



Glenn Shafer — A short biography

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ABSTRACT

This editorial article is a biography of Glenn Shafer, briefly covering his early years, his education, and his contributions as an academic to research, teaching, and administration.
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1. Early years: Caney, KS

Glenn was born in 1946 (12:30 pm on November 21) near a small town of Caney in Kansas, next to the border with Oklahoma. Most of his ancestors were farmers in the area. Already his great-great-grandfather Henry Shafer (1825–1905) lived part of his life in Caney or its vicinity.

There was no heat in the room where newborn Glenn slept on his parents' farm, so that his milk would freeze in the bottle. He had a bad cold turning into pneumonia in the first winter of his life. He was treated with penicillin, a new and expensive drug at the time. That winter was unusually cold, the coldest one on their farm that Glenn's father could remember [25, Chapter VI].

Glenn's schooling was in Caney, and his high school years were 1960–1964. Besides his interest in the history and philosophy of mathematics [18, Section 1], Glenn had a keen interest in agriculture, taking part in various activities of the FFA (Future Farmers of America). He enjoyed and performed well in contests organized by the FFA. In his last high school year, in Spring 1964, he won the state speech contest. In Autumn 1964 he placed second in the national speech contest in Kansas City with his speech "New Problems, New Solutions" that discussed ways of improving the lives of American farmers (including education). As part of his FFA work and with support of his father, Glenn started a farming project, with five Holstein cows and used milking and cooling equipment. He raised some of the grain and forage they needed, milked them twice a day, and sold the milk to a local dairy. By the time he graduated from high school, he was milking ten cows, which he had named after national political figures, Republicans and Democrats.

Another highlight of his high school years was his six-week stay at Princeton University in the summer of 1963, to study the Bill of Rights. He was awarded the scholarship that made this possible as result of his performance on a nationwide exam, the Preliminary Scholastic Aptitude Test.

2. University education

In Glenn's last year of high school he pondered whether to continue his study of agriculture and eventually become a dairy farmer with his father or to pursue a more elite education. He was admitted to Kansas State University, Princeton,

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Harvard, and Cornell, and he was fortunate to win a National Merit Scholarship to help pay for his study. He decided to go to Princeton, which he had so enjoyed in the summer of 1963, when there had not been any preppy students [5] on campus. He was an undergraduate there from 1964 to 1968.

Glenn had not studied a foreign language in high school and does not even remember hearing one spoken before entering university. Required to learn one at Princeton, he chose French and became enchanted by it. By the beginning of his second year, he was considering a major in French, and through Princeton he was sponsored to spend two months in France in the summer of 1967, in what the French called a *stage*, learning about French business. During the first month he worked in all facets of the production of Roquefort cheese, from the farms to the dairy to the packaging plant. The second month he spent in Paris, in a facility that packaged spare parts for Peugeot automobiles. This early acquaintance with the French language and culture stood him in good stead when he later became interested in the history of mathematical probability.

At the end of his second year, Glenn hesitated between the departments of French, philosophy, and mathematics, deciding in favour of mathematics at the last moment [18, Section 1]. He loved Princeton's intellectual opportunities. Even while majoring in mathematics in his last two years, he still was able to follow courses in a wide variety of fields (this is the United States system), and he would have gladly continued doing this for several more years.

After Princeton, Glenn joined the Peace Corps in Afghanistan, teaching geometry in a school for training surveyors and then trying to work in an agricultural project in the Helmand Valley. In the school for surveyors, the principal asked him to bolster the performance of an Afghan teacher. Glenn taught in English, and Afghan teacher translated into Dari, the Afghan dialect of Persian. Having studied Dari before arriving, Glenn soon realized that the translation was faulty. His attempts to improve the translation soon evolved to his teaching in Dari himself, but then he realized that the Pashtun students, about a third of the class, did not understand Dari. He began to study Pashto, but his students' papers convinced him that his efforts were only befuddling his students and humiliating his colleague. When he spoke to his supervisor about leaving, the supervisor asked him to explore the possibility of working with an expensive effort by the US foreign aid program to expand irrigation in the Helmand Valley. The ensuing experience was very interesting but disillusioning for Glenn. Convinced that both the irrigation project and the surveying project, which aimed to create secure land titles, were misguided, out of touch with the country's means and culture, Glenn left Afghanistan after only one year.

