A Conversation with Samuel Kotz

Saralees Nadarajah

Abstract. Samuel Kotz was born in Harbin, China, on August 28, 1930. After graduating with honors in 1946 from the Russian School in Harbin, he studied electrical engineering at Harbin Institute of Technology during 1947–1949. In 1949 he emigrated to Israel, where, after two years of military service, he studied at the Hebrew University in Jerusalem, obtaining an M.A. with honors in Mathematics in 1956. Following two years at the Israeli Meteorological Service, he entered graduate school at Cornell University and obtained a Ph.D. degree in Mathematics in 1960. After research positions at the University of North Carolina, Chapel Hill, and the University of Toronto, he joined the latter institution as an Associate Professor in 1964. He moved to Temple University, Philadelphia, in 1967 as Professor of Mathematics and then to the University of Maryland, College Park, in 1979 as Professor in the College of Business and Management. He took early retirement and moved to George Washington University in 1997.

Samuel Kotz has made substantial contributions in several areas of statistics—including systems of distributions, measures of dependence, multivariate analysis, characterizations, limit distributions, replacement theory, quality control, information theory and applications of statistics. He is the senior coeditor-in-chief of the thirteen-volume *Encyclopedia of Statistical Sciences*, an author or coauthor of over one hundred and fifty articles on statistical methodology and theory, twelve books in the field of statistics and quality control and three Russian–English scientific dictionaries and coauthor of the often-cited compendium of statistical distributions. His efforts, excellence and contributions were recognized by the award of honorary Doctor of Science degrees from Harbin Institute of Technology (China) in 1988, from the University of Athens (Greece) in 1995 and from Bowling Green State University (Ohio, U.S.A.) in 1997. In 1997 a volume containing thirty-eight essays was published in honor of his sixty-fifth birthday. He was awarded membership in the Washington Academy of Sciences in 1998. He is a Fellow of the Royal Statistical Society, Fellow of the American Statistical Association, Fellow of the Institute of Mathematical Statistics and an elected member of the International Statistical Institute.

This conversation took place at Samuel Kotz's office during Saralees Nadarajah's visit to George Washington University between September 21, 2000, and September 24, 2000.

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EARLY YEARS IN CHINA

Nadarajah: How was it that you were born in China? What were your early years in China like?

Kotz: Thanks for an opportunity to reminisce about my childhood! My father's family fled from their home town Ufa in the Ural mountains region in Russia around 1919 to the city of Harbin. My grandfather was the owner of a large watch and silver store in Harbin, importing watches from Switzerland. He had a branch in the city of Chang Chung, the capital of

Manchukuo (1932–1945), and was an official supplier to the Imperial Household. (I trust that you have seen the movie *The Last Emperor*.) Harbin was, in those days, the hub of the Trans-Siberian railway—an industrial city in Manchuria. My father journeyed to Liège in Belgium to obtain his higher education in engineering around 1925. There he met my mother—a daughter of a prominent rabbi from Warsaw—who went to the same university to study chemistry. Many Jews from Poland went to Liège for their higher education as they were unable to study at Polish universities. My parents met in Liège, married in 1928 and returned to Harbin shortly thereafter.

My childhood in Harbin was a happy one, especially until December of 1941. Manchuria was occupied by the Japanese in 1932 but initially it had little effect on the foreigners, in particular on the large Russian community of which Jews were a separate and autonomous part. I studied in a Jewish school until about the age of twelve and thereafter in a Russian high school. By the age of sixteen I had completed my high school education. After spending one year in an English-speaking college, I enrolled as a student of electrical engineering at Harbin Institute of Technology (HIT) in 1947, where I studied for two years. Until the early 1950s, HIT was the only Russian-speaking university in Harbin; after that time there were none.

Nadarajah: What did your parents do for a living? Did they have a big impact on you?

Kotz: My father had a degree in Engineering but he worked with my grandfather in the watch store most of the time. Both my father and grandfather were leaders of the Jewish community in Harbin. My grandfather was the treasurer of the community and the president of the main synagogue for many years. My father was very active in the Jewish school and in youth organizations.

My mother worked sporadically as a chemist but was also involved in charity and women's organizations. In the fall of 1938 she took me to Warsaw to visit her parents. We stayed there till May of 1939, almost till the beginning of World War II. There I met my grandfather from my mother's side, the rabbi, who had a substantial impact on me. He was a great scholar and implanted in me the love of studying.

Nadarajah: When did you discover that you had an interest in, and talent for, mathematics? Were there mathematicians in your family?

Kotz: My grandmother on my father's side was from the family of Gel'fand and was related to the famous Russian functional analyst I. M. Gel'fand—so I was

FIG. 1.   *At the age of five in Harbin.*

told. I had good mathematics teachers in both elementary and high schools, but an especially excellent one in advanced calculus at HIT who inspired me. I was not very good in abstract mathematics but enjoyed integrals, the theory of complex variables and linear al-

FIG. 2.   *With his father and grandfather at the age of thirteen.*

gebra. The books by Fikhtengol'ts (differential and integral calculus, 1947–1949), Kurosh (algebra) and Markushevich (complex variables) were my favorite readings. I still use the *Handbook of Higher Mathematics* (1945) by I. N. Bronshtein and K. A. Semendyaev, which I tried to study from cover to cover in my youth.

