

look well” was always answered with “I’ve no complaints about my looks.” A bright and hearty man, Goldanskii will remain in the memories of his friends, colleagues, and everyone who had the luck of meeting and working with him. With the death of this academician, Russian and world science has suffered a heavy loss.

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William Edward Caswell

William Edward Caswell, a physicist who made important contributions to both theoretical physics and national defense technology, died tragically on 11 September 2001. He was aboard the hijacked airplane that was crashed into the Pentagon. At the time of his death, Bill was a senior scientist for the US Navy.

Bill was born on 22 June 1947 in Boston. He received both of his degrees in physics: his BS from the University of Maryland, College Park, in 1968 and his PhD from Princeton University in 1975. Bill’s thesis, for which one of us (Callan) was the adviser, contained the first calculation of higher-order renormalization group quantities in non-abelian gauge theory. He was a third-generation physicist: His grandfather, Albert, received one of the first PhDs in physics from Stanford University, and his father, Randall, held an MIT physics PhD.

Bill’s graduate career coincided with the synthesis of gauge symmetry and renormalization group ideas. He made several major, path-breaking contributions to that synthesis. Perhaps their apex was his calculation, in 1974, of the beta function to two-loop accuracy. As Bill’s thesis adviser (Callan), and graduate student colleague and office mate (Wilczek), we observed firsthand the evolution of this work. Bill focused on his goal even before the basic one-loop result had stabilized. At the time, this effort required unusual courage and determination, since the calculation simultaneously features all the notorious subtleties of gauge invariance, overlapping divergences, and renormalization.

Bill quickly saw his way through



WILLIAM EDWARD CASWELL

the conceptual difficulties, but dealing with dozens of Feynman graphs, each expanding into many algebraic terms, was challenging in the extreme. Bill soon realized that a pure hand calculation would be both excruciating to perform and impractical to check. He ventured into the then-uncivilized realm of machine symbolic calculation (this was the age of punch cards, FORTRAN, and paper output), and was finally able to adapt Tony Hearn’s REDUCE program to his needs. Still, each graph was a project in itself, and there were an awful lot of them. Bill kept a master list on his blackboard, and we remember his increasingly broad smile as he ticked them off one by one and closed in on the goal. Champagne was served when all consistency checks fell into place and a reliable result could be reported.

A few weeks after Bill got his final result, two other groups reported independent calculations of the same quantity, with different answers. Bill was momentarily shaken, but after poring over his calculations once more, serenely initiated correspondence with his competitors. As things developed, his confidence was justified, and all converged on Bill’s original result, which was published in a 1974 *Physical Review Letters* article.

The impact of Bill’s calculation was enormous. His result convincingly showcased both the consistency of quantum gauge field theories and the potential of computer algebra. It has, of course, also played a central role in physics. Today the interpretation of many experiments in high-energy physics requires multiloop quantum chromodynamics calculations, and Bill’s result is a prime ingredient in

every such calculation. It is also a critical ingredient in calculating the running of the coupling constants of the Standard Model’s supersymmetric extensions, calculations that are interpreted these days as evidence for both grand unification and low-energy supersymmetry. Thus Bill’s work is also crucial to our thinking about physics beyond the Standard Model. As Bill emphasized in his original paper, his calculation indicated the possibility of a qualitatively new behavior in relativistic quantum field theory, featuring conformal symmetry at large distances due to a “reliable” zero of the beta function. Such theories have been the subject of many recent investigations.

Bill made many other contributions to particle physics after his thesis, working as a postdoc at SLAC (1975–77), as an assistant professor of physics at Brown University (1977–79), and as an assistant professor of physics at Maryland (1979–83). His development, in 1978 with Peter Lepage, of new and powerful tools for dealing with higher-order effects in bound states (such as positronium and charmonium) was a particularly valuable and influential contribution.

In 1983, Bill’s career took an abrupt turn when he moved to the Naval Surface Weapons Center in Silver Spring, Maryland, to work on applying artificial intelligence and nonlinear dynamics to signal processing problems. In 1985, he was invited by the navy to work as a civilian scientist on a major classified defense technology project. Bill rose rapidly to a position of overall technical responsibility for this project, ultimately directing a team of more than 100 scientists working on one of the navy’s most challenging problems. His technical skills and hands-on management style won the respect of his colleagues at the same time as his kindness, good humor, and thoughtfulness won their affection. Although the classified nature of the project meant that he could not discuss it with outsiders, those who knew it well tell us that Bill made many important contributions, grounded in his skills as a theoretical physicist, to its success. Indeed, he received several navy commendations on his work, one of which cites his role in a “highly successful top priority Chief of Naval operations project of unprecedented technological complexity . . . developing a profoundly new capability for the US Navy.” A long way from the two-loop beta function and a remarkable career in physics!

Bill's record of contributions to science, technology, and country was outstanding. He had much more to contribute, and his death in an outrageous terrorist attack was a terrible waste. We were proud to know him and, with his many other colleagues and friends, will sorely miss him.

