The 24th International Workshop on Matrices and Statistics

25-28, May 2015 • Haikou • China

PREFACE

During February 2015 the International Organising Committee of IWMS-2015 was encouraged to consider the publication of a Pre-Workshop Proceedings. At that stage we had not made any final decisions regarding the publishingof a formal refereed proceedings as we had not been able to reach any commitments with a publisher or a journal. However, we wanted to give participants the opportunity to present either an extended abstract or a formal paper. With the pressure of time we were conscious that a formal refereeing process prior to the beginning of the Workshop was not going to be possible.

The International Organising Committee was very grateful for the offer of financial support from Professor Kai-Tai Fang to assist us in our quest. He also arranged with Associate Professor Yong-Dao Zhou to provide technical support to undertake such an exercise. As a consequence it was decided to proceed with the publication of a Pre-Workshop non-refereed Proceedings. Following the offer from the journal *Special Matrices* to publish a formal refereed Proceedings for the International Workshop, we decided to name this publication as the *IWMS-2015 Souvenir Booklet*.

Participants of the Workshop were invited to submit a paper or an extended abstract on their intended presentation. We did not make it mandatory to make a submission. The papers in this booklet have been reproduced exactly as received from the authors (other than to ensure that they conformed with a standard presentation as per a formal template).
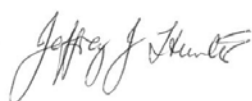
The presentations are presumed to be essentially that which will be given in the Workshop. Although the papers were scrutinised prior to publication for suitability, the papers have not been formally refereed and no claim is made by the Editors or the International Organising Committee as to the accuracy or originality of the contents of the papers.

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I would like to express my thanks to those participants who have taken this opportunity to present their work in this publication. The support of Associate Professor Yong-Dao Zhou who has single-handedly compiled the booklet from the submissions is gratefully appreciated. I would also like to thank Dr Simo Puntanen has worked with me in screening the submissions and also to Professor Kai-Tai Fang not only for pushing us to put together this publication but for his generous financial support without which this would not have been possible. I also appreciate the assistance of Professor Chuanzhong Chen in arranging for the design of a cover page for the booklet.

Jeffrey J Hunter
Editor,*IWMS-2015 Souvenir Booklet*

IWMS-2015 Souvenir Booklet

PREFACE

The first workshop in the "International Workshop on Matrices and Statistics" (IWMS) series took place at the University of Tampere in Tampere, Finland, 6 – 8 August 1990, and the IWMS has been held annually since. The IWMS has made great contributions to the promotion of the development of the Matrices and Statistics discipline. I am very excited that the 24th International workshop (2015) on Matrices and Statistics will be held at the Hainan Normal University School of Mathematics and Statistics. The workshop will have a catalytic role in promoting the development of Metrics and Statistics discipline in China, especially it will drive a rapid development of Hainan's related scientific fields. It also provides us an opportunity to make our contributions to the promotion of the development of the Matrices and Statistics discipline.

Since received the invitation to host the 2015 24th IWMS in October, 2013, we have been making every effort for more than one year and finally completed all of the preparatory work. I hereby express my gratitude to Professors Kai-Tai Fang, Jeffrey J. Hunter and Simo Puntanen who had done a great deal of preparatory work for the workshop. I would also like to thank members of the organizing team, in particular Ms. Wang Li, who had put their hard work for the various preparatory work. Hainan Province is a very beautiful area. It has plenty of sunlight, the sky-blue ocean and beautiful beach. School of Mathematics and Statistics, Hainan Normal University has a long history of 66 years. It is our honor to host IWMS-2015 here. We hope that the workshop will be of a great success; the participants will be enjoying the workshop and have a great time. The beautiful season in Hainan is between December and March. It is regretful that the workshop is not able to be held during the best season. The month of May is getting hot in Hainan.

Finally, I would like to say that, after experiencing several twists and turns, the IWMS-2015 Souvenir Booklet becomes quite a bonus for all of us. Professors Jeffrey J. Hunter, Kai-Tai Fang and Simo Puntanen were considering the publication of a Pre-Workshop Proceedings during February 2015. The Pre-Workshop non-refereed Proceedings will not preclude authors from submitting their papers to other journals for publication. Professor Jeffrey J. Hunter contacted De Gruyter Open Ltd. in March, 2015 which agreed to publish the Proceedings of the 24th International Workshop on Matrices and Statistics free of charge. However the Proceedings will not be formally published until after the workshop, possibly one or two year later. It was decided that the IWMS-2015 Souvenir Booklet was printed before the workshop according to the original plan.

Again, I would like to thank Professors Kai-Tai Fang, Jeffrey J. Hunter, Simo Puntanen and Yong-Dao Zhou for their efforts for the production of the Souvenir Booklet, especially Professor Kai-Tai Fang for his financial support.

Chuanzhong Chen

Chair, Local Organizing Committee

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3. The Journal *Special Matrices*

A Conversation with Kai-Tai Fang

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Abstract   Kai-Tai Fang was born in 1940 in Taizhou city, in Jiangsu Province in eastern China. He received his secondary education at the renowned Yangzhou High School in Jiangsu. In 1957, he entered Peking University to read mathematics and in 1963 he undertook graduate studies at the Institute of Mathematics, Academia Sinica, Beijing. After graduation from the Institute of Mathematics, Academia Sinica, in 1967, Kai-Tai Fang was appointed Assistant Researcher in the Institute of Mathematics, Academia Sinica, a position he held until 1978 when he was promoted to Assistant Professor. In the following year, he was transferred to the Institute of Applied Mathematics, Academia Sinica, shortly after which he was promoted to Associate Professor in October 1980. In 1984, Kai-Tai Fang was appointed Associate Director of the Institute and in July 1986, he became a Professor.

During 1990–2005, Kai-Tai Fang was working in various leading positions in the Hong Kong Baptist University (HKBU), at the Department of Mathematics and at the Statistics Research and Consultancy Centre. From 2006 onwards he has been the Director of the Institute of Statistics and Computational Intelligence, BNU-HKBU United International College, Zhuhai Campus of Beijing Normal University (BNU).

Sections 1–7 of this conversation appeared partly in Loie (2005) and that part was extended by Lucinda Li in 2014. The article of Loie (2005) was published in Fan & Li (2005), a monograph being dedicated to Professor Fang on his 65th birthday in June 2005. Most of the articles in that book were presented at the International Conference on Statistics in Honor of Professor Kai-Tai Fang's 65th Birthday, 20–24 June 2005, Hong Kong. The permit for reproduction of Loie (2005) by the World Scientific Publishing Company is gratefully acknowledged. Section 8 is based on communication between Kai-Tai Fang, Lucinda Li, Simo Puntanen and George P. H. Styan which took place in autumn 2014 and spring 2015.

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PHOTOGRAPH 1: Professor Kai-Tai Fang in Toronto, August 2013.

1 Some Background

Professor Kai-Tai Fang has received several awards for his statistical works, which have had a profound effect on developments in a wide range of fields. In 1982 he was awarded the special prize of the Ministry of Light Industry for the standardization of adult Chinese dress. In 1984, his unified approach to the distribution of restricted occupancy problems won him the second-class prize for Science & Technology of Academia Sinica. Kai-Tai Fang's precision test methodology and determination gained him second-class prize for National Standardization in 1988. His solutions to the distribution of some random military coverage problems also won him another Science & Technology prize from the Academia Sinica the following year.

In 1992, Kai-Tai Fang received a first-class award for Most Excellent Textbook from the State Statistical Bureau of the PRC for his authorship of *Statistical Distributions* (Fang & Xu, 1987). In the same year, his book *Generalized Multivariate Analysis* (Fang & Zhang, 1990) won him a special nationwide award for Most Excellent Book in China by the Government Information and Publication Administration, Beijing. In 1998, the number of citations of Kai-Tai's works reached the ninth highest in the country, according to the Chinese Science Citation Database.

In Hong Kong, Kai-Tai Fang was presented with the President's Award for Outstanding Performance in Scholarly Work by Hong Kong Baptist University in 2001. He was made an honorary member of the Hong Kong Statistical Society in 2002. Two years later in 2004, he was named the Outstanding Author by the Science Press in Beijing. In 2008, together with Professor Yuan Wang, Kai-Tai Fang was presented the highly honorable State Natural Science Award at the Second Level, the highest level award given in that year.

Later in 2012, he was awarded Guangdong Excellent Teacher and Zhuhai Advanced Teacher by the Guangdong Government and Zhuhai Government, respectively, for his teaching excellence. That was further enhanced by the National Statistical Research Award at the First Level conferred to him for his book *Design and Modeling of Experiments*, co-written with Min-Qian Liu and Yong-Dao Zhou in 2013; see Fang, Liu & Zhou (2011). The most recent honor was the 2014 ICSA Distinguished Achievement Award given by the International Chinese Statistical Association (ICSA), for his outstanding achievements in statistical research and teaching, and his contribution to the successful founding of the association.

