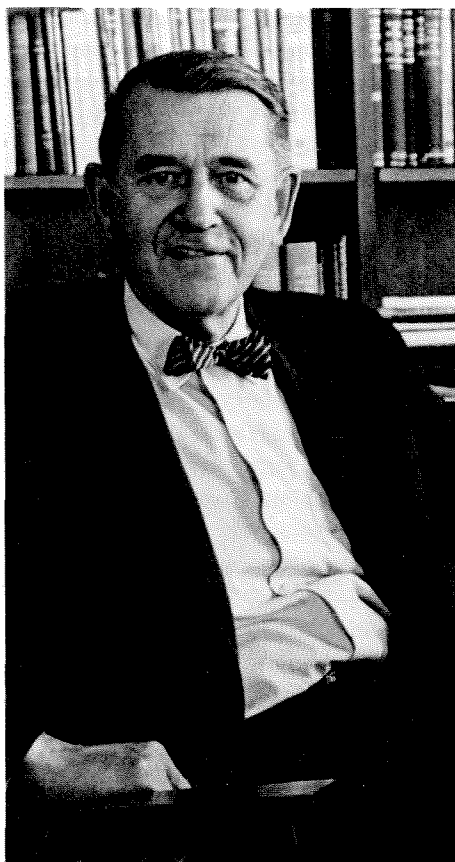


## Frederick C. Lindvall 1903–1989



*Frederick C. Lindvall, professor of engineering, emeritus, died January 17, 1989. He had been a member of the Caltech faculty since 1930, and was chairman of the Division of Engineering and Applied Science from 1945 to 1969. He became emeritus in 1970. At a memorial service on March 13, Lindvall's life and his varied interests in engineering, education, and music (and gastronomy) were eulogized by Donald E. Hudson, professor of mechanical engineering and applied mechanics, emeritus; J. Harold Wayland, professor of engineering science, emeritus; Robert Zurbach, former president of The Associates; and Ruben Mettler, chairman of the board of trustees. Rosalyn Tureck played Bach's Chromatic Fantasy and Fugue.*

Fred Lindvall was a man of many dimensions—including his long and dedicated association with Caltech, his national prominence in engineering education and the engineering profession, his wide range of engineering research interests, his many cultural and civic interests, and his love for family and friends.

In this context, it is my privilege today to speak as one of Fred's former students, and thus focus on his role as a teacher, an academic advisor, and a personal friend. I had the good fortune, as a Caltech graduate student and PhD candidate in the late 1940s, to have Fred as my principal thesis advisor. His broad knowledge of engineering and of the world outside Caltech, his teaching style, and his active encouragement made a strong impact on me. At that time he was in the early years of his long service as chairman of the Division of Engineering and Applied Science. It was an exciting time for Caltech, and

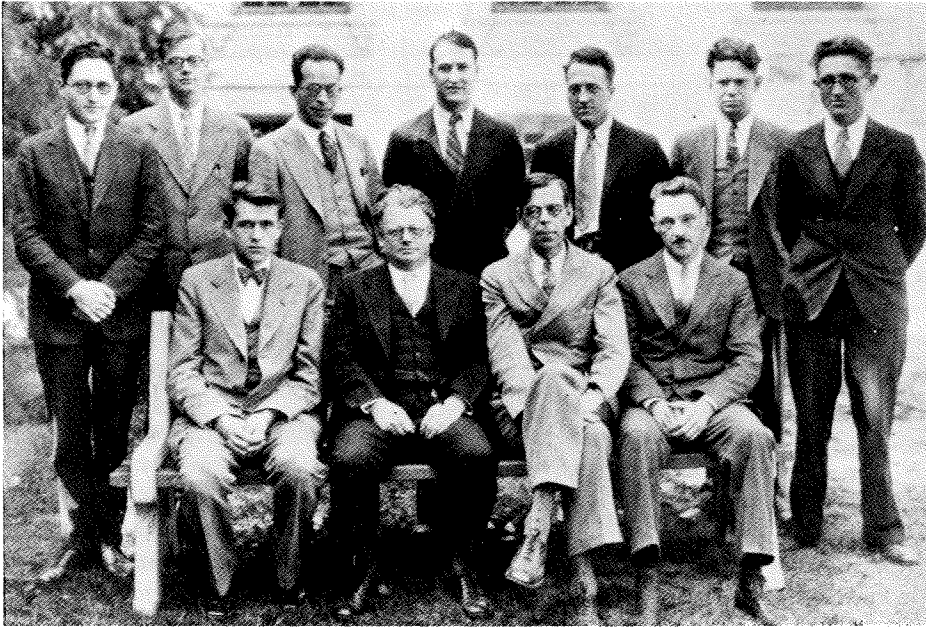
for engineering in general, and Fred was in the middle of the action.