Nadarajah: I note that you have a keen interest in languages too. How many languages do you speak and what are they?

Kotz: At home we spoke Russian, but many friends of my mother were Poles and I picked up Polish rather easily quite early. At the elementary school we studied Hebrew very intensively and I took private lessons after graduation. As I mentioned, I spent one year in an English-language college. So, by the age of eighteen I was fluent in four languages. In later years I studied Japanese for about a year and some Chinese quite sporadically for a short time in 1946–47. German was taught in my high school and I picked up a bit of French on my own, although my parents spoke French occasionally. My Master's thesis at the Hebrew University on Dirichlet series compelled me to improve my mathematical French and I also passed a French exam as the second foreign language at Cornell. Thus, I am quite well versed in four languages and have only rudimentary knowledge of the other four. In contrast, my mother spoke, wrote and read in seven languages very fluently till her last days at the age of eighty-seven.

YEARS IN ISRAEL

Nadarajah: In 1949 you moved to Israel, where you underwent two years of military service. What made you move to Israel?

Kotz: In our isolated Jewish community in Harbin, we were not aware of the dimensions of the Holocaust in Europe until the arrival in August of 1945 of the Soviet Army and later of the Chinese Communist Army in 1946. Neither did we realize the danger that World War II would have brought to our physical existence if it had lasted for another six months. My father still owned his store in 1946–47 but was selling shoes instead of watches. But it was evident that it could not last for long. The establishment of the State of Israel in May of 1948 was a pivotal event. Most of the Jewish community immigrated to either Australia or Israel in the late 1940s and the early 1950s—very few were able to enter the U.S.A.

In Israel I served in the Air Force mostly as an instructor of mathematics (and occasionally physics) in

FIG. 3.   *In the Israeli Air Force uniform.*

a school for maintenance personnel. This experience was instrumental in my development from a bookish student to a man with some sense of discipline and responsibilities. I wore my military uniform till the very last day and was proud of my rank as a first sergeant, even though some of my students were officers.

Nadarajah: Then you read for an M.A. in Mathematics at the Hebrew University in Jerusalem. Were you taught in Hebrew or English?

Kotz: The lectures at the Hebrew University were all in Hebrew except for an occasional seminar. But almost all the students, especially in advanced courses, used books in English. I had an advantage of using Russian books as well. For some reason the transformation from Russian to Hebrew was not a problem. Most of the students were native Israelis, but there were several immigrants from Hungary, and also myself—an oddball.

Nadarajah: After completing your M.A. in 1956, you worked at the Israeli Meteorological Service for two years. Did this period develop your interest in statistics?

Kotz: Yes, the work at the Research Department of the Israeli Meteorological Service (IMS) was an important stage in my development as a statistician. I started

FIG. 4. *At the graduation ceremony in 1956 at the Hebrew University, accepting his M.A. certificate from the Rector B. Mazur. Partially hidden and standing is the Dean, A. Dvoretzky, a renowned probabilist. The commencement speaker and Prime Minister, D. Ben-Gurion, and his wife, Paula, are seated in the first row.*

with fitting a Gamma distribution to the yearly rainfall amounts in Jerusalem, which has long series of meteorological observations. I still remember the excitement when the fitted values were so close to the observed ones as the obligatory χ^2-test had indicated. It was psychologically a turning point: I then decided to abandon mathematics *per se* and concentrate on statistics. My boss at the IMS, Dr. Yehuda Neuman, was a very dynamic and dedicated person. K. R. Gabriel, who was then an instructor in Statistics at the Hebrew University, was a consultant to the IMS and I learned a lot from him. He later joined the University of Rochester and is known for his research on biplots, among other subjects.

I became interested in measures of variability and co-authored a short paper (Katsenelson and Kotz, 1957), which—believe it or not—is still cited in the sixth edition of *Kendall's Advanced Theory of Statistics*. Later on, I carried out experiments on the effects of frost that caused damage to the banana crop in central Israel. It was healthy to get away from the desk and face the hardships of the real world, if only for a limited period!

EDUCATION IN THE UNITED STATES

Nadarajah: You then entered Cornell University and obtained your Ph.D. in Mathematics in 1960. Any particular reason that you chose to go to Cornell?

Kotz: It was a lucky turn of fate. While working at the IMS and the newly established Bar-Ilan University (near Tel Aviv), where I was teaching mathematics and statistics on a part-time basis, I realized that I just

did not know enough to carry out serious research in either mathematics or statistics. I tried to work on distributions with given marginals in a semiabstract setting, but the paper that I wrote was rejected by a well-known mathematical journal.

Professor Jacob Wolfowitz from Cornell University happened to visit his cousin in Tel Aviv who was a friend of my parents. I met Wolfowitz privately and he was sufficiently impressed to offer me a modest scholarship. In 1958 I flew for the first time to the U.S.A. via Stockholm, attending, on the way, the International Congress of Mathematicians.

