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**King-Sun Fu**  
**(1930-1985)**

# King-Sun Fu (1930–1985): A Biography

**P**ROFESSOR KING-SUN FU, an eminent scholar and a pioneer in the field of pattern recognition and machine intelligence, passed away on April 29, 1985, in Washington, DC, while attending a banquet given by the National Academy of Engineering to honor the directors of the six engineering research centers newly established by the National Science Foundation. At the time of his death, Professor Fu was the Goss Distinguished Professor of Engineering and the Founding Director of the Engineering Research Center on Intelligent Manufacturing Systems at Purdue University, West Lafayette, Indiana. His sudden death is an irreparable loss to the scientific community and to all of us who have known him as a great friend, extraordinary teacher, and an inspiring colleague.

King-Sun was born on October 2, 1930, in the city of Nanking, one of China's historical capitals. His father, Tzao-Jen Fu, was a general in the Chinese Army. King-Sun had one elder brother, Tse-Sun, and two younger brothers, Run-Sun and Yuen-Sun. He pursued his middle school education at the Chinese Air Force Youth Preparatory School. After his father died on duty during the war in 1949, his mother, Tzao-Wen Hsiang Fu, took him and two younger brothers to Taiwan. In the Fall of 1949, King-Sun succeeded in overcoming the hardships imposed by the dramatic move and matriculated in the National Taiwan University where he began to set the pace of an academic life in which he was to excel over the next 36 years. At the time of King-Sun's enrollment, the University's Electrical Engineering Department offered two paths for students to follow: electric power engineering and communication engineering. King-Sun chose the power engineering option. He and Mo-Shing Chen (IEEE Fellow, 1978) did their joint B.S. thesis on electrical machinery. In retrospect against his later achievements, it is hardly surprising that King-Sun was one of the top students in the college. Not only did he excel in mathematics and engineering subjects, but he also cultivated interests in classical music and literature. Perhaps the latter pursuit laid the foundation for his own prolific writing in serial journals and scientific books. His writing was distinct: clearly expressive and succinct. The demands of academia did not serve to stifle his personal exuberance and vitality in life, however, and, in finding a balance to his studies, King-Sun was also active on the basketball and volleyball teams in the school. He was indeed a versatile student on the campus.

After graduating from the National Taiwan University with a B.S.E.E. degree in 1953 and completing one year of ROTC training, King-Sun received a graduate assistantship from the Electrical Engineering Department of the University of Toronto, Canada, and went there in September 1954 to start his graduate study. He wrote his master's degree thesis on dynamic analysis of large electric machines and received the M.A.Sc. degree in the summer of 1955. In September 1955, he transferred to the Uni-

versity of Illinois, Urbana, for his doctoral study and completed his Ph.D. dissertation on "An Approximation Method for Both Magnitude and Phase by Rational Functions" in February 1959 under Professor M.E. Van Valkenburg, who is currently the Dean of Engineering at the University of Illinois, Urbana-Champaign.

During his three and a half-year's stay at the University of Illinois, King-Sun became immensely interested in statistical methods, information theory, abstract algebra, and modern analysis. Attracted by the noted mathematical treatise written by N. Bourbaki (the pseudonym of a group of renowned French mathematicians), he confided to his close friends that he intended to gather together a group of scholars and follow the example of Bourbaki in writing similar treatises in electrical engineering subjects in future years. This desire to produce important scientific tracts became manifest through King-Sun's authorship of five books and his editorship or co-editorship of eighteen others during his lifetime. On the Urbana campus, King-Sun fell in love with Miss Viola Ou, then a graduate student in library science. They were married in Urbana, Illinois, on April 7, 1958.