Kai-Tai Fang has authored and co-authored 22 textbooks and monographs, published more than 250 research papers, 9 papers in mathematical/statistical culture and 45 statistics popularization papers. He has served on numerous editorial boards, including *Acta Mathematicae Applicatae Sinica*, *Statistics & Probability Letters*, *Statistica Sinica*, *Journal of Multivariate Analysis* and *International Statistical Review*. He was the Editor-in-Chief of the book series "Modern Applied Mathematics Methods" in China from 1990 to 2003 and has been the Editor-in-Chief for the book series "Statistics Textbook Series for Higher Education" since 2010.

Kai-Tai Fang has been instrumental in organizing several influential conferences and workshops, both internationally and nationally. He has supervised the research of many graduate students and provided useful advice, encouragement and collaboration for students and their peers around the world. In honor of his scholarly contributions, Kai-Tai Fang has been elected a Fellow of the Institute of Mathematical Statistics in 1992 and a Fellow of the American Statistical Association in 2001. The latter honored him "for (his) outstanding contributions to multivariate analysis, quasi-Monte Carlo methods and design

of experiments; for (his) leadership in statistical education, consultation and administration; and for editorial service". He has also been elected a Member of the International Statistical Institute in 1985.

2 Early Life, Interest in Mathematics: 1951–57

Loie: *When did you start to develop an interest in mathematics and statistics? Did it have anything to do with your family background?*

Fang: Not really. Shortly after I was born, World War II broke out and it was an era of complete chaos. My parents took the seven of us to find refuge in rural villages. After the war, things were still chaotic and a formal education system was not in place. The teachers were not serious about teaching and that gave us a perfect excuse to follow suit with regard to learning. I remember that because of a shortage of space and manpower, two classes of different levels shared the same classroom and the same teachers. That meant that the teacher could only devote half his time to teaching us and the other half to teaching the higher level. We lacked interest and the desire to study hard. We aimed only at a mere pass. It was not until headmaster Konghou Wang stepped into our classroom that I took a positive twist in my learning attitude. It was also then that I began to develop an interest in mathematics.

Loie: *In what way did he inspire you?*

Fang: Every day Mr. Wang would give an extra 30-minutes' tuition for our grade six class and he would come up with a list of questions for us to work on. Those who finished first and got all the answers right would be allowed to leave the classroom to play. The questions he set were far from routine and were in fact pretty interesting. There was one that I remember in particular. The question was a farmer who was selling a basket of eggs. He approached the first family who bought half the basket of eggs plus half an egg. The second family bought half of the remaining total plus half an egg. The third bought the remaining half of the total plus half an egg, then the whole basket of eggs was sold out. How many eggs were there in the basket? It did not take me long to come up with the answer: seven. I was the first to hand in the answer and was instantly allowed to go out and play. Even my elder sister, who was in the same class and ranked first in class, could not get the answer right.

That was the first time in my life that I discovered my strength and competitiveness; it was also the first time I realised I had an edge over my classmates. After that, I was almost always the first to leave the classroom. This self-discovery, coupled with Mr. Wang's recognition, worked miracles in building up my confidence and had a far-reaching impact on my self-esteem.

Loie: *Would you regard Mr. Wang your first mentor?*

Fang: Indeed he was. He was instrumental in stimulating my interest in mathematics, an area that I undertook as my lifelong career.

Loie: *What happened after that?*

Fang: In 1951, I was admitted to Yangzhou High School in Jiangsu Province, one of the most reputable, well-established secondary schools in the whole nation. The school adopted a serious and professional manner and they (the school board) even employed university professors to teach us. The deputy headmaster, for example, was a famous

PHOTOGRAPH 2: Kai-Tai Fang as three years old.

PHOTOGRAPH 3: Kai-Tai Fang (2nd row from top, 5th from left) and other senior high graduates of Yangzhou High School in 1957.

English Professor. The quality of the teachers was exceptional and they attached great emphasis to independent thinking. The school had produced many famous graduates such as Zemin Jiang, Jiaomu Hu who was Mao Zedong's secretary; and more than 10 members of the Chinese Academy of Sciences.

Loie: *Was your interest in mathematics further enhanced here?*

Fang: Yes. I met my second teacher who deepened my passion for mathematics. He was Guangzhao Fang. He adopted an enlightened approach by first asking questions before giving a lecture. This was to inspire us to think. I was always among the first two to answer the questions. His lectures were stimulating and I was captivated by what he had to say. When I was invited by the school to give a talk on how to learn mathematics in the late 1980s, I was so pleased to meet Mr. Fang again and I highlighted his teaching approach in my talk.

Loie: *I heard that Yangzhou High School was renowned for its whole-person education and its emphasis on encouraging students to develop a wide variety of interest as well as nurturing their psychological quality. How did your secondary education benefit your development as a whole?*

Fang: When I entered senior high, I read many books on self-development to boost my psychological quality and I set a number of targets for myself. For example, to increase my perseverance level, I planned a series of target studies for every weekend, a practice that I maintained even when I entered university. Another example is that our school then had a scheme to encourage students to exercise. Those who succeeded in running a certain number of kilometers would be awarded a souvenir. I challenged myself to run every day, even in the severe cold winter climate. All these self-training exercises helped equip me with the determination to overcome future problems, both academic and otherwise; they also gave me the will to succeed. I never give up easily, regardless of the scale of any problem. In addition, our teachers also wanted us to help the poor people.

In the 1950s, I was deeply distressed to see so many people, particularly women, living a hard life because of their low education. In those days, most women were still illiterate. They could not read, write, or take a job. All they could do was to bear children for their husbands and depend on the male members of their families for their whole lives, financially, socially, and emotionally. Many did not even have a name and were only identified by the surnames of their own clan and their husbands'. Hoping to help them make a change, I decided despite my young age to take part in the voluntary service of combating illiteracy among poor people in the rural areas. Being able to write their own names was already something made them proud of and in themselves.

Seeing that people were battered hard by the tough lives, our school was calling for efforts to raise the spirit of the community. I took the initiative to organize the street carnival during the Spring Festivals. I mobilized students and also other supporters in the community to decorate the places, put up stalls, and stage street shows to lighten up the community as well as to broaden the minds and experience of the young.

3 University Studies, Peking University and Academia Sinica: 1957–67

Loie: *Can you tell me something about your university studies?*

Fang: Professors at Peking University had high expectations about their students. Peking University, famous as it was, wanted to do just as well as Moscow University, which then ranked first in a number of areas. Their education strategy was to let the best professors teach first-year students so that the latter would have a solid foundation for their studies. This, I think, was a wise strategy because despite my 10-year stoppage in my studies due to the Cultural Revolution, I still had a firm grasp of mathematical techniques. Because of the keen competition between Peking and Moscow Universities and also among students, all of us were under tremendous pressure. Many of my classmates were filled with a sense of negativism even though they performed exceptionally well in their secondary school days.

Loie: *How did you surpass all the difficulties and keen competition you faced in learning advanced mathematics?*

Fang: While at Peking University, I came across a book *How to Solve It: A New Aspect of Mathematical Method*, authored by George Pólya (1957), who was then a professor at the Swiss Federal Institute (where Albert Einstein graduated), and later at Stanford University. This book embodies a wealth of wisdom on thinking skills. In a nutshell, the book establishes a close-knit link between the specific and general, and advises readers to be general in order to be specific and vice-versa. It also warns readers that it is better not to have a book at all than to believe all that is written in the book. Professor Pólya's book also challenges readers to do something positive to exceed the teachings of books they read. I was deeply moved by Pólya's teachings and I put them into practice. I set high expectations of myself and required myself to look for solutions rather than seeking help from my teachers and classmates. Pólya's book has had a life-long impact on me and I have applied his teachings to my academic studies and research ever since. It never occurred to me that I would have a chance to thank Professor Pólya in person. That chance came when I visited Stanford University in 1982. Professor Kai Lai Chung took me to see him and I told him that to me, he was first and foremost a great educationalist and I trusted that his readers would agree with what I said.
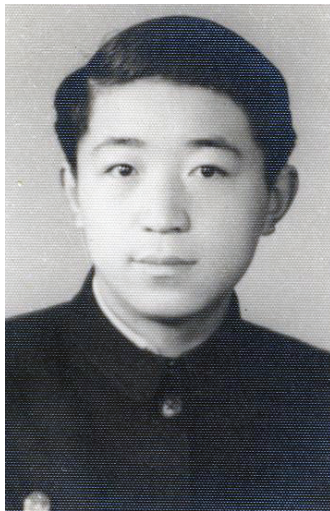
PHOTOGRAPH 4: Kai-Tai Fang during his university days.