He encouraged graduate students to spread their wings—academically and professionally. He emphasized applied science and applied mathematics as the underpinning of modern engineering, and encouraged us to take as many courses as possible in other departments and divisions at Caltech. My first acquaintance with concepts such as interdisciplinary research, system engineering, and management of technology came from Fred. He made it seem very natural for an electrical engineer to do a thesis in aeronautics, and have an examination committee consisting of professors from a wide range of disciplines, especially in physics and mathematics.

One day he suggested that I become an instructor in applied mechanics, to *teach* a course that I had just completed myself a year earlier—initially this was an unnerving experience and later a real joy. I recall my surprise when I learned that I was expected to build from scratch with my own hands the experimental apparatus needed to do my thesis research, including several racks of electronic instrumentation, a sophisticated wind-tunnel probe, and an elementary blow-down wind tunnel to demonstrate the experimental concept before I could apply for time in a regular wind tunnel in Guggenheim.

Although Fred emphasized quantitative analysis, he made it clear that, in practice, engineering (and especially engineering design) is a *decision-making* process that can lead by many different paths to an effective solution, but with no exactly right or exactly wrong answers. He made clear the difference between *analysis* and *synthesis*.

To this day, I don't need to consult



**In this 1932 photo of Caltech's electrical engineering faculty, Lindvall sits at left, next to Royal Sorensen.**

## *Paco A. Lagerstrom* 1914–1989

a Caltech catalog to remember the advanced engineering course that Fred personally pioneered and taught—EE 226—in which he demonstrated these points. More than any other course I took at Caltech, it made a lasting impression on me. Fred assigned general problems of a practical nature that we as students had never encountered before, often with a due date one or two months later, so that there was plenty of time to think about the problems and how to approach them. The student was left on his own, and was to determine (and later defend) his underlying assumptions, his approximations, his methods, and the validity of his chosen solution. The fact that the course had an EE label had no constraining influence on Fred's problem selection. I can recall problems that introduced us to long narrow bridges (such as the famous Tacoma Narrows bridge), to an earthfill dam in a canyon with a particular geology, to high voltage transmission lines, to rocket motors, and to analog computers. The key task was to take the problems all the way to final design solutions, supported by quantitative analysis.

What made this so exciting was that, as graduate students, we had just been introduced in our candidacy courses to the "magic" of Laplace transforms, the incredible scope and beauty of Maxwell's equations, the

power of vector analysis, and the mysteries and uncertainties of fluid mechanics. Fred's course helped us *begin* to understand how practical engineering solutions could be developed from such abstract theories and analytical techniques, if we could add enough common sense and engineering judgment. After several years of drinking out of an intellectual fire hose, we were finally able to sip and taste some of the water.

In just a few years after receiving my PhD degree, I found myself as the project leader of a team designing and developing a new integrated electronic navigation and fire-control system for jet fighter planes. Then a few years later I was in a similar situation as engineering project leader for a rocket-propelled, inertially guided, long-range ballistic missile that was also to be used as a launch vehicle for spacecraft. I can say without hesitation that Fred's engineering philosophy, his lasting influence, and his teaching were pivotal to the success of those projects.

In closing, I wish to salute and honor him as a giant of the engineering profession, one of Caltech's finest, a superb teacher, and a trusted advisor and friend. We will all miss him.

*Ruben F. Mettler*  
*Chairman, Caltech Board of Trustees*  
*Retired Chairman and*  
*Chief Executive Officer, TRW Inc.*

On February 2, Paco A. Lagerstrom, professor of applied mathematics, emeritus, collapsed on the street, and died without regaining consciousness on February 16, a few days before his 75th birthday. With him Caltech lost an unusual personality whose importance to the Institute, the students, and his colleagues was not realized by many but was much appreciated by those who knew him closely and managed to penetrate, at least a little, the wall he chose to erect around himself. I considered him a sometimes difficult but utterly reliable and honest close friend, with whom I debated and from whom I learned for almost 45 years. Indeed, in the last few weeks of his life he tried to teach me gauge theory!

Paco's scientific career began at the University of Stockholm where he studied logic within the faculty of philosophy. He came to this country in the late thirties and completed a PhD in pure mathematics with a thesis in topology under Bochner at Princeton in 1942. He finished when contributions to the war effort were expected even from pure mathematicians and worked first as an instructor at Princeton and then at Bell Aircraft in Niagara Falls, if I remember correctly, in flight test evaluation. I was told that during a severe blizzard only a single employee appeared at the closed plant: Paco on skis!

