University of Aachen, and during his 18 years in that position he not only established the school as the world's leading aeronautical institute, but also contributed greatly to the development of German aviation.

Prompted by the rise of Nazism in Germany, in 1931 Von Kármán accepted Robert Millikan's invitation to become director of Caltech's new Guggenheim Laboratory, which soon replaced Aachen as the leader in its field. During his 19 years at Caltech, he distinguished himself in the fields of supersonic aerodynamics and rocketry and helped found the Aerojet-General Corp. and the Jet Propulsion Laboratory. He is recognized by his colleagues as the man who has contributed more to the fundamental understanding of atmospheric and space flight than any other single person in our time.



Theodore von Kármán and Robert A. Millikan, 1930.

“And what is your definition of 100 percent?”

“All correct answers.”

“Here we differ,” I told him. “There is no such thing as an entirely correct answer to any question in engineering. It is the way the problem is treated and developed. A student who has completed an intelligent analysis, with the proper emphasis and approach, but who comes out with a wrong answer because of a mechanical slip in multiplication, would receive a much higher rating from me than a student with the correct answer but no imagination in his approach.”

Not all my colleagues agreed with my views. We usually argued these matters at Caltech’s *Stammtisch*, to which I was invited by Epstein and Tolman soon after my arrival. It was an exclusive gathering of a dozen or so faculty members who met regularly at various restaurants in Pasadena. Few engineers were ever invited. There was a strong difference in philosophy between those who believed that teaching should be directed toward theoretical understanding and those who believed in practical application.

In our group one wing of the argument (I hesitate to classify it as right or left) was represented

by the late Eric Temple Bell, an eminent mathematician who headed the math department and as a sideline wrote murder mysteries under the name John Taine. Bell was strong on theory, not much interested in application.

Bell and I had differences of opinion on how to teach mathematics. I wasn’t satisfied with the mathematical training of engineering students at Caltech and elsewhere in the United States, because it seemed too abstract. The students were not shown how to apply mathematics to practical problems, and this application was my main objective in teaching. But I couldn’t change Bell’s point of view. So one day I decided to compete with him and give a math class myself. (We had great latitude in these matters at Caltech.) The courses stimulated curiosity, and no wonder. Some bulletin boards listed them—for a while at least—as E. T. Bell’s Mathematical Analysis and Kármán’s Useful Mathematics.

The most eminent member of our group during the thirties was undoubtedly Nobel Prizewinner Carl David Anderson, who made important discoveries in cosmic rays. He worked in my laboratory, not because I knew anything of physics, but because he needed a great deal of power to operate his electromagnet, and we had the only source of power which could supply his needs. An introvert, he shunned large groups, preferring to work with only a few close associates.

He built his famous cloud chamber in our laboratory. This chamber is an apparatus into which high-energy particles are introduced. When these particles collide with atoms of the air inside the chamber, they knock out electrons, leaving the particles electrically charged. Vapor condenses around these particles, making them visible as a thin line of fog, called a “track.” The negative and positive charges can be deflected in opposite directions by a magnetic field, so it is easy to determine whether the track is negative or positive. I remember that Anderson was quite excited the day in 1932 when he discovered in his chamber the first track of electrons with a positive charge. At first he thought it was a mistake, as did others who had seen similar tracks, since electrons are negative; but when Carl repeated the work, he always got a track with a direction indicating a positive charge. Finally he realized that he had discovered a new particle. The particle was called a positron, a positive electron.

Anderson wrote to the American journal *Science* announcing his discovery. Then for a time he could not reproduce his results, and he grew worried. He thought of writing the editor not to print his letter, but it was too late. The article was in the press.

I think this was rather fortunate for Anderson

because shortly afterwards Sir James Chadwick in Cambridge made observations similar to those of Anderson's. If Carl had publicly revoked his announcement, Chadwick might have received the credit for the positron and possibly the Nobel Prize. As I've said earlier in this book, small things exert great influence on men's lives. Chadwick, incidentally, did get the prize in 1935 for discovery of another elementary particle, the neutron, which is now famous because it is used to trigger A-bombs.

The chief and guiding genius at Caltech was, of course, Robert Millikan. But, interestingly, he never allowed himself to be called president of the Institute. His title was Chairman of the Executive Committee. In fact he told me once that Caltech was the only American university that had a really democratic organization because decisions were made by committee rather than by a single top executive. The committee consisted of four businessmen and four faculty members who were in control of all budgets, appointments, promotions, and salaries. This setup was quite unusual at that time. Millikan himself called his administration a "mean course between the role of the Tzar and that of the academic proletariat."