Loie: *I understand that you were a student of the renowned Pao-Lu Hsu[1] and became greatly influenced by his supervision.*

Fang: Yes, the next person that impacted me was my supervisor, Professor Pao-Lu Hsu, a UK-educated scholar who laid a solid foundation for multivariate statistical analysis and who had four papers acknowledging his contributions published in the same issue of the prestigious international journal *The Annals of Statistics* in 1980. This was an exceptional treatment by the journal in recognition of his outstanding contributions. Hsu was severely ill in 1962 and was instructed to take full rest by his doctor. Despite his illness, he continued to work full time and take up both research and supervision duties. He required us to study a 50-page book written by a Russian mathematician, a Stalin Award winner, and asked us to try to improve his results and make a report in class. After our presentation, Hsu told students that if they followed the Russian approach, they could only come up with a single dimension. He then showed us how to solve the problem using different approaches and came up with a more powerful answer that catered not only to one-dimensional statistics but also to high-dimensional statistics. This was an eye-opening experience for me.

Hsu's insistence in fulfilling his teaching obligations, despite his weak physical condition, and his dedication to research exerted great influence on my future academic career. In fact, my first paper "The Limiting distribution of linear permutation statistics and its applications" was completed under his supervision. Hsu said to me that there was a gap in a paper originally published in *The Annals of Statistics* and should I be able to identify and fill in that gap, I would be qualified to graduate. Very soon, I was able to identify the gap and fill it in and even discovered that the paper could well be extended. I put in many new angles which produced some interesting results. After two weeks, I handed in my paper and, after reading it, Hsu told me that I could now graduate. He even recommended that *Acta Peking University* should publish my paper, which it willingly accepted. It was however most unfortunate that before my paper was published, a political movement took place and all publications and newsletters came to a halt. Fortunately, the paper was published 19 years later in *Acta Mathematicae Applicatae Sinica*, see Fang (1981).

Loie: *That was an indelibly dark era for mainland residents. How did you survive this period?*

Fang: China then was really shrouded in an intense political climate and people became distant from one another, fearing that any outpouring of genuine feelings would be betrayed, especially if they were about government and policies. Because of this, my years at the university were unhappy—a sharp contrast from my high school days. My dislike for the chaotic political movement in Peking University prompted my decision to pursue further studies at the Institute of Mathematics, Academia Sinica (later changed to Chinese Academy of Sciences) and became the first postgraduate student of Professor Minyi Yue.

Loie: *What did you do in Academia Sinica?*

Fang: My first two years at the Institute of Mathematics were fruitful under a favorable academic ambience. In 1965 I was assigned to An Shan Steel and Iron Co and was forced to turn to application instead of just theory. The engineers there treated us nicely and

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[1]Pao-Lu Hsu (1910–1970) graduated from Tsinghua University in 1933, majoring in mathematics and then worked at Peking University as a teacher. In 1936–1940 he studied mathematical statistics at University College London, earning his Ph.D. in 1938 and Sc.D. in 1940, with Jerzy Neyman and Egon S. Pearson as advisors. In 1945, he went to the United States, visiting the University of California at Berkeley, Columbia University, and the University of North Carolina at Chapel Hill. In 1947, he returned back to Peking University. Further reference: Chen & Olkin (2012).

PHOTOGRAPH 5: George Pólya sent this photo to Kai-Tai Fang by person in 1982.
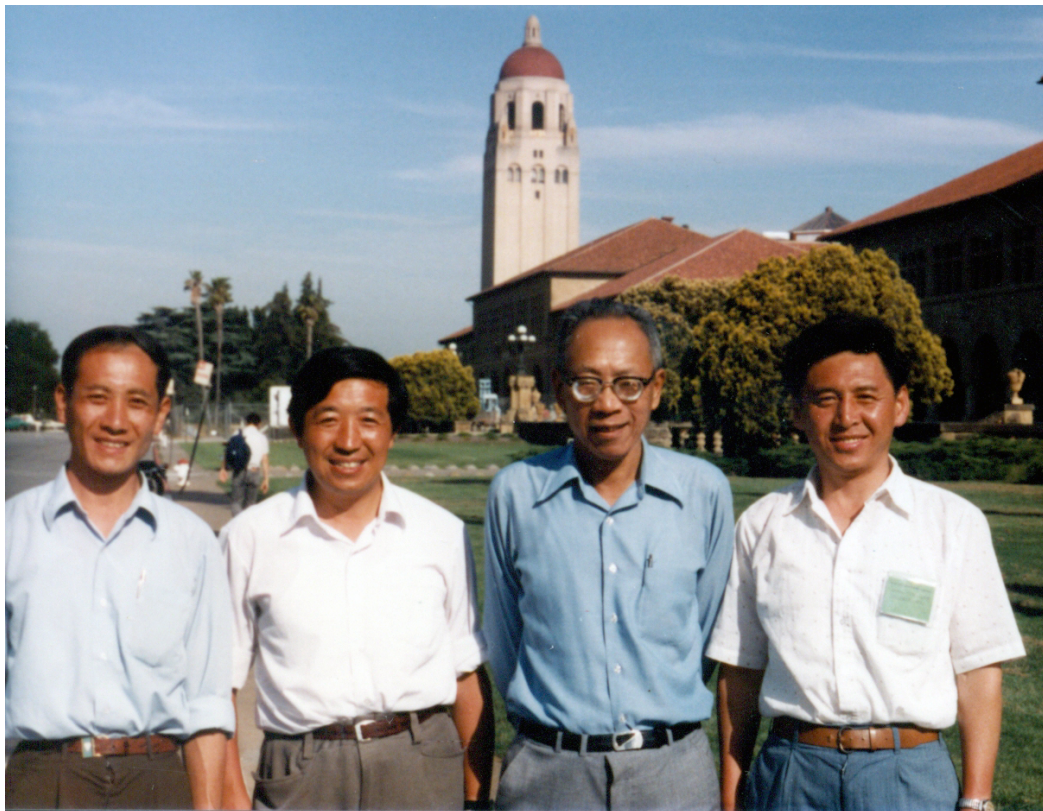
PHOTOGRAPH 6: Kai-Tai Fang and Kai Lai Chung (those in the middle), in Stanford University, 1981.

PHOTOGRAPH 7: Pao-Lu Hsu (front row, 2nd from left) with Kai-Tai Fang (back, 2nd from left) and his other graduate students at the Peking University, 1963.

PHOTOGRAPH 8: Celebration of Minyi Yue's 90th birthday and Yuan Wang's 80th birthday in 2010. Professor Wang (4th from left) and Professor Yue (5th from left) are in the middle.

had a high expectation of us. At that time, I used non-linear regression analysis to analyse the data collected. This period signaled a positive change for me in that I could apply my knowledge to meet the high expectations people bestowed on us. What I learned in Peking University focused merely on theory and did not touch on any applications, which was the weakness of the Russian education system. While I was at An Shan, I was asked to give lectures to the engineers. I covered eight topics in statistics, all of which were published for staff reference, an indication of the high regard in which they held me. My first two years at the Institute were fruitful under a favorable academic ambience. However, this favorable situation did not last long as the political movement took shape the following year.

Loie: *That was a prelude to a political storm, with the Cultural Revolution just round the corner?*

Fang: Indeed. The subsequent years were a complete waste of time. All of us were deprived of the right and opportunity to pursue our studies and research. In 1965 and 1966, I was sent to the villages as a laborer. The following two years came the Cultural Revolution and the political movement lasted until 1976. We were all under tremendous pressure and stress and were uncertain about tomorrow. What was important then was that we could survive today and we did not even dare to think about tomorrow.

As much as I hated this period, it did strengthen the psychological side of me, enabling me to face each and every bitter challenge with an unyielding manner. Like Professor Grace Yang of the University of Maryland once said me: "You have recovered your 10 lost years." She gave me a lot of encouragement on a number of issues.

4 Orthogonal Design, Uniform Design

Loie: *When did you learn the orthogonal design and start conducting experiments with this method?*

Fang: During the early 1970s, staff from Peking University and the Institute of Mathematics, Academia Sinica, attempted to promote and apply orthogonal design to the industrial sector. In 1972, I had the opportunity to go to the Tsingtao Beer Factory and other factories. I supervised the engineers there to apply orthogonal design to industrial experiments. It was a precious experience for me to witness the substantial potential of applying orthogonal design to practical industrial use. However, I also detected the considerable difficulties faced by the engineers in understanding statistical methods, especially in calculating the ANOVA Table without the help of computers or calculators. I came to realize the need for statisticians to simplify the complicated statistical theories and methods, and later created "Visualization Analysis" for analytical use on experiment data. Very soon this method was commonly used on the mainland, triggering a great sense of encouragement and inspiration on my part.

