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Jack Carl Kiefer

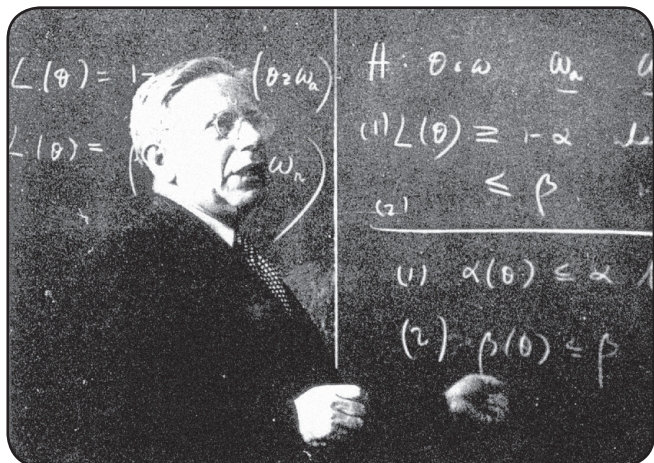
Robert Bechhofer, Cornell University



Jack Carl Kiefer died of a heart attack at the age of 57 in Berkeley, California, on August 10, 1981. He had just started his tenure as a Miller Research Professor in the departments of statistics and mathematics, University of California, Berkeley. Previously, he was in the Cornell University Department of Mathematics for 28 years, starting as an instructor in 1951 and elected as the first Horace White Professor in July 1973. He took early retirement from Cornell in 1979, and then joined the faculty at Berkeley.

Jack was an international leader in mathematical statistics and undoubtedly the foremost worker in optimal experimental design. Of the more than 100 items in his bibliography, more than 45 were on optimal design. He was also a recognized authority on mycology, having written several papers on classification.

Kiefer received many honors. He was a Fellow of the American Statistical Association and the American Association for the Advancement of Science and a former president (1969–1970) and Fellow of the Institute of Mathematical Statistics, as



(above) One of Jack's influences, Abraham Wald, as the executive officer of the Department of Mathematical Statistics at Columbia University

(right) Jack Carl Kiefer taken by Constance Reid, *Neyman*— from *Life*, New York: courtesy, Springer-Verlag, 1982



well as a Wald lecturer. He was a Fellow of the American Academy of Arts and Sciences (1972) and elected to the National Academy of Sciences (USA) in 1975. He held a Guggenheim fellowship at Stanford from 1962–1963 and was visiting professor at Oxford University (1958–1959) and at Berkeley (1975). In 1980, Jack was one of two professors to initiate the Berkeley-Beijing exchange program. In addition to statistical societies and the American Mathematical Society, he was a member of the Mycological Society of America, the North American Mycological Association, and the American Civil Liberties Union.

Jack was born in Cincinnati, Ohio, on January 25, 1924. He attended Massachusetts Institute of Technology from 1942–1943, majoring in electrical engineering and economics, but took leave during World War II to serve in the U.S. Air Force as a first lieutenant, spending part of this period teaching radar. He reregistered at MIT for the spring term of 1946. Several of his activities there were focused around the theater. He was production manager for the 1947 “Tech Show,” the annual student musical comedy, and wrote and directed the 1948 show. Professor Harold Freeman of the Department of Economics at MIT stated, “I think I was the one to interest him in statistics. If that’s true, it was certainly one of the best things I ever did for statistics. By the way, Jack was really torn between show biz and statistics. Statistics won, but it was a close thing.” Jack stayed on at MIT for his master’s degree and received both the SB in electrical engineering and the SM in economics and engineering in June 1948. His master’s thesis, under direction of professor Freeman, was “Sequential Determination of the Maximum of a Function.” This served as the basis for Jack’s 1953 paper, “Sequential Minimax Search for a Maximum,” in the *Proceedings of the American Mathematical Society*. The “Fibonacci Search” optimum seeking method proposed there has considerable practical relevance; for example, it was an operations research technique taught to workers in mainland China during the 1971–1974 Cultural Revolution (*SIAM News*, December 1976).

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Following graduation from MIT, Jack attended the 1948 Statistical Summer Session at Berkeley, taking courses with Michel Loève and Abraham Wald, who was visiting there from Columbia University. In fall 1948, he started doctoral studies in the Department of Mathematical Statistics at Columbia. Wald was executive officer of the department, the resident faculty consisting of T. W. Anderson, Howard Levene, Henry Scheffé, and Jacob Wolfowitz. Columbia attracted gifted students from all over the world. According to faculty who knew him then, Jack was outstanding among his contemporaries.

