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A Conversation with Samad Hedayat

Ryan Martin, John Stufken and Min Yang

Abstract. A. Samad Hedayat was born on July 11, 1937, in Jahrom, Iran. He finished his undergraduate education in bioengineering with honors from the University of Tehran in 1962 and came to the U.S. to study statistics at Cornell, completing his Ph.D. in 1969. Just a few years later, in 1974, Samad accepted a full professor position at the University of Illinois at Chicago Circle—now called University of Illinois at Chicago (UIC)—and was named UIC Distinguished Professor in 2003. He was an early leader in the Department of Mathematics, Statistics and Computer Science and he remains a driving force to this day. Samad has also made substantial contributions in terms of research and service to the field, as evidenced by his numerous honors: he is an elected member of the International Statistical Institute, a fellow of the Institute of Mathematical Statistics and the American Statistical Association and an honorary member of the Iranian Mathematical Society, among others. This conversation, which was conducted in September 2015 and May 2016, touches on Professor Hedayat's career, and the past, present and future of statistics. In keeping with one of his great passions, it also offers an abundance of advice for students and junior faculty.

Key words and phrases: Design of experiments, survey sampling, biostatistics, statistical research, statistical consulting, advising students.

1. CAREER PATH

Stufken: Samad, thank you for agreeing to have this conversation. To begin, how did you actually get interested in statistics and are there other disciplines that you explored before you got interested in statistics?

Hedayat: I landed in statistics and mathematics for a variety of reasons, but mostly for financial reasons. To help support my family, I became an elementary school teacher at a very young age. During that period, I continued my own education through self-study, which is how I earned the 12th grade certificate. I also discovered that math was fairly easy for me, which ultimately created a lot of opportunities. In my third or fourth year at the University of Tehran, I got a job with their Director of the Institute for Economic Research and Development. They were looking at various economic aspects in Iran, using lots of data. I was in charge of handling data, summarizing it, preparing charts and writing reports. That was when my interest in data and statistics developed.

There was also a professor in statistics at the University of Tehran, Professor Khajehnoori, widely seen as the father of statistics in Iran. He was really pushing for statistics in Iran and, in 1966, he founded the Institute of Statistics and was its director for 8 years. I worked with him in what could be considered a research assistant position for several years. It was Professor Khajehnoori who encouraged me to go to the U.S. to study statistics, specifically, at Iowa State. I received admission from Cornell and from Iowa State and, though I intended to follow Professor Khajehnoori's advice and go to Iowa State, I spent my first summer in the U.S. at Cornell. At the end of the summer, I took a bus from

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Ithaca, NY, to Ames, IA, and the Department Head at Iowa State, Professor Bancroft, welcomed me and introduced me to the other students. But beautiful Ithaca was my only frame of reference in the U.S., and the stark contrast between that and Ames was too much for me so, later that same day, I was on the bus headed back to Ithaca. I feel bad that I did not even say goodbye to Professor Bancroft.

Yang: So your decision to go to Cornell had nothing to do with statistics? Just a comparison between Ithaca and Ames.

Hedayat: Maybe if I had gone directly to Ames from Iran, I would have been fine there. But after spending the summer at the Cayuga Lake and the Adirondack Mountains, the contrast between these two cities seemed extreme to me.

Yang: How did your family feel about you coming to the U.S. to study?

Hedayat: On one hand, they were really happy for me to get this opportunity; on the other, they felt like they lost me, which, in some sense, was true.

Stufken: In terms of professional influences on your career, who are the most important people?

Hedayat: When I came to the U.S., there were some real giants at Cornell, such as Kiefer, Wolfowitz, Bechhofer, Federer, Robson, Searle and others. One person, besides Jack Kiefer, who really impressed me at Cornell was Doug Robson. He instilled in me the idea that if you want to do something meaningful, then you have to find an interesting problem, and dedicate yourself to that problem and know the ins and outs of it. I did my Master's thesis with him.

Yang: Cornell is also where you became interested in design?

Hedayat: I had been involved with design and data collection back when I was working with Professor Khajehnoori in Iran. But, yes, it was essentially at Cornell where I became interested in design. That was not very surprising with the people who were there with an interest in design, like Kiefer, Wolfowitz, Federer, Bechhofer and others.