Loie: *There were quite a number of contributions that you made to the orthogonal design. What were they?*

Fang: During my process of promoting the common use of orthogonal design, I encountered quite a number of complicated multi-factor and non-linear issues. The engineers were unable to identify a satisfactory parameter value combination for a long time. An example was a porcelain insulator factory in Nanjing.

The factory had a team of staff assigned to conduct experiments continually to identify a satisfactory parameter value combination. Although they had achieved much in their

PHOTOGRAPH 9: Kai-Tai Fang (front, 2nd from right), other postgraduate students and new staff of Academia Sinica were sent to work in rural villages during the Cultural Revolution.

PHOTOGRAPH 10: Kai-Tai Fang, S. R. Wang, Grace Yang and Lucien LeCam with his wife, in the Summer Palace, Beijing, 1987.

experiments, they still failed to get one of the responses to meet the requirement, thus failing to deliver the glass insulator products. (At that time, the factory received a large number of orders for glass insulators but was unable to deliver the products.) In view of the complexity of the issue, I adhered to the principle of "big net catching big fish". I

conducted 25 experiments and arranged six 5-level factors by an orthogonal design.

From a statistical point of view, the experiment model was non-estimable and was therefore incorrect. However, in those 25 experiments, one had all the responses fulfilling the requirements. That was great news to the factory in-charge. Should one liken the outcome to winning the US lottery or was it significant? In fact, using orthogonal design to conduct 25 experiments actually represented 15,625 experiments, thus greatly increasing the likelihood of attaining an ideal technical/manufacturing condition. In my opinion, the power of fractional factorial design was that the experimental points have a good representation. Since then, I have used the same strategy to solve many of the "lasting, major and difficult" problems of the factories. This success has also injected in me the necessary courage to initiate the Uniform Design theory and method.

Loie: *Can you tell me how you came up with uniform design, an approach so well known in the statistical field?*

Fang: Using the "big net" approach to get the best level-combination of the factors, I mustered the courage to create another new method—the uniform design approach. In 1970, I came across several occasions which called for the application of a more powerful statistical approach. For example, in 1975, a factory manufacturing steel for automobiles wanted to come up with a nationwide standard that needed the numerical calculation of many five-dimension integrals. At a time when computers were much less powerful, it was almost impossible to do so. Luogeng Hua and Yuan Wang came up with a method to solve high dimension integral problems. Professor Wang taught me how to use their method and I realized five years later that the method might be applicable to experimental design.

In 1978, there were three major missile-related projects covering land, sea and aerospace. A problem-solving approach was needed to tackle all the projects. Again, it was highly challenging. I had to come up with a new method, one that could approximate a complicated system by a simple method with required accuracy. The great challenge was a motivating force to me.

I collaborated with Yuan Wang and we worked out the uniform design. This method made possible the calculation of an accurate answer in .00001 seconds with the required accuracy. It was both time- and cost-saving and provided a valuable alternative since it could also be used in computer experiments as well as laboratory experiments. Several years after the uniform design theory was proposed, I discovered that it was being used extensively in the mainland. Not only was it used for military purposes, it was also adopted by and for civilians.

Loie: *There was some opposition to the uniform design in the mainland, why?*

Fang: In the cases mentioned above, we promoted the use of uniform design in computer experiments which was a completely new concept to many at that time. While most traditional experimental designs used ANOVA as the main tool for data analysis, we proposed the use of regression analysis for modelling. During the 1970s, especially just after the Cultural Revolution, many scholars in China were still adhering to the modeling of the traditional experimental designs. But our uniform design approach, although not quite supported by the academics, was greatly welcomed by the engineers.

5   Overseas: 1980–82

Loie: *The 1980s marked a significant chapter in your life as you started to play a key role in the global scene. Would you consider that as an epoch-making era for you?*

PHOTOGRAPH 11: Yuan Wang and Kai-Tai Fang. This photo was taken by CCTV in 1994.

Fang: In a way, yes. In 1980 when I had the opportunity for an overseas visit, I did not plan to go initially in view of my wife's illness. Tingmui suffered from asthma and, of course, my two daughters were quite young. My standard of English then was low and basically I could not communicate in the language. Besides, we were blocked from the outside world during the 10 years of political movement and we were ignorant of what was happening around the world.

After much deliberation, I finally visited Yale University with one focus in mind—to learn as much as I could within a limited period of time. The eight months I spent at Yale was, on one hand, tremendously difficult as I was learning from scratch and yet, on the other hand, it was fulfilling as I succeeded in coming up with several papers, one of which was published in *Encyclopedia of Statistical Sciences*. While at Yale, Professor Samuel Kotz sent me one of his books which inspired me to come up with a paper— my first paper, Fang (1982), to be published in a Western journal (*Journal of Applied Probability*)—and therefore a series of collaborations started between us.

Then in 1981 and 1982, I went to Stanford University for a visit and there I met Professor T. W. Anderson, a Princeton graduate who later taught at Columbia and Stanford Universities. He asked me to read two papers and then we had some idea about generalized multivariate analysis. Many statisticians wanted to generalize multivariate analysis to non-normal populations, but they failed. The combination of the essence of Pólya's and Hsu's teaching—that you need to seek different approaches and you need a powerful tool in order to exceed the work of others—prompted me to undertake a search for such a powerful tool: the $\underline{\underline{d}}$ operator. I systematically developed this tool and wrote two papers on the topic. After publication, Professor Anderson identified a vast potential for further development and subsequently selected a topic for extended research. He engaged more of his students in this research and on my return to the mainland, I also brought many students into the activity. This collaborative research of ours continued for eight years, during which more than 50 articles, two monographs and a collection of papers were published. This was a big leap forward compared to the situation prior to my overseas visit when it was a norm for one project to generate only one or two papers. I realized that for

PHOTOGRAPH 12: Visiting Samuel Kotz and his wife, 1988.

PHOTOGRAPH 13: T. W. Anderson and Kai Tai Fang in Hong Kong, 1997.

people of high standards, the choice of topics was of paramount importance.

During my visit to Stanford University, Professor Ingram Olkin organized a small seminar group on "multivariate multiple comparisons" which met every week. The participants included T. W. Anderson, Mary Ellen Bock, Zhongguo Cheng and me.

Our collaboration brought me high international reputation. I was invited by *Encyclopedia* and other journals to act as referee, author or Associate Editor. I was deeply appreciative of Professor Anderson for his identification of the potential and productivity of the generalized multivariate analysis as a research topic.

Loie: *Did you have the chance to visit other universities?*

Fang: Yes, in October 1982, I was invited to give talks at several universities, including Princeton, Yale and Columbia, and the universities of Pennsylvania, Maryland, Rutgers and George Washington. These visits were useful to my work, especially after I was promoted to Associate Director of the Institute of Applied Mathematics, Academia Sinica. Then in 1985–86, upon Professor Ingram Olkin's recommendation, I taught two subjects in the Swiss Federal Institute as a Guest Professor. It posed another challenge for me as it was the first time I had to teach in English. During my stay there, I seized the opportunity to visit various prestigious institutions including Oxford, Cambridge, University College London and Imperial College London, etc. The visits helped me to network which has proved useful throughout my career. In fact, it was during these overseas trips that I met Professors Colin White, C. Radhakrishna Rao, Norman Lloyd Johnson, D. R. Cox, A. P.

PHOTOGRAPH 14: Ingram Olkin and Kai-Tai Fang in Beijing, 1984.

Dawid, Yung Liang Tong, Y. S. Chow, George Tiao, Michael Stephens, Dennis K. J. Lin, and Agus Sudjianto. I am glad that our paths crossed as they were all inspirational to me in one way or another.

Loie: *I heard that you had a particular connection with the University of North Carolina (UNC) at Chapel Hill. How is that so?*

Fang: Well, in 1988 I first went to the University of North Carolina at Chapel Hill—where my former supervisor Pao-Lu Hsu once taught as a visiting professor between 1945 and 1947—and taught generalized multivariate analysis. In that year, Professor Norman Lloyd Johnson was in his last semester before his retirement, and he left me his teaching notes on multivariate statistical analysis. It is a unique gift to me. Since then, I have been linked to the UNC in different ways. In addition to Pao-Lu Hsu, my former student Jianqing Fan, a recipient of the COPSS Award and now professor at Princeton, was also a faculty member of the UNC. Later, my daughter Yan Fang completed her Master's degree in biostatistics at UNC and my son-in-law, Runze Li obtained his doctoral degree in statistics at the same university. Runze was my former student in Beijing. Both of Jianqing and Runze have been Editors-in-Chiefs of *The Annals of Statistics*.