After receiving the Ph.D. degree from the University of Illinois in 1959, King-Sun worked for a year and a half as a Research Engineer at Boeing Airplane Company, Seattle, Washington, from February 1959 to August 1960. During the Spring Semester of 1960, he also taught as a Special Lecturer at Seattle University, Seattle, Washington. In September 1960, he accepted a faculty position at Purdue University, West Lafayette, Indiana, as an Assistant Professor in the School of Electrical Engineering. The following semester, he was selected by Purdue to be a Visiting Scientist with the Research Laboratory of Electronics at Massachusetts Institute of Technology, Cambridge, from February to June, 1961. During the Summer of 1961, he was with the IBM Thomas J. Watson Research Center, Yorktown Heights, New York. After he returned to Purdue University in September 1961, he began to pursue his research in pattern recognition and machine intelligence—a field which he played a prominent role in developing during the next quarter of a century. He became an Associate Professor in September 1963, and was promoted to the rank of Professor of Electrical Engineering in September 1966. In 1967, he was a Visiting Professor of Electrical Engineering and Computer Science at the University of California, Berkeley. He was the Assistant Head for research at the School of Electrical Engineering at Purdue from 1969 to 1972. In 1972, he was awarded a prestigious Guggenheim Fellowship, and was a Visiting Professor of Electrical Engineering both at Stanford University, Stanford, California and the University of California, Berkeley. After returning to Purdue, he established the Advanced Automation Research Laboratory in the School. He was named the Goss Distinguished Professor of Engineering at Purdue University in 1975. During the Fall of 1984, he, along with other colleagues

at Purdue, initiated the highly innovative program of research in intelligent manufacturing. This program resulted in the start-up of the National Science Foundation Engineering Research Center for Intelligent Manufacturing Systems during early 1985. King-Sun was the founding director of the Center.

During the earlier years he first focused his study on statistical pattern recognition and learning systems. From 1961 to 1970, he and his students developed sequential methods for feature selection and pattern recognition, nonparametric procedure for pattern classification, stochastic approximation approach to learning control systems, and stochastic and learning automata. His first research monograph entitled *Sequential Methods in Pattern Recognition and Machine Learning* (New York: Academic) was published in 1970. By the late 1960's, he began his unique research on syntactic pattern recognition, which was introduced by the earlier efforts of Murray Eden, R. Narasimhan, R. A. Kirsch, Robert S. Ledley and Alan Shaw. King-Sun initiated and launched in-depth studies on stochastic context-free programmed languages and stochastic syntax analysis for pattern recognition and image analysis.

His book *Syntactic Methods in Pattern Recognition* (New York: Academic) was published in 1974. In the ensuing years, he and his students made the greatest and foremost impact on syntactic pattern recognition research. His school developed fundamental methodologies of stochastic error-correcting syntax analysis, error-correcting parsers for formal languages, and, in particular, for attributed and stochastic tree grammars, and error-correcting isomorphisms of attributed relational graphs for pattern recognition. The syntactic methods for texture analysis, shape recognition, and image modeling were introduced in the late 1970's, and the three-dimensional plex grammar in 1984. Attributed grammars were developed from the viewpoint of combining syntactic and statistical pattern recognition. In the meantime, the contextual information was also introduced into statistical pattern recognition. The unification of both syntactic and statistical approaches was always in his thoughts. Inference procedures of context-free programmed grammars, multidimensional grammars, transition network grammars, and stochastic tree grammars were developed one after another in the late 1970's and early 1980's. It is probably appropriate to say that all these constitute what we may call *Fu's theory of syntactic pattern recognition*. His treatise "Syntactic Pattern Recognition and Applications," published in 1982, made this subject material more easily understandable to contemporary researchers in various disciplines.

King-Sun and his colleagues also made important contributions to pattern recognition applications. His work on pattern classification of remotely sensed agriculture data (1969) and earth resources (1976) is considered classic in the field. During the mid 1970's through early 1980's, his biomedical pattern recognition research extended to chest radiographic image analysis, automatic recognition of irradiated chromosomes, nucleated blood cell classification, Pap smear and cervical cell image analysis and classification. The Moayer-Fu paper on fingerprint pattern

recognition based on the syntactic approach received the 1977 Outstanding Paper Award of the IEEE Computer Society. His work on seismic signal discrimination and bright spots detection appeared from 1982 to 1985. His research on industrial automatic inspection and computer vision included IC chip inspection (1980), metal surface inspection (1984), and inspection of industrial assemblies (1984). An expert system was developed by his group for the assessment of structure damage caused by earthquake (1983).