At Cornell I worked very hard, almost nonstop for two years. The initial adjustment was difficult, in particular, weatherwise—from a sunny and humid Tel Aviv to cold and snowy Ithaca. The winter started early, in 1958. At the beginning, if I recall correctly, I was the only foreigner at the Mathematics Department and was slightly older than most of the students. However, it was very rewarding to take courses with Wolfowitz, J. Kiefer, L. Weiss, R. E. Bechhofer (probability and statistics), I. Herstein (algebra) and Namioka (topology). Wolfowitz was then writing his famous book on *Coding Theorems of Information Theory*. My Ph.D. thesis was on binary channels and a portion of it was published in the 1961 *Annals of Mathematical Statistics*.

Nadarajah: How did the education system in Israel compare to the one at Cornell?

Kotz: In those days the systems were different. At the Hebrew University, following the European custom, we worked at home—and visited the department mainly for lectures, occasionally spending some time in the libraries. The university was scattered in various buildings in the downtown of Jerusalem. There was no self-contained campus then as there is now; actually, there are two large campuses at present.

At Cornell, each graduate student had a desk and many of us were burning the midnight oil—running to the student union or to one of the restaurants nearby for a quick bite. I still remember eating fish and chips twice a week for thirty-nine cents!

I hardly knew most of my classmates at the Hebrew University, whereas at Cornell the only people I knew were my classmates. I was very fortunate that both universities had very dedicated, world-famous professors. At the Hebrew University you had to visit a professor at his home if you had questions regarding a seminar or lecture you were assigned to present. Except for junior instructors, there were no women professors at both universities at that time. But it seemed to me that

there were more female students at Cornell and some of them were very smart.

Nadarajah: Who were your fellow students and notable teachers at Cornell?

Kotz: Some of my classmates at both universities, Hebrew University and Cornell University, have had distinguished careers. At the Hebrew University I was with Avner Freedman, a renowned mathematician in the differential equations area, Yitzhak Katzenelson and Shmuel Kantorovitz, who are well known for their work in functional analysis, and Gideon Schwarz, famous for his 1978 *Annals of Statistics* paper on the Schwarz criterion for model selection—an extension of Akaike's result.

At Cornell I studied together with Jerry Sacks (not Jerome Sacks, former director of the National Institute of Statistical Sciences, who also got a Ph.D. at Cornell) who became a great logician at the Massachusetts Institute of Technology, if I recall correctly. My indirect classmates were Ed Dudewicz, E. C. von Mullen from Belgium, N. Laubscher from South Africa, Anatole Joffe, now in Canada, Peter Ney and Harry Kesten (they were in the Department of Industrial Engineering and Operations Research where I took courses and attended seminars).

No doubt Professor Wolfowitz had the greatest impact on me. He supported me when I was low—having failed the first exam in his course. Both J. Kiefer and L. Weiss were very attentive. I did rather well in Weiss's course on decision theory. I must mention Professor Namioka, who taught us topology initially from Kelley's *General Topology*. At the beginning I was scared, but quite enjoyed his course at the end. Needless to mention the impact of the stimulating lectures by I. Herstein—I shall never forget Sylow's groups! Unfortunately, I had little contact with the great Marc Kac—I was there for only two years and he was on a sabbatical part of the time.

WORKING CAREER

Nadarajah: After your Ph.D., you held research positions at the Universities of North Carolina in Chapel Hill and Toronto. Who were the people that you met there who most influenced you?

Kotz: Well, when I arrived in Chapel Hill on a Sunday in late August of 1962, I happened to have a terrible toothache and I went looking for a hospital or an emergency dental service. The streets were deserted. Nobody walked in Chapel Hill in those days except on the main Franklin street. But I saw a well-dressed gentleman walking towards me. I asked him for directions and he replied politely with a British accent that he himself had just arrived in Chapel Hill for the first time. This man was none other than Professor Norman L. Johnson, who started his "sojourn" at the Department of Statistics in the fall of 1962 and has been there for the last thirty-eight years. The next day I met him at the department; we were both bachelors at that time and became friendly, had an occasional beer and started our collaboration of almost forty years which continues to today.

Another friend and mentor was W. Hoeffding (who spoke Russian); we collaborated on the *Russian–English Dictionary of Statistical Terms and Expressions*, which was published by the University of North Carolina Press in 1964. I was privileged to attend his lectures on estimation and hypothesis testing and marginally assisted him with his well-known and influential paper on bounds of binomial probabilities (Hoeffding, 1963). I learned queuing theory from Walter Smith, order statistics from the organized and lucid Carl Sandral and theoretical experimental design from the inspiring and famous R. C. Bose. I was close to J. N. Srivastava—he was very attentive and offered me the use of his car to learn driving. I value him as a friend and a great statistician. George Dal'Aglio from Italy was also a research associate at that time. The late George Nicholson was a dedicated Chair and H. Hotelling, although not in his prime, was still running the colloquia. I vividly remember Harald Cramér visiting the department in early 1963.