Martin: You ultimately chose to do your dissertation with Federer. How did that come about?

Hedayat: At that time, Federer's book on design of experiments (Federer, 1955) was one of the textbooks they used at Cornell, so I was very familiar with his style and the way that he thought about problems. Unlike Kiefer, Bechhofer and others who were interested primarily in theory, Federer was motivated by real data and real problems; this is clear from his book, which has lots of examples and discussion about the choice

FIG. 1. *With Walt Federer at the* 60*th Birthday Conference for D. Raghavarao in* 1999.

of design. Given my background in data collection and analysis, this was a very good fit for me. We ultimately wrote a number of theoretical papers but this work started from thinking about real problems.

Yang: Besides the Cornell faculty who were interested in design, there were also many visitors who shared that interest, correct?

Hedayat: Yes, a lot of visitors.

Yang: That must have been a very stimulating environment.

Hedayat: Yes. Even though I was just a student and later a junior faculty member, it was exciting to interact with visitors like Esther Seiden, D. Raghavarao and Ernest T. Parker (who was one of the "Euler spoilers" with R. C. Bose and S. S. Shrikhande). Seiden was especially interested to visit Cornell, and Parker came because we were working on sum compositions for constructing orthogonal Latin squares. Since other faculty at Cornell had families and I was not married at that time, these visitors interacted primarily with me.

Stufken: When you received your Ph.D. at Cornell, you pursued academic positions. Was there ever a thought that you might go to industry?

Hedayat: Never. None of the students at Cornell were talking about going to industry at that time. We were all getting a Ph.D. to do research, aiming for a future job in academia. For me personally, when I came here it was with the idea to go eventually back to Tehran and become a professor there. But I was so involved with the people at Cornell. They liked me and encouraged me to stay and continue doing research there. That is what I wound up doing.

Stufken: Before coming to Chicago, you spent time as a faculty member at both Cornell and Florida State. How did all of this happen?

Hedayat: The people at Cornell liked me and the research I was doing so they offered me a job. I was married by that time, and my wife, Batool, joined me in Ithaca after a year or so. But she did not like Ithaca all that much: she had no friends or family around and she missed the big city feel of Tehran, where she was from. As a junior faculty member, I was busy with research, etc., so she was basically alone. Frankly, I was not a good husband.

We were very close to Jack Kiefer, and he easily could see that Batool was in bad shape. Not long after that, I received a call from Richard Savage at Florida State University. He explained to me that they were trying to recruit new faculty and that Jack Kiefer had suggested to him that I might be interested to leave Cornell. I told him that I needed to think about it; I was concerned that Federer or Robson might think that I wanted to leave. But when I took the news home to Batool, she looked at a map and discovered that Florida is near water and she was very excited. I eventually did go to visit Florida State, arranged by their Department Head, Ralph Bradely. Shortly after returning home, I received a letter with an offer for a tenured associate professor position. I wasn't especially interested in that position but, since Batool wanted to leave Ithaca and was excited about Florida, I accepted their offer and we moved to Tallahassee.

When I got there, I discovered that it was a very good department. Many well-known people were there: Bradley and Savage, of course, as well as Hollander, Proschan, Serfling, Sethuraman and others. It turned out, however, that Batool did not like it there.

Yang: The promised land was not the improvement that she had hoped for?

Hedayat: There is nothing in Tallahassee. It is not even near the water! Even Ithaca has beautiful trees and a lake. Batool wondered why we ever went there, and she decided to go back to Tehran with our daughter, Leyla.

When I was talking with Jack Kiefer one day, he asked about Batool, and I told him that she had left for Tehran. So he knew again that something was amiss. Not long after that, I got a call from Joseph Landin, the Head of the Department of Mathematics at the University of Illinois at Chicago Circle, now known as the University of Illinois at Chicago (UIC). He explained that they were trying to develop statistics within their mathematics department. Somehow Jack Kiefer had dropped my name to them. When I passed this news to Batool, she was glad that I was finally considering a big city. I went to visit Chicago, gave my talk (on algebraic aspects of design construction), and Joseph Landin introduced me to the faculty. A couple of days after I returned to Tallahassee a letter arrived offering a full professorship at the University of Illinois—and doubling my salary at Florida State. I eventually accepted the offer from Chicago, and we came here.