At about this time a very competent and active research group was established at the Douglas Santa Monica plant, led first by Francis Clauser and later by Harold Luskin. Paco joined this group in 1945, at a time when the excitement for supersonic and space flight had begun. He contributed to both. In particular he was a member of the team which put together the first (and positive) proposal for a U.S. satellite—this in the mid-forties, some 10 years before Sputnik. The report, now known as RAND #1, was originally secret and hence did not have the general impact it deserved. Needless to say, the recommendation to launch a U.S. satellite was not followed at the time.

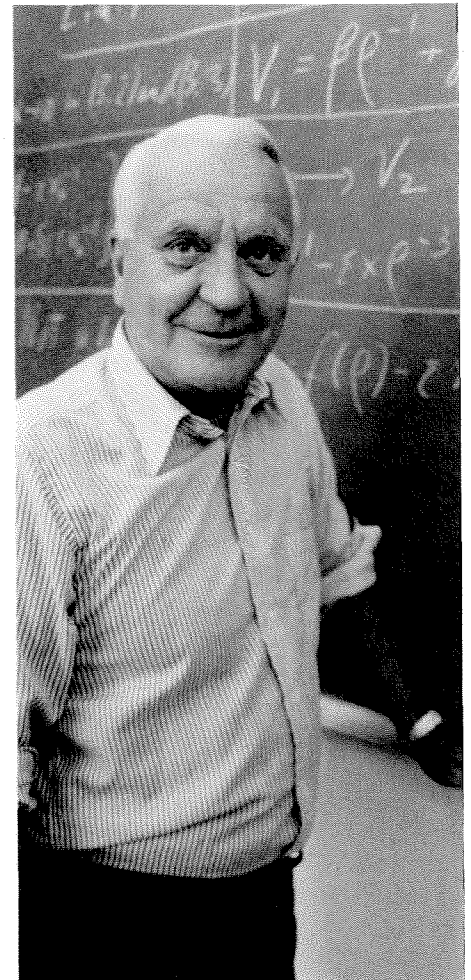
Paco's work on supersonic wing theory made a profound impression on me because of the unusual way he proceeded. I was at the time a consultant to the group at Douglas and noticed Paco doodling with a picture of a narrow delta wing in supersonic flight. He realized that the problem was topologically a torus; this was sufficient for him to obtain the solution immediately in terms of elliptic functions. I successfully conveyed my enthusiasm to Clark Millikan; Paco joined GALCIT as research associate in 1946, and his career at Caltech began. He advanced to professor of aeronautics in 1952 and when, after Clark Millikan's death, the applied mathematics option was started, he became professor of applied mathematics in 1967.

Paco was never a highly rated classroom teacher. He lacked smoothness of presentation and the ability for an easy, jocular manner, but his deep understanding of the material he taught was

always evident. He had however a profound impact on students through personal contact and tutoring, certainly on his own research students, a number of whom became prominent in academia and industry. In addition, he was sought out and spent much time in discussions with a large number of graduate and undergraduate students from various options. In this way Paco exerted a major influence on the direction and progress of numerous research projects. He had a deep knowledge of mathematics; whenever a proper, congenial interface was provided, he could be equally effective in solving engineering problems. This was the case in his days as research engineer and later as consultant to Douglas and as an active member of the GALCIT facility.

Paco's approach to linearized wing theory, on the basis of the acoustic wave equation, did not become very popular. To me it is a beautiful and very useful way to obtain subsonic and supersonic wing theory, steady or unsteady, from a single point of view. His "Laminar Flow Theory" in the *Princeton Handbook of High Speed Aerodynamics and Jet Propulsion* is a classic in the field. In addition to his and his students' set of publications, he still managed to finish his monograph on singular perturbation theory, which appeared just a few months before his death, another lasting contribution to the state of the art.

In recent years Paco felt, I believe correctly, left out and not appreciated at Caltech, a condition to which he himself of course contributed by his unorthodox, rigid approach and lack of smooth manners. I have always felt that one essential attribute of a successful academic group is the ability to appreciate



and support gifted oddballs. One can only hope that Paco Lagerstrom's experience does not indicate that this virtue has been totally lost at Caltech in this time of smooth entrepreneurs.

Paco strove to be the perfect, somewhat Victorian, gentleman. He spoke at least five languages, read and translated poetry, and took pride in his knowledge of good wine and food. His love for and knowledge of music was well known. He served for many years on the board of the Coleman Chamber Music Association and was its president in 1958-60. His contributions to the programs at Caltech are substantial and well documented. He will be sorely missed there as well as by his friends in many phases of human activity.

*Hans W. Liepmann  
Theodore von Kármán Professor of  
Aeronautics, Emeritus*