At Toronto I was in the Department of Industrial Engineering and was busy writing my 1966 Methuen monograph on *Recent Results in Information Theory* (Kotz, 1966) and the four volumes of *Distributions in Statistics* with Norman Johnson (Johnson and Kotz, 1969–1972). There were no faxes or e-mails in those days. Norman visited me in Toronto and I used to spend some time in Chapel Hill in the summers. We completed the first three volumes in two and a half years; they were published by John Wiley in 1969 and 1970. We also wrote what turned out to be often-quoted papers on distributions of quadratic forms of normal variables (Kotz, Johnson and Boyd, 1967). I was also interested in functional equations (stimulated by characterizations of the exponential distribution) and tried to collaborate with J. Aczel, who was not very far away. I was privileged to attend Marshall McLuhan's legendary seminars on information and media. I also attended D. A. S. Fraser's lectures, in which he developed his structural inference, but perhaps not as many as I should have. Fraser was away in Wisconsin part

of the time and I was too busy with my own research to interact, which in retrospect I regret. My officemate for a time was the gentle and modest C. G. Templeton, who is known for his contributions to queuing theory.

Nadarajah: You eventually left Toronto. Why?

Kotz: In early 1967 I realized that there were not enough students for my course on information theory and that some of my other courses overlapped with those offered at the Mathematics Department, where Fraser and M. S. Srivastava were prominent professors. I also suffered from Toronto winters—I never learned how to drive properly and used public transportation, which had a tendency to be on strike.

I wrote to the Chair of the Mathematics Department at Temple, whom I knew via a mutual friend. He was a kind and gentle person. He offered me a Full Professorship and an increase in salary. My wife, I and our two babies moved to Philadelphia and stayed there for twelve years.

At Temple University I developed a popular course on the art of guessing and wrote a book *Educated Guessing: How to Cope in An Uncertain World* (Kotz and Stroup, 1983) on this topic with Donna Stroup (currently at the Centers for Disease Control and Prevention in Atlanta). I also collaborated with my colleague J. Galambos on what some consider to be an innovative monograph on characterizations of exponential and related distributions (Kotz and Galambos, 1978). In addition, Norman Johnson and I completed the fourth volume of *Distributions in Statistics* in 1972 and started thinking about the *Encyclopedia of Statistical Sciences* (ESS; Johnson and Kotz, 1982–1989). Finally, I worked with Alu Srinivasan on tests of separated families of distributions, mimicking and to some extent extending Sir David Cox's work in that area.

I spent many a summer at Penn State as a guest of W. L. Harkness and G. P. Patil and was involved with organizing the 1975 Calgary Symposium on Statistical Distributions in Scientific Work with G. P. Patil and J. K. Ord. I was also involved with a similar more extended conference at Trieste organized by G. P. Patil et al. in 1981. I was fortunate to have several Ph.D. students at Temple, among them J. P. Seeger and I. R. Goodman, both of whom wrote excellent theses on problems related to dependence, but then regrettably discontinued their research and worked in industry. Another student of mine, N. S. Kambo, is now Professor in New Delhi.

Nadarajah: But then in 1979 you moved to the University of Maryland.

Kotz: In the late 1970s I again saw the writing on the wall. The Business School at Temple University was aggressively promoting their newly established Statistics Department and attracted good faculty and students. My Dean and the Mathematics Department were not particularly interested in their probability and statistics program. I realized that it was time to look for greener pastures. A Professorship in Statistics was open at the Management Science and Statistics Department at the University of Maryland in College Park and I jumped to take it, in spite of a reduction in salary.

I stayed at Maryland for eighteen years (1979–1997), developing courses in regression, experimental design and multivariate analysis. I worked with Norman Johnson and C. B. Read on the ESS—nine volumes and a supplement were completed by 1989 and published by John Wiley. I had the pleasure and privilege of corresponding with the most prominent statisticians in the world and was able to understand the profound changes in the statistical sciences as computers became prominent and indispensable. I had a number of good students in the Business School and assisted them with their statistical problems. The Department of Accounting was the main source of these students and its Chair, Larry Gordon, appreciated the importance of statistics.

In the early 1990s I became interested in applied engineering statistics. Norman Johnson and I wrote several papers and notably two Chapman and Hall monographs: *Inspection Errors for Attributes in Quality Control* with X. Z. Wu (1991); and *Process Capability Indices* (1993).

Nadarajah: I understand you went back to China in the 1980s.

Kotz: Yes. In 1982 I returned to China and to my home town Harbin—it was a highly emotional experience for me. My alma mater, HIT, bestowed on me my first honorary doctorate. Since then I have visited China and Hong Kong many times, developing friendships and productive working relations with Kai-Tai Fang, Kai-Wang Ng and Xi Zhi Wu, which resulted in joint work, notably a Chapman and Hall monograph, *Symmetric Multivariate and Related Distributions* (1990). I also collaborated with researchers from the Institute and universities in the Tian-Jin area.

I met and became friendly with the Distinguished Professor Hu Gou-Din, who had studied with A. N. Kolmogorov in Moscow in the early 1960s and made important contributions to information theory. He was for many years the Director of the prestigious Mathematical Institute at Nankai University located in

FIG. 5.   *With faculty members of the Mathematics Department at HIT in the early 1980's.*

Tian-Jin. In the late 1940s and early 1950s, he also had been a close "comrade-in-arms" and associate of the current President of China.