PHOTOGRAPH 15: Runze Li and Yan Fang, graduate ceremony in University of North Carolina (UNC) at Chapel Hill, 2000.

PHOTOGRAPH 16: Kai-Tai Fang, Norman Lloyd Johnson and Gordon Simons in UNC, 1988.

6 Back to China: 1982

Loie: *What happened when you returned to the Academia Sinica in 1982?*

Fang: I returned to Beijing in October 1982 after 2 years visiting in USA (Yale and Stanford Universities). In the spring of 1984, I was appointed the Deputy Director of Institute of Applied Mathematics, Academia Sinica. In 1985 I was approved to become Doctoral Supervisor in Applied Mathematics including Statistics by the National Committee. There were few professors who could be doctoral supervisors in China then. There were about 6 doctoral supervisors in statistics around the country in 1985. Many young scholars wanted to be my postgraduate students or to attend our seminars. Most of those young scholars eventually went overseas after my supervision. Jianqing Fan (to Princeton), Gang Li (to UCLA), and Jianxin Pan (to the University of Manchester) were among this group.

Loie: *What were your main contributions to the development of statistics in China in the 1980s?*

Fang: During that period of time, I was devoted to the promotion of research on and the use of multivariate statistical analysis. I organized several national conferences on the topic. After a lot of hard work with Professor George Tiao and others, I proposed and managed to have the first Sino-American statistical meeting held in Beijing in 1987. This was the first time that so many statisticians from USA came to visit China.

Loie: *As the Deputy Director of the Institute of Applied Mathematics, Academic Sinica, what were your special contributions to the Institute?*

Fang: I was very active in encouraging research staff to expand their research porfolio by seeking external projects. I suggested, and was accepted by the Director of the Institute to change the research funding system from center-based to project-based. That succeeded in raising the initiatives of the staff, as well as the income of the Institute and the researchers. In addition, I established the first technical report series in the Institute of

Applied Mathematics. To help save printing cost and enhance presentation of the reports, I bought an HP laser printer which was not available in China then, and carried it all the way from California to Beijing for the Institute. I even undertook to train the Institute staff on how to use LaTeX.

Loie: *Did you still have time for your own research?*

Fang: Meanwhile, I was also productive in my own work. I produced two monographs, *Symmetric Multivariate and Related Distributions* (Fang, Kotz & Ng, 1990) and *Generalized Multivariate Analysis* (Fang & Zhang, 1990), and two reference books, *Statistical Distributions* (Fang & Xu, 1987) and *Applied Regression Analysis* (Fang, Quan & Chen, 1988).

7   Hong Kong Baptist University: 1990–2005

Loie: *When did you move to Hong Kong and why?*

Fang: I always have had more interest in research than administration. When I knew that the Academia Sinica had a plan to promote me from the Deputy Director to Director of the Institute of Applied Mathematics, I decided to take leave from the mainland for a few years. I joined the Hong Kong Baptist College which happened to be in the process of planning to become a university. She needed scholars who excelled in research. Due to the need of the College and its continuing development after successful upgrading, I decided to stay there permanently.

Loie: *How would you describe your academic and research pursuits at the Hong Kong Baptist University (HKBU)?*

Fang: With the encouragement of Kai-Wang Ng, I moved to the Hong Kong Baptist University (then College) in 1990. My years at the HKBU were the happiest and smoothest of my academic life. Many of my important papers were all published during this period in international journals, gaining me global exposure and reputation. The academic ambience here was stimulating and the congeniality among colleagues was notable. The support I gained from the top administrators was keen, facilitating my collaboration with overseas and mainland academics. The number of PhD and MPhil students supervised by me was comparatively large. All these factors created an environment conducive to both academic and research developments. I must thank our former Presidents Dr. Daniel C. W. Tse and Professor C. F. Ng, as well as Academic Vice-President Professor Herbert H. Tsang for their encouragement and support. It was at the HKBU that I reaped the most fruitful harvest in terms of academic and research pursuits. It was also here that I received various honors and awards.

Loie: *You have developed or further developed quite a number of methods during your academic career at the HKBU. Can you tell me more about them?*

Fang: The Quasi-Monte Carlo method was one that was expanded and further developed here in Hong Kong. We started applying the method in Beijing to develop the uniform design. In Hong Kong we continued to apply the Quasi-Monte Carlo method to experimental design, and also to a variety of statistical problems, including simulation and statistical inference. In 1994, I co-authored a book, *Number-Theoretic Methods in Statistics*, with Yuan Wang to further promote the method and its applications; see Fang & Wang (1994).

我所部分师生与来访外宾合影。

PHOTOGRAPH 17: Samuel Kotz (left 5) and Yung Liang Tong (left 6) visited the Institute of Applied Mathematics, Beijing, 1987.

PHOTOGRAPH 18: Kai-Tai Fang (fifth from left) with C. F. Ng (centre), then Dean of Science and now President and Vice-Chancellor, and departmental colleagues at the Hong Kong Baptist University, 1993.

It was also in the same year that I became President of the newly-established Uniform Design Association of China, a post which I held for 10 years until 2003.

There was a hiccup in the development of uniform design as the uniformity was categorized as a geometric criterion instead of a statistical one. This criticism provided an excuse for people to reject our papers. In view of this, I decided to spend more time on the uniform design theory. In 1992, a participant from North Carolina State University attended my conference in Hong Kong and told me that it was a pity that the Western community did not know about the uniform design. This remark was of great encouragement to me and inspired me to work on more solid basic theory for the uniform design method.

Loie: *How did you overcome the technical difficulties of promoting the uniform design theory and method?*

Fang: I indeed encountered a number of problems in tackling the issue. First, I was not familiar with the typical tools employed by the Quasi-Monte Carlo method as they were invented by mathematicians such as Luogeng Hua and Yuan Wang. Besides, I am a statistician and not a pure mathematician. One way to solve the problem was for me to learn to use the tools but it would not be effective in light of my age and time.

Second, the uniform design theory in itself was difficult. I therefore spent the first four years, i.e., from 1992–96, working on it. It was like an exploration for me and I made slow progress. It was necessary for me to identify the tools that suited me—on which I spent an enormous amount of time. As the Chinese saying goes: "*It is of little use for peonies to blossom only by themselves. They need green leaves to bloom with them.*" I was stimulated to focus more of my time on the uniform design. In fact, 90 per cent of my academic pursuits has focused on uniform design since then. My collaboration with several scholars led to the discovery of a breakthrough that suited me. I came up with the conjecture that most orthogonal designs were uniform in a certain sense. If that was the case, we could link up orthogonal design with uniform design and obtain a vast development potential for uniform design.

I spent one year with Peter Winker of Germany, a doctoral student then and a professor now, to prove with the computer that my conjecture was true. It was exciting to find that my conjecture was true in that many existing orthogonal designs were also uniform designs. Our result was based on the measure of uniformity proposed by my colleague, Fred J. Hickernell. This discovery was of mutual benefit to both Fred and myself. For him, his proposed measure of uniformity was initially not appreciated by many but his measure became necessary in uniform design. For me, his measure of uniformity helped prove that many existing orthogonal designs were uniform designs. With this, we still had one step to complete—to come up with a mathematical proof.

To achieve this, I invited Rahul Mukerjee, Professor of the Indian Institute of Management in Calcutta, to collaborate with me. Rahul is a worldwide expert in experimental design. After two weeks, he told me that my conjecture was not always true, even for a two-level factorial case. However, he came up with an excellent result—that we could link up uniformity with orthogonality. A criterion "aberration" was used to measure orthogonal design. For uniform design, the centered discrepancy was used to assess uniform design. With this, Rahul and I established an analytic relationship between centered discrepancy and aberration. This discovery was immediately published in a top journal, *Biometrika*, see Fang & Mukerjee (1999). It opened up an entirely new area that linked up uniform design and factorial design, an area in which I collaborated with Chang-Xing Ma and others, and which resulted in the publication of more than 20 papers since 1999–2000.

Then in 2000, I began collaboration with S. G. Ge from Suzhou University and Min-Qian Liu from Nankai University to link up combinatorial design and uniform design.

PHOTOGRAPH 19: Peter Winker and Kai-Tai Fang in Germany, 2004.

PHOTOGRAPH 20: Jianxing Yin, Min-Qian Liu, Rahul Mukerjee, Kai-Tai Fang, Hong Ma and Yizhen Liang, 2001.

PHOTOGRAPH 21: Chang-Xing Ma, Kai-Tai Fang and Dennis K. J. Lin, 2010.

PHOTOGRAPH 22: Kai-Tai Fang and Fred J. Hickernell, 2004.

Another new direction was established and this also led to the publication of many research papers.