Yang: So Batool came back from Tehran?

Hedayat: Yes, she came back to Tallahassee, and from there we moved together to Chicago. We've been here now for more than 40 years.

Stufken: How was your transition into a math department?

Hedayat: I tell you, when I came here, the first three months or so, I felt that I had made a terrible mistake. Since I was hired as professor to build statistics, I served on many of the major departmental committees by default. On one occasion, we were discussing developing statistics, and I said that I would like to invite my colleague from Cornell, Jack Kiefer, to visit and give us some recommendations. I remember them asking me: "Who is Jack Kiefer?" At such moments, I was really wondering what did I do to myself!

Martin: When you came to UIC, it was to the Department of Mathematics, but now it is called the Department of Mathematics, Statistics, and Computer Science. What role did you have in the name change?

Hedayat: When computer science was becoming a hot topic, the School of Engineering wanted to create a separate Department of Computer Science. Our department was also teaching some computer science-related courses but we agreed to let Engineering create their new department if we could stake claim to our own version of computer science by changing the department's name to include "Computer Science." Since the name was being changed anyway, I started a campaign to have "Statistics" in the name, too. There was not a lot of support for my proposal among the mathematicians but, fortunately, the department head at the time, Louise Hay, a close friend of mine, took my side. It was in Fall 1983 when the name change was official.

Stufken: Did having "Statistics" in the name of the department help to ease any of the tension you felt previously?

Hedayat: No, not really. Early on, I felt like I was constantly fighting for statistics with some of the senior math faculty. But gradually I learned that fighting was not helpful, and that my focus had to be on solving problems constructively. I discovered that going for a

cup of coffee or lunch together was a much more efficient way to resolve a disagreement.

In retrospect, I am really glad that I came to Chicago. First of all, Batool liked it very much here. But also, professionally, I discovered that there were lots of opportunities for a statistician in Chicago. For any bona fide statistician, interested in solving real problems, the sky was the limit.

2. RESEARCH AND CONSULTING

Yang: You are perhaps most well known for your contributions to the theory of design of experiments. Can you tell us about how you became interested in design and about your early work?

Hedayat: Since way back, from my time in Tehran, my heart has always been devoted to data collection and analysis for real life problems. Without data, we would have no statistics profession so, in some sense, data collection is fundamental. Since the burden to collect "good data" is on the statistician, it is essential that we have designs which are efficient in terms of time and money and also robust and resistant to unexpected events. During my time at Cornell, taking courses in analysis, algebra, group theory, finite fields and so on, I developed the necessary technical skills to build these tools in a mathematically rigorous way, so it was natural for me to proceed with research along these lines.

In my early academic life, I was fascinated with Latin and orthogonal Latin squares as a special case of factorial designs. Soon I discovered that if Euler knew how to add Latin squares, then he would not have made his famous wrong conjecture (Euler, 1782) that pairwise orthogonal Latin squares do not exist for order $4t + 2$; the conjecture is correct for $t = 0$ and 1, but not for other t, as shown in Bose, Shrikhande and Parker (1960). Esther Seiden and I built up a series of tools based on sum composition for the construction of pairwise orthogonal Latin squares of all orders, including those of order $4t + 2$ (Hedayat and Seiden, 1974). We also generalized the idea of Latin and orthogonal Latin squares to F-squares and orthogonal F-squares (Hedayat and Seiden, 1970).

Stufken: Design researchers like us can stay in business thanks in part to the reality that things rarely go exactly according to plan. A number of your contributions have been along these lines, concerned with designs that are "adaptive" in one way or another. Can you share a few highlights about this work?

Hedayat: No design is completely immune to things going wrong, but we should be prepared for certain problems. For example, a pharmaceutical company may want to include, in its study, additional replications at a high dose of a drug in case, for one reason or another, data from patients at the high-dose level cannot be fully collected. I collaborated with Peter John on this topic, and we produced a series of designs which we called then resistant and susceptible designs.

Another example is in cases where, in the course of a study, certain aspects of the design should be updated or modified while maintaining the qualities of the original design. With my colleague Robert Li at UIC we introduced a concept of trade-off in design and showed how to modify designs in the middle of a study.