Jack's orientation to statistics and his research interests were strongly influenced by Wald and Wolfowitz, and he became a life-long advocate of statistical decision theory as a way of formulating problems. His first published statistical paper, "Almost Subminimax and Biased Minimax procedures," *Annals of Mathematical Statistics*, 1951, was written with Peter Frank while both were graduate students at Columbia.

In 1951, after Wald's death, Wolfowitz left Columbia and joined the Department of Mathematics at Cornell. Jack accompanied Wolfowitz as instructor in the same department. He completed his dissertation, "Contributions to the Theory of Games and Statistical Decision Functions," under Wolfowitz during the first year, receiving his PhD from Columbia in 1952.

Under Wolfowitz, research in mathematical statistics flourished at Cornell. In the early years, Aryeh Dvoretzky was a frequent visitor; others included Julius Blum, Leonid Hurwicz, Milton Sobel, Henry Teicher, and Lionel Weiss. Kiefer quickly became involved in the constant whirl of research activity. Over the years, he and Wolfowitz collaborated on 24 papers, six of these with Dvoretzky. Among these six were three fundamental papers on inventory theory that were inspired by earlier work of K. J. Arrow, T. E. Harris, and J. Marschak and two on sequential decision problems for processes with continuous time parameters. Other early papers with Wolfowitz included one on stochastic approximation, several on statistical inference, and two on topics in queuing theory. A key paper, "Some Properties of Generalized Sequential Probability Ratio Tests," *Annals of Mathematical Statistics*, 1957, was written jointly with L. Weiss during this period.

Jack married Dooley Sciple on September 15, 1957. She had been one of his undergraduate advisees, majoring in mathematics. Dooley and Jack shared a love of music. Jack aspired at one time to become a proficient pianist. Although he practiced conscientiously,

he eventually abandoned that goal with reluctance because of other demanding and conflicting interests. Dooley and Jack were devoted parents of two children, Sarah Elisabeth and Daniel Jonathan Baird, with whom they shared their love of music, stamp collecting, and mushroom hunting.

Jack's trailblazing paper, "On the Nonrandomized Optimality and Randomized Non-Optimality Symmetrical Designs," *Annals of Mathematical Statistics*, appeared in 1958; he defined optimality criteria (D-, E-, M-, and L-optimality) for designs, as well as the terms "randomized design" and "nonrandomized design." The following year saw the publication of another fundamental paper, "Optimum Designs in Regression Problems," *Annals of Mathematical Statistics*, 1959, written jointly with Wolfowitz and motivated by earlier work of P. G. Guest and P. G. Hoel.

Jack spent his 1958–1959 sabbatical leave at Oxford University, where he prepared a paper surveying recent developments in the theory of the determination of optimum experimental designs, an area of statistical research to which he was already perhaps the foremost contributor. The paper, "Optimum Experimental Designs," *Journal of the Royal Statistical Society, Ser. B*, 1959, was read before a Research Methods meeting of the Royal Statistical Society. Jack's intent was to provide "methods for verifying whether or not given designs satisfy certain optimality criteria, and for comparing designs which satisfy such criteria ... the approach being in the spirit of Wald's decision theory." In this paper (deliberately emphasizing theory rather than practice), Jack used simple examples to illustrate the basic ideas under consideration. The response of the British statisticians to the paper was overwhelmingly negative. Most objected that the decision-theoretic approach was not relevant to the objectives of practical experimentation; many misinterpreted the illustrative purposes of his simple examples. Jack was hurt and dismayed by the ferocity of their attack. His published reply attempted to clarify the misunderstandings voiced. The effects of that unsettling encounter lingered long with Jack, but he lived to see the optimum design approach embraced by many British statisticians. Along with A. C. Atkinson, V. V. Federov, P. J. Laycock, and D. M. Titterton, among others, Jack participated in a conference on this subject organized by D. R. Cox at Imperial College, London, in June 1974; papers based on their talks appeared in *Biometrika* in 1975. Subsequent issues of *Biometrika* and *JRSS, Ser. B*, continued to contain papers on optimum design.

In July 1959, Roger Farrell joined the Mathematics Department at Cornell. Jack greatly valued Roger's opinions and research abilities, and they later published together.