Nadarajah: You took an early retirement at the University of Maryland. This certainly wasn't because you were tired of teaching and research. Was there a particular reason for your decision?

Kotz: Things turned a bit sour at the Maryland Business School in 1993 with the departure of the dynamic and open-minded Dean, Professor Rudy Lamone, who was appreciative of my research work. The new Dean, a businessman from Wall Street, focused his attention on the M.B.A. program with the encouragement of the President of the University. His main goal was

FIG. 6.   *With Kai-Tai Fang and his family in Beijing, August 1987.*

FIG. 7. *With Professor Grace Yang in Beijing, June 1986.*

to attain a place among the top twenty-five business schools in the country. We moved to a large new building with crammed offices for the faculty and more spacious ones for the administrators—and without any library facilities. The placement of the M.B.A. graduates into well-paid positions was a primary concern because it was an important criterion for achieving a high rating as stipulated by *U.S. News and World Report*. The statistics program was substantially curtailed; statistics courses were watered down and basically reduced to playing with software. Students from Finance, Marketing, Organizational Behavior and even Accounting departments were encouraged to take easy courses in statistics outside the college—in the Education and Psychology Departments, for example.

It was time for me to go again! I decided to take early retirement and moved to the George Washington Uni-

FIG. 8. *In a cluttered office at the University of Maryland, College Park, October 1994.*

versity, where the Department of Operations Research has provided me with a spacious office, half a block away from an excellent library, a computer and other facilities. I feel very much at home in a truly scientific environment and am grateful to the Dean, Professor Thomas Mazzuchi.

BOOK PROJECTS ETC.

Nadarajah: Among all your book projects, the ESS was perhaps the most daunting and important project that you undertook. What motivated this project?

Kotz: In the mid-1970s the two-volume *International Encyclopedia of Statistics*, edited by W. H. Kruskal and J. Tanur, was in preparation. I have known Kruskal since 1960, when he had been the Editor of the *Annals of Mathematical Statistics* and handled my first papers in that journal. I suggested to Kruskal that he enlarge the coverage of his Encyclopedia (which consisted of well-written review articles on the main areas of statistics, as well as some biographical sketches). He encouraged me to compile such a more comprehensive work. I was in my prime and was very eager to transform statistics from the status of an appendix to mathematics to a bona fide science, and wanted to emulate physics, psychology and engineering, which already had comprehensive Encyclopedias. This project also suited Norman Johnson, who was planning to retire in the early 1980s. A dynamic editor at John Wiley, Ms. Bea Shube, provided encouragement and incentive, as did the late Geoff Watson, who was an advisor to Wiley's publications in statistics. The project was approved by the publisher in 1979 and we started sending letters of invitation to contributors. Professor C. B. Read joined us as Associate Editor and shortly thereafter as Executive Editor. We were fortunate to have this erudite and dedicated statistician aboard.

Nadarajah: You have also coedited, with Johnson and Read, two volumes giving the history of statistics: namely, *Breakthroughs in Statistics* and *Leading Personalities in Statistical Sciences*. How did you get started on these projects?

Kotz: The three volumes of *Breakthroughs in Statistics* (Johnson, Kotz and Read, 1991) could be viewed as a spinoff of the ESS. It resulted from our desire to bring the original classical papers in statistics to the attention of the new generation of statisticians who had acquired their training in the computer-intensive environment of the 1980s and did not, we felt, realize the treasures buried in the original works of K. Pearson, R. A. Fisher, J. Neyman, B. de Finetti and C. R. Rao,

to mention a few fathers of modern twentieth-century statistics. We were fortunate that such luminaries like T. W. Anderson, E. L. Lehmann, D. A. S. Fraser and I. J. Good—again to mention a few—agreed to prepare introductions. The volumes were successful and are being used as textbooks for seminars at a number of leading universities. There was justifiable criticism that some of the papers were not reproduced in full, but we were constrained by the publisher's demand that we not exceed five hundred pages. It would perhaps be worthwhile to continue this project electronically on a yearly or biyearly basis.

Leading Personalities in Statistical Sciences (Johnson, Kotz and Read, 1997) is also a direct spinoff of the ESS. This book was reviewed under the title "People Who Really Count: At Last, Some Leading Figures" in the influential British newspaper, *The Guardian*, on August 14, 1997, by their permanent contributor, Tim Radford. I was interviewed on the phone by the British Broadcasting Corporation (BBC). The book received relatively little attention in the U.S.A. It was priced far too high to be affordable for the students and teachers of statistics for whom it was primarily intended. I do hope to be able to prepare a second more extended edition of this volume that would contain biographies and evaluations of scientific activities of some one hundred and sixty prominent statisticians from Graunt (1620–1674) to Deming (1900–1993).

Nadarajah: The volumes on *Distributions in Statistics* have been through their second edition. What were the major changes in the new edition?

Kotz: The first volume of *Distributions in Statistics*, *Discrete Distributions*, of some three hundred pages, appeared in 1969. It also contained material on multivariate discrete distributions as its final chapter.