Another family of designs which has broad applications in medical and pharmaceutical fields, among others, is crossover designs or repeated measurement designs. In collaboration with my students, colleagues and friends, including Kasra Afsarinejad, Gregory Constantine, Zhiwu Yan, William Zhao, Wei Zheng and you two (John and Min), we have produced a significant collection of optimal and efficient crossover designs. Indeed, I am proud to say that UIC is famous for its contributions to this area of design.

Martin: My favorite question: what is your favorite paper you've written?

Hedayat: Very good question! I'd have to say the paper (Hedayat and Majumdar, 1985) with my UIC colleague, Dibyen Majumdar, at UIC, published in *The Annals*. I like this one specifically because it has a very nice mix of theory and application. The focus is on a difficult practical statistical problem, namely, designs for comparing several treatments simultaneously versus a control, with a blocking structure. But then to demonstrate optimality of the proposed designs, we needed to make use of some beautiful theory from projective geometry.

Yang: We can't have a discussion about your research contributions without mentioning orthogonal arrays. Your book (Hedayat, Sloane and Stufken, 1999) is the undisputed authority on the subject, cited by virtually every paper on design construction. How did this book come to be?

Hedayat: Orthogonal arrays are generalizations of the notion of Latin squares and orthogonal Latin squares. These were useful tools in design construction, as well as in coding theory and other places. There were good papers here and there, but we found that there was no good single source, so we set out to write it. At that time, Neil Sloane was visiting UIC from time to time, primarily to interact with Vera Pless, my colleague, an expert in coding theory. Given Neil's interest in coding theory and its connections to orthogonal

FIG. 2. *With C. R. Rao and Dibyen Majumdar.*

arrays, it seemed like a good idea to invite him as a collaborator on the book-writing project. My goal was to write the book for two different audiences simultaneously: one who just wants to see the result so they can use it, and another who wants to understand the details of the construction. To accomplish this took lots of precision, and this is why it took nearly 10 years to complete. My role was more as an advisor or manager, John and Neil did most of the heavy lifting. C. R. Rao had been interested in orthogonal arrays for many years, and gave us very positive feedback; he even wrote the foreword for our book.

Martin: Are there any other problems that you wished you could have worked on but never found the time?

Hedayat: Over my career, I worked on almost all aspects of design. Thanks to having lots of good collaborators and students, the work stayed fresh for me, so I never felt the need to branch out any further.

However, I should mention that I also have worked a lot on finite-population sampling which, of course, is a type of design problem. There were lots of consulting projects over the years related to sampling. I have also published a book on the topic (Hedayat and Sinha, 1991), with my good friend Bikas Sinha, from ISI Calcutta, who visits UIC regularly, since the early 1980s till now.

Yang: You mentioned previously about the many opportunities for statisticians in Chicago to do consulting or collaborative research. Can you tell us about your most memorable projects?

Hedayat: My students and I did a lot of work for the Chicago and Rockford Forensic Laboratories. We helped them to develop a sequential sampling procedure (Hedayat, Izenman and Zhang, 1996) for confiscated illicit drugs, such as crack cocaine and heroin. Later, we also prepared software for them, and did the same for the Forensic Laboratory in Albany, NY. The need for all of this arose because, believe it or not, drug dealers cheat! Some of what they sold was simply innocent powder. So simply weighing bags of powder that were confiscated did not provide an accurate measure for the amount of crack cocaine or heroin in their possession which was needed for successful prosecution. Our procedure helped the labs to come up with reasonable estimates for these amounts without having to go through all of the bags that were confiscated.

We have also been involved extensively with the NIH funded Center for Botanical Dietary Supplements Research here at UIC. Several of my students were funded through the center and have participated in research resulting in several published papers. We were also involved in clinical trials that they ran. One in particular was on benefits from the use of black cohosh for post-menopausal women compared to the drug Prempro, which has lots of bad side effects. NIH provided the center with some ten million dollars to study this.

Later, when Microsoft's Xbox first came to the market, there was a problem with it. There was a loose part or something inside the box that was causing electric shocks. They became aware of this and contacted an engineering company for testing. The problem landed on my desk somehow. We collected and analyzed data, and prepared a report. At that time, Bikas Sinha was visiting me, and we wrote a paper for *The American Statistician* (Hedayat and Sinha, 2003). We called it "Toy box" because we couldn't use the real name.