Since the late 1970's, he envisioned the importance of integrated and special computer architectures and parallel algorithms for pattern recognition, image processing, and database management. This led to his works in the 1980's on parallel parsing of tree languages, query languages for image database systems, and VLSI implementation of parallel parsing algorithms and hierarchical scene matching. In the meantime, his research on three-dimensional object representation and shape description, orientation estimation, overlapping workpiece identification, knowledge organization, and robotic vision for path planning laid the foundation for the establishment of the Engineering Research Center on Intelligent Manufacturing Systems by Purdue University and the National Science Foundation in 1985. As mentioned earlier, King-Sun was the chief architect and the first director of the research center.

He wrote 5 books, edited or co-edited 18 books, authored or coauthored 43 book chapters, and 156 serial journal papers. These are listed in the Bibliography at the end of this Biography. In addition, he authored and coauthored 248 conference papers. Seventy-two Ph.D. dissertations were completed under his supervision; these are also listed at the end of this Biography. Naturally, his research works were supported by a number of funding agencies including the National Science Foundation, Air Force Office of Scientific Research, Office of Naval Research, the Defense Advanced Research Projects Agency, Department of Agriculture, etc. Particularly worth mentioning is that he had received National Science Foundation research grants continuously without any interruption since his first grant in 1961. We know that he was deeply appreciative of this special honor and privilege.

Of course, King-Sun was literally showered with honors in recognition of his monumental research contributions and contributions to the profession. He was elected a Fellow of the Institute of Electrical and Electronics Engineers (IEEE) in 1971. He was elected a member of the National Academy of Engineering in 1976, and a member of the Academia Sinica in 1978. He served on the National Science Foundation's Advanced Automation Panel in 1973, Automation Research Council for 1972-1978, and Committee on Cytology Automation of the National Institutes of Health, 1978-1981. He was a Member of the Engineering Committee of the Council for the International Exchange of Scholars from 1976 to 1979, and served as its Chairman from 1977 to 1979. Among many awards which he received are the Herbert N. McCoy Award in 1976 for Contributions to Science; American Society of Engineering Education (ASEE) Senior Re-

search Award in 1981 for outstanding loyalty and contributions as a pioneer in the contemporary engineering disciplines of pattern recognition, image processing, and machine intelligence; IEEE Education Medal in 1982 for contributions to engineering education through inspired teaching and research in computer engineering, system theory, and pattern recognition; American Federation of Information Processing Societies (AFIPS) Harry Goode Memorial Award in 1982 in recognition of his contributions in pattern recognition and its applications, and his leadership in education in information processing; Chinese Institute of Engineers-USA (CIE-USA) Achievement Award in 1983 for leadership in engineering education and contribution to pattern recognition; and the IEEE Centennial Medal in 1984.

His activities in professional societies started in 1965–1967 as the Chairman of the IEEE Discrete Systems Committee and the Chairman of the Fifth Symposium on Discrete Adaptive Processes. Under his leadership, he organized and served as the first Chairman (1967–1969) of the IEEE Automatic Control Group's Learning and Adaptive Systems and Pattern Recognition Technical Committee. He was on the official American delegation to the International Conference on Artificial Intelligence, Moscow, USSR, in 1967, and an official American delegate to the 1969 International Federation of Automatic Control (IFAC) International Congress held in Warsaw, Poland. He served on the administrative committee of the IEEE Automatic Control Group (1969–1971) and later of the IEEE Control Systems Society (1974–1976), was the Chairman of the 1969 IEEE International Convention, a Director (for IEEE) of the American Automatic Control Council in 1972, and the General Chairman of the 1977 IEEE Conference on Decision and Control. He took part in the IEEE Systems, Man, and Cybernetics Society activities, beginning in 1969 when he served as the Chairman of the Adaptive Systems Technical Committee of its predecessor, the IEEE Systems Science and Cybernetics Group, and was on the administrative committee of the Group (1970–1972). He became the Cybernetics Technical Committee Chairman (1972–1976) and then the Society's Vice President for Technical Committees (1978–1979). He was an Associate Editor of the IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS since 1969.