In the early 1990s, Norman Johnson and I felt that it was time for the second edition. Being truly exhausted from the concentrated effort with the ESS for seven years, we did not feel up to the task of revising the volume on our own. Fortunately, Freda and David Kemp agreed to join us with the revisions. It was great fun and a valuable learning experience to work with Freda and David, and I shall never forget my 4:00 am phone calls to Scotland. We soon realized that the univariate discrete distributions merited a separate volume of some five hundred pages and that the multivariate discrete distributions ought to be temporarily excluded. The revised volume, published in 1992, contains over fifty pages of references and close to a thousand citations.

When the time came for revisions of the two original *Continuous Univariate Distributions* volumes, we

invited Naranswamy Balakrishnan to join us. We managed to publish the second editions of the two volumes, each about seven hundred pages (as compared to three hundred pages in the first edition), in 1994 and 1995, respectively. We were in close telephone contact almost weekly and benefited by being in the same time zone. Professor Balakrishnan also joined us in expanding the final chapter of *Discrete Distributions* into a book, *Discrete Multivariate Distributions*, which we published in 1997. There were difficulties with the final volume on *Continuous Multivariate Distributions*, but it finally appeared in print this year as a book of some seven hundred pages instead of the original three hundred and thirty-three. In the multivariate volume, we omitted the so-called sampling distributions: Wishart, multivariate t and the distributions of the latent roots of a Wishart matrix. However, the material on multivariate Gamma, multivariate exponential and multivariate extreme value distributions was expanded quite substantially.

Nadarajah: Are there plans for new editions of your other volumes?

Kotz: At present there is serious talk about a second electronic edition of the ESS, which of course needs further updating in spite of the three updated volumes that appeared between 1997 and 1999.

The editors of the ESS are glad that their initiative was mimicked by biostatisticians who produced, in a record time, a six-volume *Encyclopedia of Biostatistics*, edited by Armitage and Colton, in 1998. That Encyclopedia, not surprisingly, duplicates many of our entries. I also hear rumors about an Encyclopedia of Environmental Statistics. In this connection I should mention the series of *Handbooks of Statistics*, initiated by my friend, the late P. R. Krishnaiah, to which you recently contributed an important article on extreme value theory.

The three volumes of *Breakthroughs in Statistics* were useful contributions to statistical education. At present, with the availability of papers via the electronic medium, I do not see a great necessity for additional hard-copy volumes. Considering the rapid changes occuring in the field, an update by means of a web-site would seem to be more efficient, and this should perhaps be an American Statistical Association (ASA) or International Statistical Institute (ISI) undertaking.

We hope to revise and extend the volume on *Leading Personalities in Statistical Sciences*, which, as I have

already mentioned, did not receive the attention it deserves. Again there are rumors about competing or duplicating volumes, but as a Hebrew saying goes: "Competitiveness among writers only increases wisdom."

Nadarajah: What other things are you doing now?

Kotz: As you know I wrote a monograph with you on *Extreme Value Distributions: Theory and Applications* which is due to appear momentarily (Kotz and Nadarajah, 2000).

This summer I collaborated with Norman Johnson on a review article on the process capability indices (PCI). We view this project as an important educational task: to convince the engineers that, contrary to their belief and that of a reviewer of our 1993 book on the subject, understanding and intelligent use of the PCI is no harder than understanding derivation of the distribution of the t-statistic and does not require a Ph.D. in Statistics. (It seems to me that the distribution of the t-statistic is not being derived anymore in typical engineering courses in probability; perhaps this is due to a heavy reliance on software.)

I am awaiting publication of a book in Chinese, *Modern Bayesian Statistics*, written jointly with my ex-student and colleague, Professor Xi Zhi Wu. D. V. Lindley was gracious enough to write an introduction for this book. The only other book in Chinese in this area is a translation of J. O. Berger's masterpiece, *Statistical Decision Theory and Bayesian Analysis*.

I am completing a monograph on *Dependence, Correlation and Other Permissible Relations* written jointly with Dr. Dominique Drouet-Mari of the Université de Bretagne Sud in Vannes, France.

A book on *Laplace Distribution and Its Generalization* with two young probabilists, T. Kozubowski and K. Podgorski, should be completed by the end of this year. It started as a one-hundred-and-twenty-page monograph and grew rapidly to become a four-hundred-page volume.

Nadarajah: You have over one hundred and fifty papers, covering many important areas in statistics. Of which of them are you most proud?

Kotz: I am proud of my first monograph, *Recent Results in Information Theory* (Kotz, 1966), which originally appeared as a paper in the 1961 *Annals of Mathematical Statistics*, and of the two joint papers with Norman Johnson and D. W. Boyd on distributions of quadratic forms that I mentioned earlier.

I was satisfied being able to assist Professor E. Grosswald in the 1970s to prove the infinite divisibility of the t-distribution.

The two papers with D. N. Shanbhag on new approaches to probability distributions, published in 1980 and 1987 in *Advances in Applied Probability* and *Journal of Multivariate Analysis*, respectively, did attract attention. I was fortunate to collaborate with him.