We were also consulting with the Argonne National Laboratory, and one of my students was sponsored for five years by the lab as a research assistant. In fact, we published a paper in *JSPI* with one of the chemists at Argonne.

3. OTHER CONTRIBUTIONS

Stufken: You were on the editorial board for *The Annals of Statistics* from 1973–1980. This was actually the first editorial board after *The Annals of Mathematical Statistics* was split into two journals by Ingram Olkin. Any memories about this time that you'd like to share?

Hedayat: What was particularly interesting for me, both good and bad, was that I was just a junior faculty member at that time, a few years out of my Ph.D., serving as an Associate Editor for *The Annals*. I knew a little bit about reviewing papers, since Robson, who was an Associate Editor for *JASA*, had given me some papers to read and to check the details, but nothing about

the editorial process. Olkin would send me papers—they were sent by regular mail at that time—and due to my inexperience and my desire to avoid getting a reputation as a reckless guy, I would read the whole paper before even sending it to reviewers. This job was difficult and a lot of responsibility for a junior faculty member, but it was a good experience overall, since it kept me up to date with theoretical developments.

Martin: You were also involved in the creation of the *Journal of Statistical Planning and Inference*. Care to say a few words about this unique experience?

Hedayat: Before the split of *The Annals of Mathematical Statistics* into *The Annals of Statistics* and *The Annals of Probability*, there was a home for very theoretical papers with only a hint of statistics. For example, those statisticians working on design construction were writing papers that were almost entirely algebra, very little to do with statistics. After the split, however, those papers had trouble finding a home, and people, especially in the design community, were getting upset. This was in the early 1980s. Around that same time, there was a conference at Colorado State, hosted by J. N. Srivastava, and all the design people from the U.S., Europe, Australia and other places were there. There, people started floating around the idea of creating a new journal with a particular emphasis on design and design-related papers. It was from here that *JSPI* was born; Srivastava became the first editor and I was on the editorial board from the beginning.

Yang: You also had an impact more locally. Tell us about your work with the Chicago ASA chapters.

Hedayat: There are lots of pharmaceutical companies in Chicago and I was talking to many of the statisticians at these companies. I quickly found out that they were not very happy with the Chicago ASA chapter—it was dominated by discussions on business statistics. So we formed a new chapter, the Northeastern Illinois Chapter, which is focused primarily on issues relevant to biostatisticians from industry. I was involved in developing that chapter.

Yang: Was it through talking with these statisticians in pharmaceutical companies that you developed your interest in medical statistics?

Hedayat: Yes, I was regularly talking to these statisticians to learn what they were doing. They were working on drug development, on medical procedures and medical devices. Their companies were spending millions of dollars, and if they could not get approved by the FDA, then it was a dead end. I knew nothing about FDA. We didn't have anything like this back in Iran. I had to see this place.

So I started corresponding with the FDA—I had a contact there, Kooros Mahjoob—and eventually they invited me as a visiting scientist for one year, 1989–1990. I went there to learn firsthand about procedures and expectations at this regulatory agency. They were talking all the time about pharmacokinetics, pharmacodynamics, phase one, phase two, phase three and so on. What are all these things? I registered for an advanced course, taught by the center's director, Carl C. Peck, on these pharmaco-things and received an advanced certificate from them. I really learned the material.

Later on, I became a member of data safety monitoring boards for Fujisawa, USA, Inc. (1994–1996), Otsuka America Pharmaceutical Inc. (1996–1999), G.D. Searle & Co./Pharmacia/Pfizer (1996–1999), Takeda Pharmaceutical North America Inc. (2003–2004), Astellas Pharma Global Development Inc. (2004–2012) and GE Healthcare (2005–present). I even chaired some of these. The year that I invested in FDA was really hugely beneficial to myself and my students. I learned their procedures, regulations, restrictions, language, etc., and my students got involved in projects on medical and pharmaceutical statistics; many later got internships or jobs here in the Chicago area.

Yang: Talking about your students, you had your first student already at Cornell, is that right?

