LUCIEN A. SCHMIT JR.
1928–2018
Elected in 1985

“For pioneering work in structural synthesis, combining finite element analysis and nonlinear programming algorithms to create a powerful class of modern structural design methods.”

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Lucien André Schmit Jr., widely recognized as the father of modern structural optimization and multidisciplinary design optimization (MDO), died March 16, 2018, at the age of 89.

He was born May 5, 1928, in New York City and raised in Forrest Hills, NY. His father was a cellist in the New York Philharmonic Orchestra, and his mother, Eleanor J. “Jessie” Donley, was a homemaker. Growing up in Forrest Hills, young Lucien developed a lifelong passion for the game of tennis.

He was a bright, ambitious student who pushed himself to excel. He enrolled in MIT, where he earned his BS in 1949 and MS in 1950, both in civil engineering. During his graduate studies he met his future wife, Eleanor Trabish, and they were married in 1952; their son Lucien was born in 1960.

After serving for one year in the Air Force, Lucien père worked as a structures engineer in the Grumman Aircraft Engineering Corporation, Bethpage, NY (1951–53). He then returned to MIT and worked as a research engineer in the Aeroelastic and Structures Research Laboratory (ASRL) until 1958. Under the leadership of Raymond Bisplinghoff and Holt Ashley, ASRL was a pioneering research laboratory in aeroelasticity, high-temperature structures, and finite elements. Lucien’s tenure there had a major impact on his professional development and approach to conducting research. Based on
advice from Bisplinghoff, he decided to pursue an academic career.

In 1958 Lucien was appointed assistant professor in the Division of Solid Mechanics, Structures, and Mechanical Design at the Case Institute of Technology (predecessor of Case Western Reserve University) in Cleveland. Two years later he published his landmark paper “Structural Design by Systematic Structural Synthesis,” considered the beginning of modern structural synthesis, which evolved into what is now known as MDO.

Promoted to associate professor in 1964, his research activity expanded rapidly to encompass a variety of aerospace applications and his academic advancement was meteoric. In 1966 he was promoted to professor and simultaneously appointed head of the Division of Solid Mechanics, Structures, and Mechanical Design. In 1969, in addition to his position as head of the division, he was named Wilbert J. Austin Distinguished Professor of Engineering.

Lucien’s national reputation grew rapidly and he was recruited aggressively by the University of California, Los Angeles, where, in 1970, he was appointed professor of engineering and applied science in the Mechanics and Structures Department. He initiated a vibrant research program and several important contributions to structural synthesis and optimization as well as MDO. His exceptional ability to lead an academic department was also recognized and he chaired the Mechanics and Structures Department from 1976 to 1979. He was appointed Rockwell Aerospace Chair in 1991 and in September of that year retired as Rockwell Professor of Aerospace Engineering Emeritus. More than 20 PhD students graduated under his guidance.

During the early 1970s Lucien saw that the main obstacles to efficient implementation of the structural synthesis concept were due to the fact that the general formulation of the basic structural design optimization problem involved (i) large

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numbers of design variables, (ii) large numbers of inequality constraints, and (iii) many inequality constraints that are computationally burdensome implicit functions of the design variables. To overcome these obstacles he introduced the approximation concepts approach to structural synthesis in 1974, in what became his most cited paper.²

His innovative formulation produces a sequence of tractable approximate problems via the coordinated use of design variable linking (and/or basis reduction), temporary constraint deletion (regionalization and truncation), and the construction of high-quality explicit approximations for the retained constraints. At each stage, the selected mathematical programming algorithm is applied to an algebraically explicit approximation of the actual design optimization problem, and move limits are used to protect the quality of the approximations.

In follow-on research, the approximation concepts approach was extended to structural optimization problems involving fiber composite structures, thermal effects, natural frequency constraints, body force loads, and relative displacement constraints.

Results for a rather interesting set of thin delta wing problems (which included consideration of fuel mass, a stringent constraint on fundamental frequency, graphite-epoxy fiber composite skins, and thermally induced stresses) were presented in a coauthored article in 1978.³ This work is particularly important because it showed that by using approximation concepts it was usually possible to obtain useful optimum designs after only 5 to 10 structural analyses. In other words, the number of finite element analyses needed to obtain a practical optimum design could be reduced by two orders of magnitude. This approach was the precursor of current approaches to using approximations for the objective function

and the constraints in modern MDO by employing response surface methods or surrogate-based approximations.

He also introduced dual methods of mathematical programming for a significant class of structural design optimization problems, and in the mid-1980s developed combined structural design methods with active control techniques, demonstrating that the design of both the structure and the control system has to be done in an integrated manner. Thus system optimization has to be performed in a design space that spans both structural and control system design variables. In this multidisciplinary class of problems, dynamic response, dynamic stability constraints, and limitations on actuator force levels and control effort all play an important role.

Because this line of Lucien’s research had its roots in structural synthesis, it came to be known as control-augmented structural synthesis (CASS), falling into three main categories: work based on direct output feedback control, research based on state feedback control, and efforts aimed at optimal placement of actuators and sensors.

Lucien was author or coauthor of more than 100 publications on analysis and synthesis of structural systems, finite elements, optimization of fiber composite structures, and multidisciplinary design. His contributions were recognized in a special issue of the *AIAA Journal* celebrating the 50th anniversary of AIAA, *History of Key Technologies*, with an invited article by Lucien.

Lucien received many other honors during his lifetime. In 1969 he was elected a fellow of the American Society of Civil Engineers (ASCE), and in 1970 received ASCE’s Walter L. Huber Civil Engineering Research Prize. He was a member of the USAF Scientific Advisory Board (1977–84) and in 1984 received the USAF Meritorious Civilian Service Award. In 1979–80 he was selected to serve on a blue ribbon

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Ad Hoc Committee of the Federal Aviation Administration for Investigation of the DC-10 Pylon Structure of American Airlines Flight 191, which crashed moments after takeoff from Chicago; with 273 fatalities, it is the deadliest airplane accident in US history. In 1977 he received the Structures Design Lecture Award of the American Institute of Aeronautics and Astronautics (AIAA), followed by the AIAA Structures, Structural Dynamics, and Materials Award in 1979; in 1986 he was elected an AIAA fellow; in 1994 he was the inaugural recipient of the AIAA Multidisciplinary Design Optimization Award, and in 1999 he received the AIAA Crichlow Trust Prize for “pioneering seminal contributions to the initiation of structural optimization and multidisciplinary design and their evolution from abstract concepts to widely used practical tools.” Amid this profusion of honors he was also elected to the NAE in 1985.

Since publication of Lucien’s pioneering paper in 1960 the field has evolved tremendously. In the 1980s structural optimization and MDO found their way into commercial finite element software packages developed by several companies. Modern software optimization tools and packages can now deal with hundreds of thousands of design variables, a large array of objective functions and constraints, changes in topology, nonlinear material behavior, and millions of finite element degrees of freedom. These software packages involve diverse disciplines and complex system behavior, and are used in many branches of engineering. The approaches are dominant in aerospace and mechanical engineering applications. Conferences and journals are devoted to this subject and thousands of papers have been published. Clearly, Lucien Schmit had a profound influence on engineering.

In the mid-1990s Lucien moved from Pacific Palisades, California, to Edmonds, Washington. His wife Eleanor passed away in 2015 after 63 years of marriage. He is survived by his son Lucien A. Schmit III.