A paper "Statistics in the U.S.S.R." that I published in *Survey* in 1965 was quite timely and required substantial effort in reading numerous obscure sources. For a time, in the early 1970s, I wanted to switch my research to the history of statistics and translated with annotations a Russian book on the history of probability theory, but soon realized that I did not have the talent and qualifications possessed by others (e.g., S. Stigler or E. Seneta) to contribute substantially in this area. I did do more work on statistical history afterwards: a review of "Neyman: From Life" by C. Reid that I was invited to write by P. Halmos for the 1985 *American Mathematical Monthly*, another paper on Soviet statistics in the 1988 *American Statistician* almost on the eve of the breakdown of the U.S.S.R., and a twenty-two-page paper with Seneta on Lenin as Statistician which appeared in the 1990 *Journal of the Royal Statistical Society* at a time when nobody was much interested in Lenin.

I value papers—over fifteen of them—related to faulty inspection and faulty Dorfman-type screening procedures written jointly with Norman Johnson. We hoped that they would be useful for AIDS research, but the health industry and the medical community were not particularly interested in this methodology. My joint work with Norman Johnson on urn models, including our 1977 book on the subject, also did not receive much attention.

I do not consider the distribution associated with my name to be of great importance, but T. Cacoulos and several other researchers liked it and derived interesting properties. It was not well known and was rediscovered as recently as 1998.

NORMAN JOHNSON

Nadarajah: So many of your books and papers are jointly authored with Norman Johnson. What is it like working with him?

Kotz: When we were colleagues at Chapel Hill, Norman and I tentatively agreed to embark on the *Distributions in Statistics* project, but once I moved to Toronto in July of 1963, I was busy with other matters. However, I was glad to receive a letter from Norman in the early spring of 1964 saying that he was serious about the project. He visited me in Toronto with his charming

and most distinguished mother in the summer of 1964 and several times after that. We worked by mail and via telephone, and during summers I visited Chapel Hill. Our literature search and compilation—I would usually write the first preliminary draft and Norman would provide an almost finished product—resulted in a number of spinoff papers. After completing the four volumes on distributions, we stumbled on the Farlie–Gumbel–Morgenstern distribution, which kept us going for a number of years. Next came the era of inspection errors, simultaneously with the ESS editorial work (in the early 1980s). We jointly wrote over two hundred short entries for the ESS.

Norman Johnson is a man of substantial mathematical abilities and remarkable insight and intuition. His research output is enormous—by far exceeding mine. Norman is very hard working—often seven days a week. He is very easygoing, well read and is also interested in religion and politics. His wife, Regina, is a renowned statistician in her own right, and they have jointly written a classic on survival analysis.

In the earlier years, on Norman's visits to Philadelphia, we used to sleep in my office and work continuously for sixteen hours per day. I remember visiting him at Vanderbilt University one summer, where he was giving a course. I stayed in his efficiency apartment for three nights: we wrote two papers and completed our 1977 book on *Urn Models and Their Application*, which was in preparation for a year between our larger multivolume projects. We also used to meet at various airports in the eastern part of the U.S.A.

I owe Norman a lot. Norman is not interested in money or power. He truly enjoys learning and creating statistical methodology and is well aware of the importance of applied work. I am glad to have been able to help persuade the ASA to grant him the well-deserved Wilks Medal, even though I had to resign from the Association as a protest when my first nomination of him for the Medal was rejected. I sincerely hope that he will very soon be awarded the Guy Medal in Gold from the Royal Statistical Society. I wish him longevity which will exceed Wilcox's and Jeffreys'.

REFLECTIONS

Nadarajah: In addition to your immense research contributions, I gather that you were an excellent teacher too. For instance, you served as a Distinguished Teaching Scholar at the University of Maryland in College Park from 1984 to 1985. Tell us about your philosophy for teaching.

Kotz: In China, Confucius is considered to be the "father" of the teaching profession. One of his teachings is that a student should be taught regardless of background, ability, race or any other considerations—a belief that I strongly embrace. Confucius also held that, once he had taught a person, that person continued to be his student for life. I am a follower of this admirable teaching philosophy: I try not to abandon my role as teacher and continue to hold myself responsible for the ongoing education of my former students. I am flattered that many still contact me for help with their research and other matters.

Although I have had relatively few M.S. and Ph.D. students, all were very close to me. I still receive New Year's and Christmas cards from New Delhi, Harbin, Beijing, Taipei, England and, of course, Canada and the United States. I am touched by letters that I get from my undergraduate and graduate students, who liked my teaching, and I value very much unsolicited congratulatory letters from my distinguished colleagues throughout the world.

Nadarajah: You have now retired, but you still seem as active as ever. What keeps you going?

Kotz: I think it is the routine exercised for over forty years and the tremendous technological and scientific advances that we are witnessing at present. To keep up with the literature is by itself a full-time job. I am as busy as I was twenty years ago and still have not found the time to organize my files or even update my list of publications since 1995.

Nadarajah: In retrospect, what do you think are the most fulfilling points of your career?