Hedayat: Yeah, although I didn't know the name of the game at that time. John Eccleston was writing his thesis with me, but officially he was Kiefer's student. We did write a paper together. Then, in my two years at Florida State, I had my first official Ph.D. student, Kasra Afsarinejad.

Stufken: After that, at UIC, you've supervised almost 40 Ph.D. students, a tremendous accomplishment. Is there a secret to your success?

Hedayat: I am not sure. I suppose you would have to ask the students, including yourselves (John and Min), why they decided to work with me. It is probably a combination of things. From the beginning, I treat my students like my children. I care about them, tell them what I think, also when I am critical about them, and a relationship of trust develops.

The circumstances in which I have worked are perhaps also a partial explanation. I have taken advantage of the opportunities that Chicago has to offer for statisticians which, in turn, has created lots of research, internship and job opportunities for students. Beginning students see these opportunities and gravitate towards them. I have also been lucky to work with some smart students.

FIG. 3. *With some former students at the* 2006 *Joint Statistical Meetings in Seattle.*

Yang: Let's go to the legacy question! You have published four books and more than one hundred seventy papers, and still counting. What, in your mind, is your most significant contribution? What has had the most impact?

Hedayat: Let me tell you a funny story. When I was visiting at Berkeley, we often had lunch or dinner with Jack Kiefer. On one occasion, I asked him: if he could trade his papers or books for something else, what would it be? He said that he would give up all his accomplishments to be a member of the Beatles.

Stufken: The Beatles?

Hedayat: This was at the time when the Beatles were really famous. He was telling me that the impact that these guys had on society was so much greater than anything he had done in his professional life. If you measure the worth of your activity by the impact it has on people and society, he was saying, I'd give up anything to be one of the Beatles.

But seriously, forget about the books and the papers; my greatest impact has been through the impact of my students in the profession. That is why I proudly place the students' names and their jobs on my website. It is really my pride. When you write a paper for *The Annals* or *JASA*, sometimes only a few people look at it. But with students, whether they take positions in academia, industry or government, it is an almost everlasting contribution. It impacts the future generations. This is what I consider to be my major contribution to the profession. And, as I mentioned before, I have been lucky to get smart and caring students here at UIC. They have been able to get good positions in some of the best universities, like you guys, or in government or industry.

4. ADVICE FOR STUDENTS AND JUNIOR FACULTY

Martin: Are there any experiences from your time as a student at Cornell or elsewhere that you'd like to share with today's students?

Hedayat: At Cornell, I was famous among students for wanting to take courses from every statistician and probabilist. I took courses from everyone, even though this was not required as part of the program. I knew that this was my best chance, to really learn from these people, from these giants. For students who want to have an impact, to be a player in whatever field they choose, they need to work hard to develop the necessary technical skills; this is essential.

And this learning process shouldn't end at graduation. I mentioned previously my yearlong visit to the FDA and the advanced training course I took. In that course, I remember that the first homework was on

FIG. 4. *Near the Great Wall in China in* 2006 *with former students John Stufken, Hegang Chen and Min Yang.*

the pharmacokinetics and pharmacodynamics of water. How does it move through the system, the stomach, the liver, the kidney, etc.? I had no idea, so I got a D grade for that. Despite this initial setback, I stuck with it and eventually completed the course, earning an advanced certificate on pharmacokinetics and dynamics from FDA. It would have been easy for me to drop out after failing the first assignment, but then I would have missed out on this experience that had such huge impact on my career.

Stufken: As you have already described, your transition through the ranks was rather unusual. Some of the activities that we have discussed are, depending on the department, easier to devote large amounts of time on for a person with tenure. What about a junior faculty member? What advice do you have for a tenure track junior faculty member?

Hedayat: This is related to the discussion piece you and I wrote a few years back (Hedayat and Stufken, 2009). I think it depends very much on where you are. If I were a young person in this department here at UIC, or in a statistics department that highly values first class methodological research, then I know that publishing in good statistics journals and getting grants is what I have to do to get tenure and get promoted. That has to be my first priority. After that, if you are interested in being a practicing statistician instead of a mathematical statistician, then you can get involved with applied projects.

