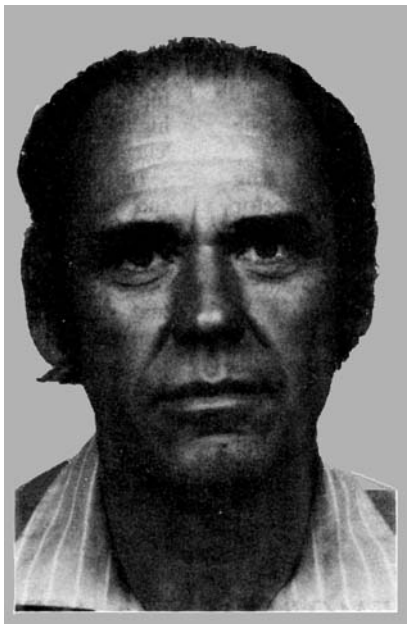
IN MEMORIAM BO ÖSTEN ALMROTH



born 15 July 1921 in Srösö, Sweden
died 25 February 1983 in Palo Alto, California

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We are greatly saddened by the loss of our colleague and friend, Bo Almroth, who died of cancer on 25 February 1983. Bo is well known for his contributions in the field of buckling of shells. He co-authored the widely used text, *Buckling of Bars, Plates, and Shells* (McGraw-Hill, 1975), and was leader of the team at Lockheed that developed the STAGSC-1 computer program for the static, dynamic, and buckling analysis of general shells. This program is used worldwide for the nonlinear analysis of branched and stiffened structures made of thin shells and beams. The STAGSC-1 code has been used to design and verify the safety of such important structures as NASA's SKYLAB and Space Shuttle, nuclear reactor containment vessels, planetary entry vehicles, and submarine pressure hulls.

Bo worked as an engineer and supervisor for the SAAB Aircraft Corporation in Linköping, Sweden from 1946 to 1956. In June of 1956 he emigrated to the United States and worked for Lockheed in Burbank, California from 1956 to 1957, where he specialized in the buckling of integrally stiffened skins of aircraft fuselages and wings. In 1957, Bo transferred to Lockheed in Palo Alto, joining the Applied Mechanics Group, where he remained until his death. He became a U.S. citizen on 28 June 1977.

During most of his 26 years in the Applied Mechanics Group, Bo worked on difficult nonlinear problems in the field of shell buckling and collapse. He and his colleagues performed tests on buckling of nearly perfect cylindrical shells under axial compression. In a very early computerized analysis, Bo was one of the first to show that the postbuckling minimum of the load–deflection curve for an axially compressed thin cylindrical shell occurs at too small a load to be useful as a lower bound for design purposes, thus putting to rest a 'classical' problem that had been studied intensively for many years. Another of Bo's major contributions to the literature reveals the effect of various boundary conditions on the buckling behaviour of cylindrical shells.

From 1961 to 1973, Bo contributed greatly to the literature on the buckling of perfect and imperfect cylindrical shells: unstiffened, stiffened, orthotropic, supported by continuous and intermittent elastic foundations, eccentrically loaded, with and without cutouts, etc. In the late 1960s he initiated the development of a program for the buckling of shells of revolution which later became the first BOSOR code. It was Bo's idea to try a finite difference based energy method for solving shell buckling and modal vibration problems. He wrote many of the subroutines that establish the integrated constitutive law [the 6×6 $C(i, j)$ matrix] for complex shell walls used frequently in lightweight designs required for aerospace vehicles.

In the late 1960s and early 1970s, Bo became interested in multiaxial plastic flow. He and his colleagues designed tests, built a test rig, and conducted experiments on biaxially loaded specimens deformed plastically via multiple nonproportional loading histories.

The STAGS (Structural Analysis of General Shells) computer program occupied most of Bo's time from 1969 on. This program was developed from the beginning to handle difficult nonlinear problems. Initially the first STAGS program released to the public, STAGSA, was based on the finite difference energy method. Over the years, especially since 1976, a variety of finite elements has been introduced into STAGS and the current version, STAGSC-1, is totally a finite element program. Much of Bo's effort during these later years was spent investigating the capabilities of various finite elements to handle nonlinear shell behaviour.

More recently, Bo became very interested in the use of global shape functions to reduce the computer time required to solve nonlinear problems with thousands of degrees of freedom. His idea was to generate Ritz vectors as needed along a load–deflection path in order to solve a greatly condensed nonlinear problem for most load steps, returning to the full-sized finite element model only when certain error measures indicate the need to do so.

Bo was named Lockheed Missiles and Space Company's Scientist of the Year in 1982 'in recognition of his 16 years development of a most advanced computer program, "Structural Analysis of General Shells" (STAGS), including his unique software modules to solve difficult nonlinear structural problems'.

During his more than 25 years at Lockheed, Bo was a constant source of ideas for new approaches to the solution of difficult nonlinear problems. Many of these ideas were incorporated into the STAGSC-1 program, which is the foundation supporting much of the work reported in this volume.

Bo never strived for credit or recognition for his accomplishments. His friendship and unique qualities as a leader are sorely missed in our applied mechanics group at Lockheed, and his untimely death is a great loss to the entire applied mechanics community.

Whenever Bo felt oppressed or confined by the pressures of the office, he took to the mountains for long, strenuous hikes. During the last several years of his life he was a very active leader in the Sierra Club. Almost every week he led hikes in the mountains of the San Francisco Bay area and the Sierra Nevada. He knew these mountains and their flora and fauna better than most, and could recount many humorous and sometimes hair-raising stories about breakdowns in equipment, cross-country 'short cuts', and the bad manners of bears. After his death, a majestic redwood tree in

Big Basin Park in the Santa Cruz Mountains was named for him in remembrane of his great love of the out-of-doors.

As I sit at my desk today, 25 February 1984, the anniversary of Bo's death, looking at the picture of Bo, I remember so clearly his unique qualities: his physical toughness—a man for whom, at 62 years of age, a 20-mile hike up and down a mountain was easy; his forebearance in adversity—none of us knew he was sick until about a month before he died, although now it is apparent he must have been in pain during many of his last days at work; his extreme soft-spokenness and gentleness in his dealings with others—you had to listen carefully to hear him, especially at a restaurant or other social gathering; his deep understanding and love of philosophy and literature—he never missed the Ashland Shakespeare Festival in Oregon; his discriminating epicurean tastes—Bo was a fine cook and an infallible judge of wine and beer; his carelessness in things that didn't really matter—driving his car until it broke down, often in some wild place in the mountains; and his rare brilliance—his ideas not pushed and touted like those of a politician, but quietly there, like polished stones in a mountain stream. I hope some of the spirit and style of Bo has rubbed off on us: his colleagues in the Sierra Club, at Lockheed, and in the applied mechanics community worldwide. It is a rare, loyal, strong, courageous, and selfless spirit, a spirit that enriched our lives while Bo was with us and enriches us still as we remember him.

DAVID BUSHNELL
25 February 1984
Palo Alto, California, U.S.A.

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