The breakthrough we achieved in relation to uniform design won international recognition. The *Encyclopedia of Statistics Science (Second Edition)* has chosen uniform design as an entry, see Fang (2006), while the *Handbook of Statistics (Volume 22)* already included uniform design as a chapter; Fang & Lin (2003). Springer's *Handbook of Engineering Statistics* invited us to write a chapter on uniform design for engineers and this too will

soon be published; Fang & Chan (2006).

Uniform design also won national acclaim. The Uniform Design Association of China, for example, reflected the need to conduct national conferences, training courses, workshops and other activities to meet the calls to promote the applications of uniform design.

Loie: *Are there applications of uniform design in real case studies?*

Fang: Application-wise, there were numerous successful applications of uniform design in China. With the keyword "uniform design", you can call up (on the Internet) hundreds of published case studies. The application of uniform design by Ford Motor Co in the USA is exemplary of the applicability of this method. At Ford, Dr. Agus Sudjianto introduced to us that the technique had become a critical enabler for them to execute "Design for Six Sigma" to support new product development, in particular, automotive engine design. I was told that today, computer experiments using uniform design have become standard practices at Ford Motor Company to support early stage of product design before hardware is available. As a result, Runze Li, Agus Sudjianto and myself decided to publish a textbook/monograph *Design and Modeling for Computer Experiments*, Fang, Li & Runze (2005), where many case studies were from the real cases in Ford Motor Co. In 2001 the 50th Gordon Research Conference: the Statistics in Chemistry & Chemical Engineering invited the topic "Uniform design for simulation experiments"as one of the nine topics, and each topic was given 3.5 hours for introduction and discussion. Professors Dennis K. J. Lin, Yizhen Liang (a chemist) and myself formed a panel for this topic.

Loie: *Apart from research, you also spent much time on statistical education. Can you elaborate on that?*

Fang: To promote statistical education, I wrote international monographs, textbooks for undergraduate and postgraduate studies as well as textbooks for engineers in the mainland and for various targets on different occasions. I was also willing to take up guest professorships. Often, many of the participants who are now professors and industry and university leaders came to me and said they had listened to my lectures on various occasions or studied my textbooks when they were students. I found that quite rewarding.

I have been told that one of my textbooks, *An Introduction to Multivariate Analysis*, Zhang & Fang (1982), has been assigned as a compulsory textbook for Analytical Chemistry students. That was beyond my expectations. Although promoting statistical education has increased both my exposure and reputation as a by-product, what I found most gratifying and encouraging was the fact that I can make some contributions to my country.

I also understand that some of my textbooks and articles have been published in layman's terms for different professions so that the non-statistical sectors could also conduct research with statistics including uniform design. For example, the application of multivariate statistics to devise a common dress standard in 1976–78 was successful and the National Standards Bureau invited me to write a series of lectures. The published articles were collected as a book entitled Statistics and Standardization. Another example was the An Shan Steel and Iron Co which I mentioned earlier.

Loie: *I know that you have organized or co-organized quite a number of significant conferences, both international and national. Organizing conferences of this scale requires an enormous amount of time and attention. How did you find time to organize these activities amid your already hectic schedule?*

Fang: On a national basis, China had fallen behind for at least two decades because of the political turbulence. It was necessary to bring it to par with our counterparts overseas. Collaboration was useful in this regard. I took part in organizing seven nationwide multivariate analysis conferences since 1979, with one part of it theoretical and the other on applications, to provide a platform for establishing collaboration between the two. To attract international collaboration, I organized the Sino-American Statistical Meeting in 1987, which attracted more than 200 participants. In Hong Kong, I organized

- the International Symposium on Multivariate Analysis and Their Applications in 1992,
- the International Workshop on Quasi-Monte Carlo Methods and Their Applications in 1995,
- the International Symposium on Contemporary Multivariate Analysis and Its Applications in 1997,
- the Symposium on Theory of Uniform Design and Its Applications in 1999,
- the 4th Monte Carlo and Quasi-Monte Carlo Conference in Scientific Computing in 2000 and
- the Symposium on the Uniform Experimental Design in 2003.

Loie: *You have been accorded high international reputation as a result of your contributions to the global statistical field. The honors and awards bestowed on you include Fellow of Institute of Mathematical Statistics (1993), Fellow of American Statistical Association (2001) and numerous awards for your outstanding contributions to multivariate analysis, quasi Monte Carlo methods, design of experiments, and for your leadership in statistical education, consultation and administration as well as for your editorial service. Despite all these prestigious honors, you are still a modest man of high integrity, as reflected in the tributes dedicated to you by your peers. How did you manage to always conduct yourself in such a good manner and with such a positive attitude? Was there any advice you took to heart and which helped shape you the way you are today?*

Fang: My parents set a good example for me. To this day, I still remember vividly the advice my father gave me. He said if you extend your help to others, you should forget about it. On the contrary, if you receive assistance from other people, you should always keep that in mind and return the favor. Before I reached 40, the country had become poor. My wife Tingmui was weak and my daughters were still young. Our standard of living was basically minimal. Some of my friends helped me, but I was incapable of paying them back. When my economic situation improved, I paid back all the debts and whenever we came across a friend who needed financial assistance, we never hesitated to lend a helping hand.

My mother was exemplary of how one should conduct one's self, even in an adverse environment. She came from a village background and had no educational opportunity or cultural heritage. It was not until after her marriage that she had the chance to learn how to read and write. My father, on the other hand, came from the upper class. My mother kept a low profile but she learned exceptionally fast. And she always presented herself well, regardless of the situation. I learned from my mother that if you want to adapt yourself to a new environment you have to learn to be aware of your surroundings and should not be self-centered. I adhered strictly to this philosophy when I first visited the United States, a country so vastly different from my own in almost every aspect— in cultural, logic, systems, terms, etc. I thought of my mother and I began to watch attentively other people's behaviour, their culture, their logic, their way of thinking, their

PHOTOGRAPH 23: A. P. Dawid, Fred J. Hickernell, Kai-Tai Fang and T. W. Anderson at a conference in Hong Kong, 1997. Sitting behind Kai-Tai is C. Radhakrishna Rao.

PHOTOGRAPH 24: Kai-Tai Fang poses with his former students; from left: J. J. Liang, Jianxin Pan, Jianqing Fan, Kai-Tai, H. B. Fang and M. Y. Xie, during a conference break, Hong Kong, 1997.

strengths and their weaknesses. I became happy when I began to appreciate differences in my environment. I learned the things that were desirable and brought them back to the mainland. My positive attitude allowed me to keep an open mind in my management style and, because of this, I was promoted to Deputy Director of the Institute of Applied Mathematics, Academia Sinica, in a mere one-and-a-half years after my return to the mainland.

Another person who influenced my personal development was Professor Kai Lai Chung[2], the first Ph.D. student of Pao-Lu Hsu. While I was in the USA, he told me that many people hid themselves in the office or laboratories to do research and declined to mix with Americans. He asked me why I went to the States and advised me to go out and mix with the people. Following his advice, I joined an activity every two-and-a-half days, be it a seminar or party or social gathering. I benefited greatly by joining these activities and I became aware of a significant improvement in my English communication skills and in my understanding of the Western culture.

I am a firm believer that great achievements involve great risks. I encountered a dilemma in 1980 when I was offered an opportunity to go abroad as a visiting scholar. My wife then was sick and my two kids still small. This, coupled with my unfavorable financial situation, somehow deterred me from making a positive move. One of my friends said to me that if I did not go abroad, my career development would be limited. He said every person must face at least one difficult period in his lifespan and that one must face it with bravery and courage in order to overcome it. This remark was inspirational to me. I therefore took the risk of traveling abroad and was psychologically prepared to come back anytime should I receive a telegram with bad news. My wife, who was told by some of the neighbours that she might not be able to see me again should I go abroad, supported my move. I deeply appreciate her much-needed understanding and unfailing support.

Loie: *Do you have any motto and if yes, could you share it with the younger generation?*

Fang: I don't have one in particular but I think that to me, the most important thing is to be a person of integrity. Good character precedes good academic achievements. Also, don't be afraid of difficulties. Face the problems head-on and find a way to solve them. Remember that there is always a way out for those who look for one. I went through the 10-year Cultural Revolution without even knowing whether there would be a tomorrow and I survived. It is important to build a strong psychological shield to shelter yourself from external attack. I also encourage youngsters to work hard. If you decide to go for something, do it with all your might and give the best you can.

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[2]Kai Lai Chung (1917–2009) graduated from the Department of Mathematics of Tsinghua University, Beijing. In December 1945 he went to Princeton University and obtained his PhD in 1947, with Harald Cramér and John W. Tukey as his advisors. In 1950s, Chung taught at the University of Chicago, Columbia University, Berkeley, Cornell University and Syracuse University. In 1961 he transferred to Stanford University, providing fundamental contributions to modern probability theory.