At the beginning of the summer of 1969, Glenn flew back to the US via the Soviet Union, stopping in Dushanbe, Tashkent, Moscow, and Leningrad. Dushanbe looked very modern to him compared with the cities in Afghanistan, but he was only able to see what the ethnically Russian tour guide would show him. Moscow and Leningrad looked imposing.

After coming back from Afghanistan, Glenn had to deal with the expectation of military service. He applied for officer training programs and was accepted for an air force program. But within a month the program was cancelled, following the Congress's refusal to appropriate further money for the air force, and then Glenn was called for a draft physical. When the examining doctor saw Glenn's educational credentials, he stunned Glenn by telling him that he did not need to go, and when Glenn said nothing, he excused him from the draft, marking him "4-F" for minor medical problems. Glenn was the only member of his high school class to attend an Ivy League university, and the only male in the class never to serve in the active military or the national guard.

After spending part of the summer at home in Kansas with his parents Glenn went to San Francisco to look for a permanent job, in the meantime working at various temporary jobs, including cleaning offices and being a substitute teacher. He did not find anything that seemed interesting, and he went to graduate school to do a PhD in mathematical statistics. Initially he was not thinking about probability and statistics, but when he showed up in Berkeley, CA, in July 1969, the members of the Mathematics Department in charge of advising applicants were on vacation. Fortunately, Lucien Le Cam was the graduate advisor in the Statistics Department, he was in his office, and his door was open. He assured Glenn that they also did mathematics. Glenn's choice of Statistics over Mathematics in 1969 was also fortunate in view of his interests in philosophy.

Glenn studied at Berkeley for only two quarters, in the winter and spring of 1970, but in addition to being introduced to probability and statistics, he took a course in swimming. His instructor, Teresa Ann (Terry) Shistar, became his first wife.

Glenn was treated very well by the Berkeley statistics department, and learned a lot there; his teachers included Peter Bickel, Eric Lehmann, Florence Nightingale David, and even Jerzy Neyman. But he was very dissatisfied with the Neyman–Pearson philosophy. Having applied for and been awarded a graduate fellowship by the National Science Foundation, he had the option of looking elsewhere, and he was admitted to Chicago and Harvard. One of his teachers suggested to him that he might find Harvard more interesting because it was more applied. He persuaded Terry to move with him to Harvard, and they were married in very private ceremony in Boston in September 1970.

Glenn spent only a year at Harvard, where he again learned a great deal; his teachers included Fred Mosteller and Art Dempster. But Boston proved an unpleasant environment for Terry, and at the end of the year they moved again, to the statistics department at his alma mater, Princeton.

Art Dempster was obviously Glenn's most influential teacher at Harvard. During his year there, Glenn valued most the course Art taught in the history of statistics, but at Princeton he began an intensive study of Dempster's papers on upper and lower probabilities. Glenn kept in close contact with Dempster during the Princeton part, 1971–1973, of his PhD study. His dissertation committee included Dempster and two Princeton faculty members, Geoff Watson, the chair of the Statistics Department, and Gil Hunt, the famous probabilist in the Mathematics Department (and tennis player reaching the quarter-finals of the US National Championships in 1938 and 1939). In 1973 Glenn was awarded a PhD in Statistics from Princeton

University. The dissertation “Allocations of Probability: A Theory of Partial Belief” was submitted in May 1973 and defended in September 1973.

In all three places where Glenn did his PhD studies he had an opportunity to learn more about the history of statistics [18, Section 1], from the statisticians Florence Nightingale David at Berkeley and Art Dempster at Harvard, from the historian Ivo Schneider at Princeton, and from the excellent libraries in all three universities. Glenn still believes that “the most enduring advances will draw on history” [18, Section 13], and this has been one of the main guiding principles in his research. He is convinced that we assume too readily and thoroughly that what is presently taught is natural and inevitable, and that we can overcome this assumption only when we see how fortuitously present thinking arose.