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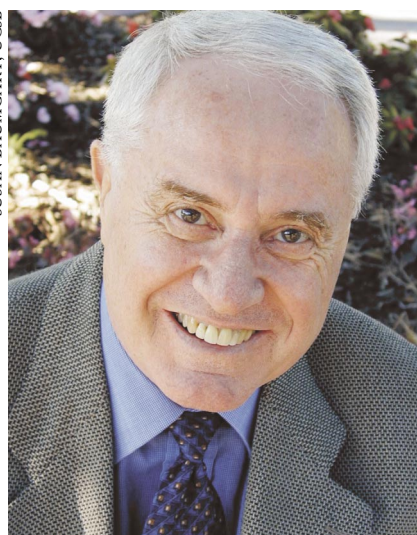
John Edward 'Jack' Estes

John Edward "Jack" Estes died of cancer in Santa Barbara, California, on 9 March 2001. Like the geographers of old, Jack, a pioneer in the fundamental and applied aspects of remote sensing and geographic information systems, helped us see the world in new and more complete ways.

Born in San Diego, California, on 21 July 1939, Jack earned his degrees in geography: his BA in 1962 and his MA in 1963 from San Diego State University and his PhD in 1969 from UCLA. His doctoral thesis, completed under Norman Thrower, was on multi-image systems for geographic research.

Jack began his faculty career as an assistant professor of geography at the University of California, Santa Barbara, in 1969 and, with David Simonett, formed the nucleus of what has become one of the nation's outstanding geography departments. Jack founded the department's geography remote sensing unit in 1972 and served as the unit's director throughout his tenure.

He was a pioneer in promoting innovative applications of space-based Earth observations and geospatial information by cartographers and geographers. Jack had extensive experience in the federal government, mainly with NASA and the US Geological Survey (USGS). The 1969 oil spill in the Santa Barbara Channel led him to work on the detection of marine oil pollution, and from the early 1970s to the time of his death, he conducted studies for NASA on land-use change, crop identification, water-demand modeling, and soil moisture conditions. Initially, in the 1970s, his primary regional focus was the southern San Joaquin Valley, but the work was of such wide applicability that, during the 1980s, he and his students extended it worldwide. He also applied remote sensing technolo-



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JOHN EDWARD "JACK" ESTES

gy to fire fuels monitoring and modeling, hazard and pollution detection, and resources management.

Jack had an exceptional ability to lead and guide graduate students, rather than direct them, in pursuit of their education and research objectives. More than 50 of his students received degrees and are now employed in prominent positions in various professional fields. His strength in teaching both undergraduate and graduate students lay in his thorough knowledge of his subject, his ability to organize and present complex materials, his sense of humor, and his sincere interest in his students' well-being. He had a splendid sense of loyalty to his colleagues and students, and he made many lifelong friends.

Jack's significant, generous contributions to the remote sensing and geographic information systems communities went far beyond academia. In the 1990s, he took extended assignments of several years' duration with both the USGS and NASA to assist in formulating national and international programs and policies for space-based Earth observations. Before his death, he had been the chair of the international steering committee for global mapping since its establishment by the United Nations in 1996, and he served on NASA's international space station science utilization advisory committee. On the NASA committee, he successfully worked to secure the Window Observation Research Facility, an optical-quality window in the space station that allows Earth remote sensing and that was successfully tested on a space shuttle mission in 2000.

As an outgrowth of his research,

Jack published widely in a variety of venues. His work covered such fields as monitoring marine oil spills, analyzing agricultural crop identification and water demand, preserving biological diversity, and integrating remote sensing information with expert systems. He was the editor of the interpretations and applications volume of the *Manual of Remote Sensing* (2nd edition, American Society of Photogrammetry, 1983). With Daniel Botkin, he edited *Changing the Global Environment: Perspectives on Human Involvement* (Academic Press, 1989), and with Jeffrey Star he wrote *Geographic Information Systems: An Introduction* (Prentice Hall, 1990).

Jack received the 1999 William T. Pecora Award, presented jointly by NASA and the US Department of the Interior to recognize outstanding contributions by individuals or groups toward an understanding of Earth by means of remote sensing. In 2001, NASA awarded Jack the Distinguished Public Service Medal in recognition of his pioneering achievements.

For more than three decades, Jack helped those who study and manage the Earth to realize the tremendous potential of emerging geospatial and information system technologies, and he promoted this goal through his teaching and practice in modern geography. Jack will be missed greatly, though his legacy lives on through his numerous valuable national and international scientific contributions and his students.

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Leslie Lawrance Foldy

Leslie Lawrance Foldy, Institute Professor Emeritus of Physics at Case Western Reserve University, whose pioneering work elucidated the theory of the multiple scattering of waves and the nonrelativistic limit of the Dirac equation, died on 18 January 2001 in Cleveland, Ohio, after suffering a heart attack on the previous day.

Les was born in Sabinov, Czechoslovakia, on 26 October 1919, into a family with Hungarian roots. His parents named him Laszlo Földi. In the turbulent times following World War I, he immigrated with his parents to the US in 1921. His father changed the family's last name and Les's first