In practice this meant that if you went to Millikan, say, for money for your laboratory, and he did not want to give it to you, he would always say: "If I could do it, I would, but the Executive Committee won't let me." He reminded me at times of certain world leaders who blamed bad decisions or lack of decisions on their politburos. In jest I once mentioned this similarity. "Well, at least we have no Gestapo," he said, smiling.

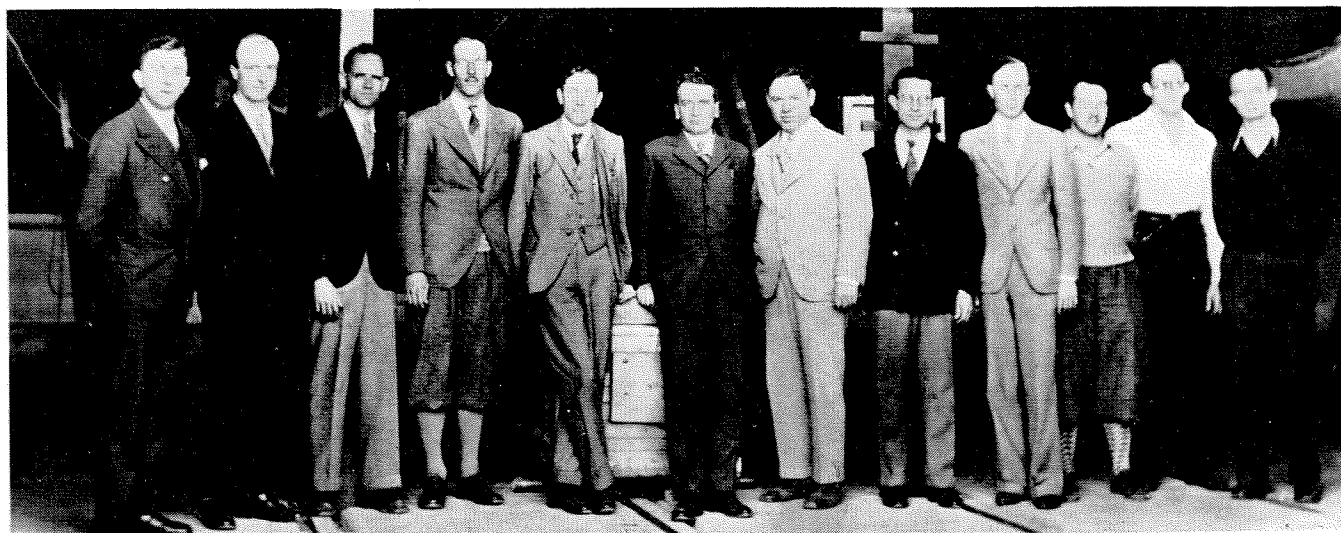
There was considerable liberality and independence of thinking at Caltech, which I am glad to say has lasted through the years. For despite Millikan's one-man rule he was tolerant to a wide variety

of ideas, particularly in matters of religion. He liked Thomas Hunt Morgan, for instance, knowing he was an avowed atheist. I once asked Morgan how, in the absence of scientific proof for or against, he was so sure that God did not exist. Morgan countered: "I don't understand how you, Kármán, and your friend Einstein, don't see that God is not supreme but is only an anthropomorphic construction of the human mind."

There is no better example of Millikan's tolerance than his attitude toward the occasional digs in his direction. I remember one faculty meeting at which Morgan presided. He introduced speakers in several of the scientific disciplines. After biology the program called for discussion in astronomy. Morgan rose, looked around the assemblage, and said solemnly: "I think I'd better give the chair to my friend R. A. Millikan—he is nearer to Heaven than I am." Millikan joined in the ensuing laughter.

Millikan's basic hope was to bring science and religion together. To him the purpose of science was to develop a "knowledge of the facts, the laws, and the processes of nature," while religion more importantly would "develop the consequences of ideals and aspirations of mankind." This was a point of view I shared.

But Millikan's desire to bring the two together succeeded in a way that he never contemplated. I recall visiting a so-called science museum in Moscow. One atheistic show started with photographs of the Mt. Wilson Observatory and its findings, accompanied by some words about the heavens by Dr. Edwin Hubble, Mt. Wilson's great astronomer, who made impressive studies of the galaxies. I think Millikan would have been amused, as I was, to find the Institute, founded by a minister and run by a devout Protestant and son of a minister, was used as an introduction to Soviet antireligious propaganda.



Von Kármán (center) and staff members of the Guggenheim Aeronautical Laboratory at Caltech in 1930.