PHOTOGRAPH 25: Kai-Tai Fang with his parents, sisters and brother.

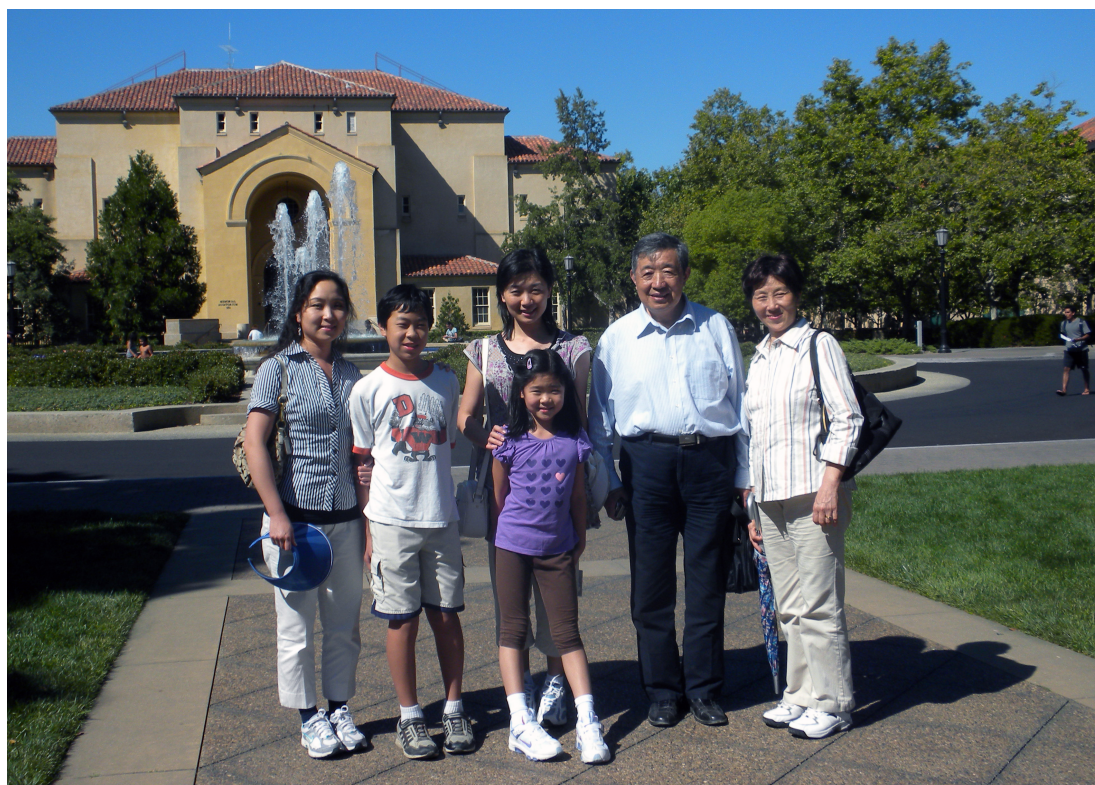PHOTOGRAPH 26: A family picture taken at the Summer Palace in Beijing, 1981.

PHOTOGRAPH 27: Kai-Tai and wife Tingmui in 1985.

PHOTOGRAPH 28: Kai-Tai Fang's family with C. Radhakrishna Rao's family, 2003.

PHOTOGRAPH 29: A happy family reunion in Stanford University, 2010.

8   HBNU-HKBU United International College, Zhuhai Campus: 2006 onwards

Li, Puntanen & Styan = LPS.

LPS: *When did you retire from the HKBU?*

Fang: The usual retirement age for the public sector in the last century of Hong Kong was 60. Thus I should have retired in the year 2000. But due to the development need of the HKBU, the senior management of the University made a special exception in my case to retire in January 2006.

LPS: *You were working in Hong Kong since you emigrated there in 1990, how come you are teaching in a college back in China?*

Fang: Everyone nearing retirement has to make a decision as to what to do, where to stay, and how to contribute to the host society after retirement. Several universities of the US and New Zealand invited me to teach there. At the same time, the newly appointed President of HKBU, Professor C. F. Ng had a plan of building a liberal arts college in the Pearl River Delta in Southern China. The new College would be modeled on the public universities of Hong Kong for its structure and management, with English as its teaching medium, whole-person education in orientation, knowledge for application, and be more internationalization. I liked this challenge and thus accepted the invitation of Professor Ng to become a member of the planning team for this innovative institution.

LPS: *When did your involvement with the UIC begin?*

Fang: In the winter of year 2000, Professor C. F. Ng formed a delegation consisting of the vice-presidents, deans, faculty members and administrators of the HKBU, to begin the search for a site in China for the building of the UIC. The delegation visited many cities in the Pearl River Delta and municipals in the mainland and met with their senior officials. After much comparison and deliberation, all of us found Zhuhai to be the best location due to its green and clean environment, its emphasis on education, and the enthusiastic support of its government leaders. The delegation was given a very high profile reception by the Municipal Government led by the Municipal Party Secretary Mr. Longyuan Huang and City Vice-Mayor Mr. Ningke He at the time.

According to the Chinese law, a local partner had to be found for all local-foreign joint enterprises. The new college, as such nature, needed to find a local collaborator. For this mission, a committee was set up by the HKBU, headed by the then Vice-President (Development), to begin the search. Finally, through the connection and recommendation of Professor Jialu Xu, the then Deputy Chair of the Standing Committee of the National People's Council and a good friend of HKBU, the Beijing Normal University (BNU) was chosen. The new college was named as "Beijing Normal University-Hong Kong Baptist University United International College" (UIC for short), being the longest name of a university/college in China.

LPS: *Was the joint venture well received right from the start?*

Fang: While still on the drawing board, the College was shrouded with intense scepticism. Many people questioned its chance of success. The College, being new and financially self-supporting, had many aspects worked against its smooth birth. The negative factors included the low confidence of parents towards a new institution especially its being such new model of education in China, the high tuition fees charged (compared to the local universities), the limited academic profile with only three Science programmes (Computing Science, Statistics, and Environmental Science) and two Business programmes (Finance, and Applied Economics) on offer, and inability to lure the Associate Degree students from Hong Kong. Nevertheless, the UIC was born, out of the hard labour and perseverance of the founders/pioneers.

LPS: *How difficult was it to recruit students?*

Fang: In its first year, without the full support of the Guangdong Education Bureau, less than 200 students were recruited, picked from those who were turned down by other universities under the National College Entrance Examination (NCEE) system. After years of hard work, the UIC now has 20 Major Programmes and more than 4900 undergraduate students.

LPS: *How difficult was it to recruit teaching staff at that time/ How about staff recruitment at that time?*

Fang: As a private college, tuition fee is the only source of income for the College. In the early years, due to the low salary and short history, many newly graduated doctorates, worrying about their future prospect, turned down the College offer for elsewhere. At this difficult moment, I came up with an innovative solution: inviting Professor Yung Liang Tong who had just retired from Georgia Institute of Technology, Atlanta, USA, to come and teach for one semester, and Philip Cheng of the Statistical Institute of Taiwan for another.

LPS: *What made the College a success?*

Fang: The UIC built up its reputation by its teaching quality and excellence. The strong commitment of its staff to provide the best for their students, and their seriousness in teaching was greatly impressive to and appreciated by the students and parents. Repeat students, programme transfer students, and students returning from sick leave were given extra hours and special courses free by the teachers to help them catch up with their studies. There was a Statistics student who was in a coma after a car accident. He could not continue his study for almost a whole semester. Teachers not only donated to a fund to help pay his medical bills and health recovery, but also redesigned his study plans so that he could catch up with his academic study and graduate on time. The student of course worked very hard so not to let down those who had supported him and he successfully completed his final year project. Despite his poor family background, the student through part-time work and scholarship supported himself to further study at the Georgetown University in Washington, DC, USA, after graduated from the UIC. Another student, internally transferred from the Teaching English as a Second Language Programme to Statistics, was able to gain admission to the University of Oxford, UK, for postgraduate there after years of patient teaching and guidance of the programme teachers.

Such caring attitude and devotion of staff to the well-being of students was a living proof of the College's educational philosophies of four point education (students-parents-staff-community) and whole-person education which were clearly seen by many parents as education of a very different kind.

On average, about 65% of our Statistics graduates went to further studies in overseas, many to the USA, UK, Australia, Canada, and Hong Kong. The rest found work in mainland China and Hong Kong.