Unfortunately, some faculty do not get the message. You need to know the name of the game in your department. You should play that game, and if you can't, you better leave that place. Otherwise, the place will essentially destroy your professional life. My recommendation to junior faculty is to discover the name of the game to be successful at your place. Play that game hard, and if you can't, then prepare for a different game that you can play elsewhere, perhaps through applied work or interdisciplinary collaborations. Not only can that help you prepare for a game that suits you better, but in the process you may also be able to support and create opportunities for your students.

5. PAST, PRESENT AND FUTURE

Stufken: You have seen many changes in the profession over the years. What do you see as some of the major changes, for example, in terms of opportunities for statistics and statisticians?

Hedayat: When I was a student, statistics was important, but not nearly at the same level as it is now and not for all fields. Even at a place like the FDA,

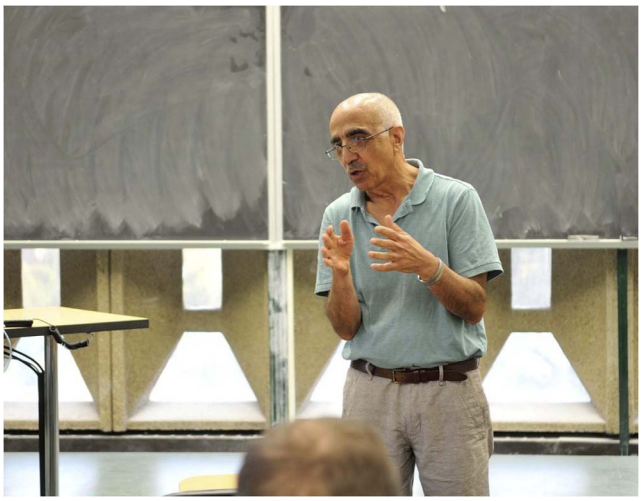

FIG. 5. *Hedayat lecturing in Fall* 2011.

they were using statistics, but not in a serious manner. Now this is completely different. In industry and government agencies, these days everything has to be evidence-based. Most research and decisions made in society are evidence-based. And evidence-based means data-driven.

Martin: So all of this means that there are more opportunities for statisticians.

Hedayat: Yes. But it comes with positive and negative consequences. It is good because there are so many more doors that have opened for statisticians. No statistician needs to be professionally homeless. But this plethora of opportunities also is a liability, and this affects both faculty and students. The need to work hard for something diminishes with an increasing number of opportunities. If someone is not happy on the job, or not doing such a great job, they can just leave and take a job somewhere else. Similarly for students, no matter how they perform or what they know, they can find a job somewhere.

Yang: So students don't have to excel or stand out anymore?

Hedayat: You can see that many students are not committed to learning and exploring because the job is there when they finish. If they cannot find a university job, they can find one in industry or government. Or they team up and form a consulting group. The availability of software also creates a liability. Why learn the basics if the software is doing the job for you? So while we should be happy that statistics and statisticians have all these opportunities, there is a flip side to it.

Stufken: Given the pluses and minuses, how do you see the future of statistics as a field? Are you optimistic?

Hedayat: I really believe that the world will become more democratic, everywhere, in part because of the internet and means of communication. There will be increasing amounts of information, and the trend of evidence-based decision-making will only become stronger. I think that statistics is not only going to survive but is going to flourish for a long time to come.

Yang: So you think that statisticians will be able to take advantage of the opportunities that exist?

Hedayat: As a statistician, you have a choice to be a player or a spectator. To be a player, you have to get in the game, get involved. Unfortunately, some statisticians are acting like spectators. However, the impact that we can have in an evidence-driven society will be exciting enough to inspire enough statisticians to be players, which will allow the field to flourish.

Yang: Let's talk a bit about current trends in statistics. Just as in any other field, there are leaders and followers, resulting in "hot areas" and trends. These days, some of the buzzwords are computing, big data, data science. What do you think of those trends?

Hedayat: I have mixed feelings about it. More important than being part of a trend is the contribution that a statistician makes. I am concerned that some people hide behind these buzzwords, but are neither making a contribution to solving a scientific problem nor to the foundation of statistics. They call themselves a statistician but do not make a meaningful contribution to the field.

I like to tell my students that once they have a job, they should make contributions that force their employer to see them as irreplaceable. Unfortunately, as we discussed before, because there are so many opportunities for statistics, not enough people put in the effort to excel. Some of them are very good and could produce great results, but they don't feel the need to do so.