In order to provide an international forum to promote advances in pattern recognition, he and the contemporary leaders in the field organized the First International Conference on Pattern Recognition in Washington, DC, in 1973, for which he served as Chairman. The biannual conferences evolved into the formation of the International Association for Pattern Recognition by 1976; he was elected to be its President from 1976–1978, a Member of its Executive Committee (1976–1980), Chairman of its Long Range Planning Committee (1979–1981), and a Member of its Governing Board (1976–1985). In the meantime, he reorganized the Pattern Recognition Committee into the Machine Intelligence and Pattern Analysis Technical Committee (later renamed as the Pattern Analysis and Machine Intelligence Technical Committee) of

the IEEE Computer Society and was its first Chairman (1974–1977). He was an Associate Editor of IEEE TRANSACTIONS ON COMPUTERS during 1977–1978. His initiative led to the founding of the IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE and he served as its first Editor-in-Chief (1978–1981) as well as a Member of the Editorial Committee (1981–1985). He also served as an Associate Editor of the IEEE TRANSACTIONS ON GEOSCIENCE AND REMOTE SENSING (1984–1985). He was on the IEEE Computer Society Governing Board (1978–1981), and served as the Society's Vice President for Publications and as a Member of the Executive Committee (1982–1983) and Fellow Committee (1972–1976, 1984–1985). He served as the President of the Chinese Language Computer Society (1983–1985). He was the Vice President (1984–1985) and President-elect of the newly formed IEEE Robotics and Automation Council. He was on the IEEE Fellow Committee (1977–1979), IEEE TAB Awards and Recognition Committee (1977–1978), AFIPS Harry Goode Memorial Award Committee Chairman (1982–1985), ASEE Award Committee (1983–1985), and IEEE Award Board, Education Medal Committee (1983–1985).

He chaired and co-chaired the Engineering Foundation Conference on Pattern Information Processing in 1972, on Algorithms for Image Processing in 1976, and on Algorithms for Image and Scene Analysis in 1978. He was Program Chairman of the 1975 IEEE-ACM Conference on Computer Graphics, Pattern Recognition, and Data Structure of the 1978 IEEE Computer Society Conference on Pattern Recognition and Image Processing, and of the 1979 IEEE Computer Society COMPSAC Conference. He chaired the 1980 IEEE Picture Data Description and Management Workshop, initiated and chaired the IEEE Computer Society Workshop on Computer Architecture for Pattern Analysis and Image Database Management in 1981 and 1983. He was the General Chairman of the 1984 IEEE Workshop on Language for Automation, Honorary Chairman of the 1984 IEEE Workshop on Visual Languages, Hiroshima, Japan, and General Chairman of the 1985 IEEE International Conference on Robotics and Automation. His leadership was well recognized for organizing many international joint seminars and workshops. He served as the coordinator of the National Science Foundation supported United States-Japan Seminar on Learning Processes in Control Systems, Nagoya, Japan, in 1970 and the Second United States-Japan Seminar on Learning Control and Intelligent Control, Gainesville, Florida, in 1973; as the Vice-Coordinator of the United States-Japan Seminar on Fuzzy Sets and Their Applications, Berkeley, California, in 1974; as a Co-Director of the NATO Advanced Study Institute on Pattern Recognition and Applications in 1975; as the Co-Chairman of the Dahlem Konferenzen on Biomedical Pattern Recognition and Image Processing, Berlin, West Germany, in 1979; and the coordinator of the National Science Foundation sponsored United States-France Seminar on the Applications of Pattern Recognition and Machine Intelligence to Automatic Testing at Alexandria, Virginia, in 1983. As a guest editor, he helped put together the Special

Issue on Feature Extractions and Selection in Pattern Recognition of IEEE TRANSACTIONS ON COMPUTERS, September 1971; the special issue on Syntactic Pattern Recognition of *Pattern Recognition*, Part One, November 1971, and Part Two, January 1972; Special Issue on Pattern Recognition of *IEEE Computer*, May 1976; and on Robotics and Automation of *IEEE Computer*, December 1982.