During the 1960s and 1970s, Jack was sole author of many papers, including two of which he was particularly proud: "Iterated Logarithm Analogues for Sample Quantiles When $P_n \searrow 0$," *Proceedings of the VI Berkeley Symposium*, 1970, and "Skorohod Embedding of Multivariate RV's and the Sample DF," *Zeitschrift für Wahrscheinlichkeitstheorie*, 1972. He jointly wrote papers with N. Giri, C. Stein, J. Sacks, and R. Schwartz on problems of minimaxity, asymptotic optimality, and admissibility of various statistical tests, all published in the *Annals of Mathematical Statistics*.

One of Jack's brightest PhD students, Larry Brown, returned to the Cornell Mathematics Department in 1966. He and Jack shared many research interests; although they never formally collaborated, their professional relationship was deep and mutually supportive.

An extended period of research culminated in 1968 with the publication of the book *Sequential Identification and Ranking Procedures*, written jointly with R. E. Bechhofer and M. Sobel. Selection procedures also were considered in Kiefer's articles on conditional inference published in 1977.

In summer 1973, an Israeli graduate student in computer science at Cornell, Zvi Galil, started doing computing for Jack on optimum designs. Their relationship evolved into one of full-fledged research collaboration and personal friendship, their joint efforts resulting in more than 10 papers in optimum design. During his last years, Jack also worked with Henry Wynn of Imperial College, London, who he first met at David Cox's design conference in 1974. Henry visited Jack during summers at Berkeley, working with him and Zvi. A strong bond developed among the three.

Zvi Galil was among those who eulogized Jack at a funeral service held in Cincinnati on August 14, 1981. His remarks below illustrate the feelings of Jack's coworkers and friends:

Having cooperated with Jack over many years, I can tell you how wonderful it was working for him, and how one learned by doing so. . . . Jack was unbelievably humble, especially for a man of his stature. He would not hesitate to praise a student by favorably comparing the student's work with his own. He was very kind and considerate and spent a lot of time with his students. . . . Jack was very critical. He would fight and not give in for a just cause. But mostly he was critical, probably too critical and demanding of himself.

Jack was a superb lecturer and teacher. He had the rare ability to teach well at both elementary and advanced levels, and to communicate complex ideas in a way that clearly exhibited the essence and the technical difficulties of the problem. His lectures were beautiful, well-constructed works of art and logic. Jack was easily accessible to all students, undergraduate and graduate. He was sometimes impatient, but always helpful, fair, and firm, convincing his students to strive for excellence as he did in all aspects of his life. Many fine students wrote their PhD dissertations under Jack's guidance, among who were Jerome Sacks (Jack's first PhD student), Corwin Atwood, Lawrence Brown, Cheng-Shiu Cheng, Ker-Chau Li, Gary Lorden, David Moore, Praesert NaNagora, William Notz, Douglas Robson, Richard Schwartz, Sally Sievers Nerode, Josefa Lopes Troya, Yehuda Vardi, and Gloria Zerdy.

The following was written by Richard Korf, professor of mycology at Cornell and a long-time friend, about Jack as a mycologist:

Jack Kiefer was one of the most thorough of "amateur" mycologists: He studied the fungi he collected exceptionally carefully, comparing their features with those described in his extensive library on mushrooms, frequently consulting "professional" mycologists who quickly discovered that Jack was far more knowledgeable about the fungus in

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question than they ever had thought to be. He delighted in sharing his knowledge of mushrooms with others; if one was particularly lucky, he might share a feast of morels or other prized finds with you. (Alas! Like all true morel hunters, he kept secret his choicest collecting sites for the elusive morels.) If there are mushrooms in Heaven (There must be!), Jack is surely searching them out!

Jack was often called upon to serve on key departmental and university committees, and rarely turned down such requests. He was unstinting in his service to scholarly and professional societies and equally available to various educational and governmental agencies, such as the National Academy of Sciences, National Research Council, Army Research Office, and Guggenheim Foundation. At his death, he was on the editorial boards of four journals and statistical series.

Jack was warm, sensitive, and sincere—always willing to fight for the causes that he believed in: human rights, civil liberties, the protest against the war in Vietnam. He worked to help Soviet scientists leave Russia, and he and Dooley fought fervently for various environmental causes. In 1968, he was a Liberal Party candidate for the New York State Assembly.

Jack was a special human being. There was a friendliness and a charm about him, a lilt to his voice, a twinkle in his eye, a smile that attracted everyone. He was a witty, delightful conversationalist, maintained long and deep relationships, and was beloved by many. He was honest and true to his high ideals. The profession has lost a great scientist; the many who knew him well have lost a wonderful friend. ■

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