Stufken: Having touched on the future and current state of the field, let us look back briefly. Over the length of your career, you have seen many developments in statistics. Is there anything that stands out to you as a game changer?

Hedayat: From my perspective, it is the growth and development of biostatistics. The importance of biostatistics for medical research has an enormous impact on our field. Now, with requirements from regulatory agencies and the broad interest to study human health and to find solutions for diseases, this has benefited our

field tremendously. And there are so many outstanding statisticians working in biostatistics, who have developed powerful statistical tools and procedures. The search for solutions for diseases and viruses is again evidence-based. Perhaps I am biased because I am interested in medical statistics and have spent a year at the FDA. Maybe there are parallel stories in astronomy, physics, chemistry, social sciences, engineering, etc. I am willing to listen to anyone making an argument about other areas of application, but I will be shocked if they were to claim that the development of biostatistics is not a major breakthrough.

Yang: Much of our discussion so far has been about statistics in general. What do you think about the state of design of experiments? How has it developed and where does it currently stand?

Hedayat: I think that for research in design of experiments to shine, it has to address a practical problem. And you don't have to give highly efficient or optimal solutions. When you go and see a doctor, she is going to give you some suggestions. These may not be the best, and may not even be very efficient, but you walk away with an answer. The doctor is not going to tell you, sorry, I don't know what the best answer is, so you do whatever you want to do. The same thing with design. Get involved with practical problems, and provide an answer, however unsatisfactory. If you then want to dig deeper in your spare time, do so.

Martin: Are there any important topics that we didn't address?

Hedayat: We have covered a lot, but there is one other thing. We are moving to a virtual world, and this will have enormous consequences for our profession. I am not sure that we are really preparing ourselves for that. For example, libraries will be replaced by a virtual library. Everybody will pay a fee to a virtual library for access to journals and books. The same will happen for teaching. There will be a virtual university, providing unparalleled access.

Whether I am in the Middle East or South America, if I want to take a course from a particular professor at, say Berkeley, I will be able to do that. The same will also happen for consulting. How are we preparing ourselves for this new reality? I have some friends who are radiologists. Nowadays, they take a picture, and then send it to Bangladesh for analysis. It is cost-effective to do this.

Stufken: Universities will also become very different institutions.

Hedayat: This is already happening. As statisticians we are lucky that, even if teaching opportunities diminish, we can continue to contribute through consulting and data analysis. The virtual set-up automatically means big data. There is information about millions of students who are taking courses. There will always be opportunities for a statistician provided that we are players and not spectators.

Yang: But we will have to compete with others in the data science realm.

Hedayat: This is the reality of life. When you go to be a player in the game, you may discover that there are others with different skills or more energy. This means that you have to spend more time or put in more effort. You look around and find ways to contribute. As in football, if you want to be a player but can't be a quarterback, then you become a receiver, center or safety.

6. CONCLUSION

Stufken: The fact that we are having this conversation means of course that you are no longer at the beginning of your career. You are still active, however, so what does the future hold for you?

Hedayat: Well, it is now mostly about helping my "tribe" to do well. My former students are my friends, and I would like to see them do well, and help with that where possible. See them become famous, productive and influential. I also care about my academic grandchildren.

I have never understood colleagues who did not place students at the core of their activities. When they left the profession, there was essentially no trace left of them. While you may write good books or papers, these are things that, for the most part, get lost over time, but successful students make a lasting impact. I am really proud of my students, and I hope that they share their experience and philosophy with the next generation.

Stufken/Yang: The impact that you have had on our careers is indescribable. We have benefited from your wisdom and constant advice, and would not have been where we are without your devotion. Your friendship has also been precious. Thank you so very much!

Martin: You were not my advisor but, even just as a colleague, you have had a substantial impact on my development, both personally and professionally. I cherish your friendship and mentorship and it is a tremendous honor to be a part of this interview.

Hedayat: It has been an honor for me to talk with you three, and many thanks for helping to share this conversation with the statistics community. I have been lucky and indeed honored to be the academic advisor to John and Min and a colleague to Ryan whom I consider a great friend. Thanks.

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