He served on Editorial Boards (Editor, Associate Editor, Advisory Board) of many scientific journals. These include *Pattern Recognition* (Associate Editor, 1971–1985), IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS (Associate Editor, 1969–1985), *International Journal on Information Sciences* (Associate Editor, 1970–1982; Editor, 1982–1985), *Journal of Cybernetics* of the American Society of Cybernetics (Editorial Board, 1970–1985), *International Journal on Computer and Information Sciences* (Advisory Editor, 1971–1985), IEEE TRANSACTIONS ON COMPUTERS (Associate Editor, 1977–1978), IEEE TRANSACTIONS ON PATTERN ANALYSIS AND MACHINE INTELLIGENCE (Editor-in-Chief, 1978–1981; Editorial Committee, 1981–1985), *Journal of Information Processing* (Editorial Advisory Committee, 1978–1981), *Journal of Analytical and Quantitative Cytology* (Editor, 1978–1985), *International Journal of Fuzzy Sets and Systems* (Advisory Editor, 1979–1985), *International Journal of Cybernetics and Systems* (Advisory Board, 1980–1985), *Computer Vision, Graphics and Image Processing* (Associate Editor, 1981–1985), *Pattern Recognition Letters* (Advisory Editor, 1982–1985), *IEEE Computer* (Editorial Board, 1983–1985), and *Journal of Parallel and Distributed Computing* (Editorial Board, 1984–1985). Over the last twelve years, he also served on series editorship of the following scientific publishers: Marcel-Dekker (Editor on Pattern Recognition and Artificial Intelligence Series, 1973–1976), Birkhauser-Verlag, Basel and Stuttgart (Co-Editor of interdisciplinary Systems Research Monograph Series, 1975–1981), and Springer-Verlag, Heidelberg (Co-Editor of Communication and Cybernetics Series, 1975–1985, Co-Editor of Electrophysics Series, 1978–1985, advisory board of Texts and Monographs in Computer Science, 1977–1985).

King-Sun helped the Republic of China with his scientific advice in various ways. Over the past fifteen years, he gave invited lectures there almost every year. He was the Program Chairman of the Academia Sinica International Computer Symposium, Taipei in 1978. He helped found the Institute of Information Science, Academia Sinica, and was instrumental in establishing the Microelectronics and Information Science and Technology Research Center at the National Chiao Tung University, Taiwan, in 1984. He nurtured a number of young scholars who have become the principal researchers and engineers for the vital development of computer engineering and information science in Taiwan. Likewise, he educated scholars from the People's Republic of China; he was honored as a Distinguished Visiting Professor of Beijing University, an Honorary Professor of Qinghua University, Beijing, and an Honorary Professor of Fudan University, Shanghai.

Because of an extraordinary sense of efficiency and organization in his professional life, King-Sun was proud to enjoy successes in both his career and his family life. He took great pride in his two sons, Francis and Thomas, and one daughter, June. When they were young, he always spent his leisure time playing ball or other sports with them. Together with Viola, he provided their children with the best education in the home and at school; Francis is now a computer systems engineer; Thomas, a doctoral student in oceanography; and June, a student in biochemistry. Reflecting the highest traditions of his Chinese heritage, King-Sun felt great piety for his parents. His mother was happy to share the joy of his early success until her passing away in Taiwan in 1958. He never forgot to pay special tribute to the memory of his father, who had been buried amidst the chaos of war in Chowsan, Chekiang, China in 1949. In 1979 when King-Sun was invited to give lectures to the Institute of Automation, Chinese Academy of Sciences, he made a special effort to locate his father's grave and have his father's remains reinterred in the Fu family's native city, the scenic Hangchow, Chekiang, after thirty years.

In spite of his overwhelming achievements, King-Sun was a modest man with great sensitivity, especially in dealing with junior colleagues. Considerate and generous to his friends and students, he exemplified the notion of greatness both professionally and in his personal relationship with others. Anyone could literally knock on his door and talk to him. It was not uncommon to see him advising a doctoral student at 10:00 p.m. in his office. He, of course, worked long hours—an eighty-hour week was the norm. As his colleagues at Purdue University have remarked, King-Sun inspired trust and confidence in many persons of all types of temperament. He had a deep appreciation of human nature and its complexities, the flexibility in reconciling and synthesizing different opinions, and the ability of extracting out essentials of a complex problem. His foresight in choosing research areas and forecasting their developments was nothing short of amazing. Standing alongside his outstanding contributions to the scientific world, King-Sun's great wisdom and human warmth will always be remembered as a constant inspiration to all of us.

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