Kotz: It is really hard to say! My contributions to statistical distributions, however modest they may be, are a source of great satisfaction. My uncle, a leading Talmudic scholar in Jerusalem, has written a fas-

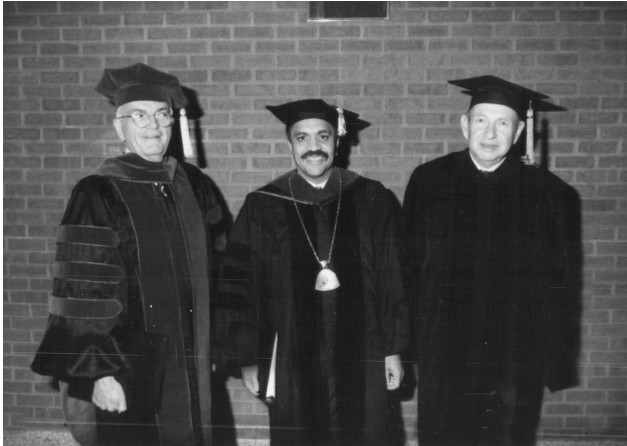FIG. 9. *With one of his ex-students, Professor J. S. Huang, in 1997.*

FIG. 10. *With Professor H. Papageorgiou at the degree ceremony at the University of Athens, Greece, 1995.*

FIG. 11. *With President S. Ribeau at the degree ceremony at Bowling Green State University, 1997.*

cinating book on the letters of the Hebrew alphabet. For him each letter was a living creature with its own melody and destiny. This is the way I feel about distributions: majestic Gaussian, barren Cauchy, chameleon-like Beta, forgetful but often reliable exponential, pricky Laplace, impartial uniform, and shocking bivariate Marshall–Olkin are all living entities!

The work on the Encyclopedia allowed me to attain at least a bird's-eye overview of the richness of the statistical sciences with their mountain peaks, valleys, seas, streams and gorges.

Nadarajah: What people or events made the biggest impact on you personally or professionally?

Kotz: I have already mentioned several names of people who touched my professional life. In addition, a number of great personalities have had a substantial impact on my professional thinking.

I was inspired by Francis Galton, whose immortal words I repeat almost weekly like a prayer:

> I find (statistics) full of beauty and interest. Whenever . . . not brutalized . . . their power of dealing with complicated phenomena is extraordinary.

K. Pearson, R. A. Fisher, M. G. Kendall and E. J. Gumbel influenced me and I tried to follow in their giant footsteps. The late Director of the ISI, Dr. Zoltan Kenessey, served as a model for me. J. Neyman, being a close friend of Norman Johnson and his wife, was very sympathetic towards our efforts in connection with the ESS. His demise in August of 1981 was a tremendous loss to our project and to the statistical community as a whole. Of those who are with us, D. V. Lindley, E. L. Lehmann, D. R. Cox, C. R. Rao,

P. Hall, G. Letac and J. Gani have had a direct or indirect influence on me and I have been privileged to correspond with them over the years (quite intensively with Lindley).

My colleague and office neighbor, Nozer Singpurwalla, has been a great inspiration for me during the past three years. We try not to disturb each other on Sundays!

Kerstin Vännman from far away Northern Sweden served as an example for me of balancing personal and professional life, which I have not always followed.

I do not blame you, Saralees, for unintentionally pulling me in the direction of total professional immersion and dedication—some of my Chinese students and colleagues are having the same effect.

I know that I have also unintentionally missed a few important people who affected me professionally in the last forty years.

FIG. 12.   *With his wife*, Rosalie, *in Philadelphia*, *1976.*

Chief among those who have touched my life personally is, of course, my best devoted friend and very kind and loving wife, Rosalie.

Nadarajah: At what point did you meet her?

Kotz: In Toronto. We were married in Toronto in August of 1963 and spent our honeymoon at the ISI conference in Ottawa and the conference on Distributions in Statistics in Montreal, organized by G. P. Patil. During the first twenty-five years of our marriage, Rosalie was immersed in helping me with my research and being also a very devoted mother. In 1965 she was pregnant with our first daughter. But even while waiting at the doctor's office, she used to proofread the galleys of my books and papers—the receptionist already knew to provide her with a portable desk! Without Rosalie's assistance and support neither *Distributions in Statistics* nor the ESS would have seen the light of day.

We both are fortunate to have three very capable, successful (personally and professionally), married children and by now five grandchildren.

Nadarajah: What is your assessment of the current state of health of the field of statistics?

Kotz: It would be presumptuous for me to make such an assessment. The changes in the spirit and the content of the field of statistics are by far too rapid and oscillatory to predict.

I am a product of the late 1950s and the 1960s. Brad Efron once told me that he is a product of the 1970s and already has a different perspective on statistics. We both probably have a different view than statisticians who were trained in the 1980s and more so in comparison to those who were educated in the 1990s. But we all strongly believe in the growing importance and impact of statistical sciences in our information age.

Nadarajah: Thank you, Sam, for taking time to participate in this conversation. I think it is an understatement to say that you have made immense contributions to the world of statistics over the past forty years. We are sure that we will see still more useful contributions from you.

Kotz: Thank you, Saralees. I do appreciate your interest and initiative.

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