LPS: *How about the Chinese Government's support to education? It seems to be very good, maybe better than in many Western countries?*

Fang: Support from the Chinese Government to public institutions has grown on a regular basis. But as a private institution, no support comes to the UIC from either the Hong Kong or Zhuhai Governments. Tuition fee is its only income. Even then, the tuition fees cannot be raised without the permission of the Guangdong Price Bureau, the authority that regulates the level of charges for all goods and services in the province. The development path of the College has not been a smooth one. Recently, the Zhuhai Government has offered the College a piece of land for its future development. This may be deemed as a commendation for its contribution and achievement.

LPS: *Ten years ago you had some plans in mind regarding how you see the years after your "retirement". We now see that you actually did not retire at all. So, can the same question be asked again? And how did your plans work?*

Fang: In the past ten years, most of my time was spent on the establishment of the new Statistics Programme in the UIC. But my research on experimental design, data mining, statistical simulation and magic squares has never stopped. From 2005 to now I published one monograph *Design and Modeling for Computer Experiments* (2005), three textbooks in Chinese, 48 research papers, and nine papers in mathematics/statistics and culture. I have also done a lot of services in refereeing research papers, organizing sessions in some international conferences, etc.

LPS: *What is the role of Statistics in Chinese universities these days?*

Fang: In the recent 30 years, Statistics has grown enormously in status in China. The discipline used to be subsumed under Mathematics which was a Class 1 discipline, whereas Statistics was only a Class 2. Three years ago, the Chinese Ministry of Education decided to turn Statistics into a Class 1 discipline. At present, most universities and colleges already have an independent Statistics department, offering Master and Ph.D. programmes. Unfortunately, there is a lack of qualified teachers for it. In view of the teaching need, the Higher Education Press of China invited me to be the Chief Editor, to assist them in the publication of a series of statistics textbooks. Several books have been published including three of my works with other professors. These are: *Design and Modeling of Experiments* (2011) with Min-Qian Liu and Yong-Dao Zhou, *Matrix Algebra in Statistics* (2013) with Min Chen, and *Modern Basic Statistics* (2015) with Xiaoling Peng.

LPS: *What has been your main research interest during that 10 years?*

Fang: Due to my duties as the department head of the new Statistics Programme, and chairs/members of many committees, the time I could devote on research has been substantially less when I was at the HKBU. However, I kept myself closely informed of the new development of experimental designs, especially uniform design. I continued to provide help to many users of the uniform design in different countries. In 2008, Professor Yuan Wang and I were awarded the Chinese State Natural Science Award, the highest recognition for the initial concept, theory and application of the uniform design

I have a definite concern over the "Big Data". I disagree with some authors who attempted to exclude Statistics out of the research and application of Big Data. No matter what, the popularity and application of Big Data is a challenge for the statisticians who can find ample space for development from there.

Recently, I have some interest in magic squares. The concept of magic squares was originated from China. Over the years, mathematicians and its fans in China have made huge contribution to the development of magic squares. I have great respect for George P. H. Styan especially for his research and achievement in this area. The series of papers by him and his collaborators were greatly inspiring for us.

LPS: *Could you please tell some collaborators over the last ten years?*

Fang: Due to the convenient location of the UIC (in the Pearl River Delta), I have had many opportunities to visit the numerous universities in the region, such as Sun Yat-sen University, Guangzhou University, South China Normal University, Shenzhen University, Beijing Normal University at Zhuhai campus, etc. I was even able to make frequent visits to the Chinese Academy of Sciences, where I studied and worked for about 27 years. I have been working with Professors Yuan Wang, and Min Chen there on some joint projects.

The founding of the Statistics Programme at the UIC had taken up much of my time and I was unable to take part in international conference as frequent as before. However, I was invited to be a member of the Institute of Mathematical Statistics (IMS) Fellow Committee for the selection of IMS fellows from 2007 to 2009. I have also attended two International Workshops on Matrices and Statistics: one in Shanghai, China (2010) and one in Toronto, Canada (2013). I am going to attend the one in Haikou City (Hainan, China) in 2015. Those occasions enabled me to meet up with many old friends. Through my personal contact with Tam Ming, UIC and Georgetown University, USA, have started a close cooperation for Master Programmes in biostatistics and other areas. Similar cooperation will take place with the Victoria University of Wellington, New Zealand, and Illinois Institute of Technology, Chicago, USA.

PHOTOGRAPH 30: UIC teaching staff in statistics, 2010.

PHOTOGRAPH 31: Hans Joachim Werner, Jeffrey J. Hunter, Yonghui Liu, Kai-Tai Fang, Shenfang Zheng, Simo Puntanen, Tingmui Li; IWMS-Shanghai, June 2010.

LPS: *How big is the teaching staff in statistics in the UIC?*

Fang: Currently we have four full professors, three associate professors, three assistant professors and many instructors and teaching assistants.

LPS: *Importance of your wife, Tingmui Li. As we all know, her role and support in your career has been go utmost importance.*
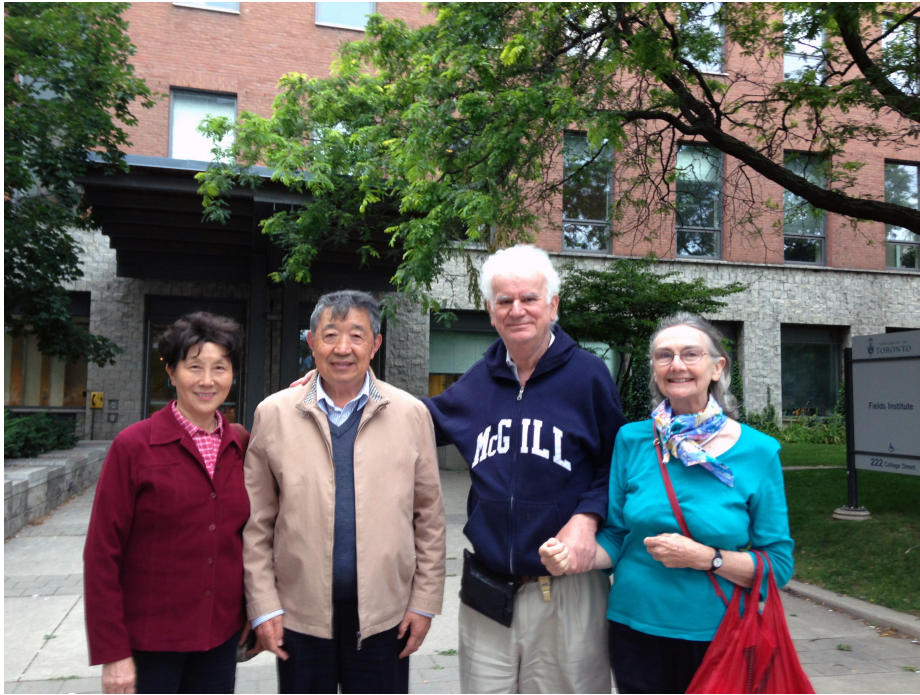
PHOTOGRAPH 32: Kai-Tai Fang with his wife Tingmui, George P. H. Styan with his wife Evelyn; IWMS-Toronto, August 2013.

PHOTOGRAPH 33: Kai-Tai with his wife Tingmui Li in Kunming (capital of Yunnan Province), 2014.

Fang: Tingmui retired from the Peoples' University of China (also known as Renmin University of China) in 1999. We married in 1968 and during the first 31 years of our marriage we lived apart for some 20 years. Soon after we got married and for seven years (from 1968 to 1975), I worked in a military farm or in in Beijing while she worked as a technician in a chemical factory in Shandong Province; from 1980 to 1986, she lived in Beijing and I spent three years in the USA and six months in Switzerland; during the nine years of the 90s (1990–1999), I was in Hong Kong and she was in Beijing. We finally got back together when Tingmui moved to Hong Kong after her retirement in 1999. Next year is our Golden Jubilee. Despite our long periods of separation, we managed to bring up two wonderful daughters: Ying Fang and Yan Fang. They successfully completed a Master of Business Administration and Master of Biostatistics, respectively. We have one grandson and two granddaughters.

LPS: *Hobbies these days?*

Fang: When I was a secondary school student, I liked playing Chinese Chess, swimming, reading all sorts of books; while at university, I liked long-distance running, watching modern drama, reading novels; in Hong Kong, my favourite sports were table tennis, swimming and hiking; nowadays, I can only take walks and watch TV.

LPS: *What do you like to do when you are not doing statistics?*

Fang: When I retire, I would like to write my own stories and through them to illuminate the changes and development of the nation.

LPS: *Any particular advice that you would like to give for a young student having the academic career in mind?*

Fang: We would like to see in our young scholars the team spirit, perseverance, tolerance, and ability to work hard and endure hardship. For research students, we would like them to pay more attention to seminars, as many good ideas come from discussion and exchange.

LPS: *Thank you very much for your time devoted to this interesting conversation, Kai-Tai! It was indeed a great pleasure for us.*

Acknowledgements

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