3. Academic career: Princeton period

Glenn's PhD dissertation was more or less finished already by the summer of 1972. At that time he agreed to become an assistant professor at Watson's department starting from Autumn 1973 (he was “hired casually from the inside” by Watson [18, footnote 7]). This allowed him to spend 1972–1973 planning what he regards as the first of his several attempts to write the great American probability book [18, Section 3]. The project did not materialize, but shortly afterwards Glenn wrote his most successful book to date *A Mathematical Theory of Evidence* (1976) [10] launching in earnest what came to be known Dempster-Shafer theory. Having an enthusiastic supporter in Watson, Glenn had ample time for conducting research for the book and for writing it.

The 1976 book began as an article about a conjecture, the *weight-of-conflict conjecture*, later proved by a Chinese student, Lian-Wen Zhang [28]. In order to explain the conjecture, Glenn had to explain the intuitive appeal of what he called “Dempster's rule of combination”. His explanation was so long that the article became a book. It was also this explanation, rather the conjecture, that made the book successful. The idea of mathematical method for combining evidence attracted attention in computer science, engineering, philosophy, and other fields, and tens of thousands of citations.

See the celebratory issue of the *International Journal of Approximate Reasoning* [4] devoted to the 40th anniversary of Dempster-Shafer theory. Numerous papers on Dempster-Shafer theory published in the journal are listed in the editorial [3].

4. Back to Kansas

In 1976, shortly before [10] was published, Glenn had returned to Kansas to teach in the Department of Mathematics at the University of Kansas (Lawrence, KS), disregarding Watson's warning “Mathematicians don't know how to treat statisticians” [18, Section 4].

Two sons were born to Glenn and Terry in Kansas: Rick in March 1978 and Dennis in April 1981. Sadly, Glenn and Terry divorced in 1985, when the boys were still very young. But both parents remained fully involved in the boys' lives. Rick now works in IT at the University of Pittsburgh. Dennis lives in Salem, Massachusetts, where he continues to pursue a career as a musician, participating in a successful wedding band and teaching at various locales.

Glenn spent most of the academic year 1978–1979 at the Department of Statistics at Stanford on a National Science Foundation postdoctoral fellowship. At Stanford Glenn met many other visiting statisticians, including Tze Leung Lai, who later became a Professor at Stanford, and Akimichi Takemura, a young Japanese statistician. Philippe Smets, who became the foremost leader in developing belief functions until his untimely death in 2005, visited Stanford briefly and surprised Glenn by knocking on his office door to introduce himself.

Glenn's book was just beginning to attract widespread attention, and this led to interactions with computer scientists and psychologists, including Patrick Suppes, Lotfi Zadeh, David Krantz, and Amos Tversky. Suppes was skeptical about Glenn's ideas, wanting a mathematical definition of *evidence*, whereas for Glenn evidence was an episode of experience, formalized only when degrees of belief are constructed from it. Zadeh seemed to have perceived a possible rival. Krantz became a proponent of belief functions, publishing several articles on the topic and becoming a dear friend.

Tversky, when they first met, asked Glenn whether the degrees of belief of the Dempster-Shafer theory were normative or descriptive. Glenn answered that they were neither; they were constructive. They were judgements constructed from evidence and argument, judgements that might be more or less convincing. Glenn and Tversky's efforts to understand each other led to a joint paper [22] comparing the Bayesian and Dempster-Shafer languages as tools for analyzing evidence. Tversky had similar discussions with Howard Raiffa and others. They concluded that the third category, after normative and descriptive, should be “prescriptive” [1]. In Glenn's eyes, this did not quite hit the mark, as one need not “prescribe” a judgement or an argument to others.

In 1981, Glenn's 1976 book suddenly became widely known in artificial intelligence (AI) as a result of its discovery by three different research groups in California. This is when Jeff Barnett, at Northrup in Los Angeles, called the book's theory the *Dempster-Shafer theory*, a name that stuck [18]. This led to many invitations to speak at meetings and departmental seminars across the country and in Europe. The “fuzzy” community that had developed around Zadeh was especially interested and friendly.

In 1982, Glenn's critique of Thomas Bayes's famous paper was published in the *Annals of Statistics* [11]. The paper argued for bringing time back into the foundations of probability. Glenn insisted that conditional probabilities have a claim to validity as degrees of belief or evidential support only when they are conditional with respect to a pre-chosen protocol

(often formalized as a filtration). The idea was further developed in [12] and eventually evolved into his theory of probability trees.

In the first years of his career, Glenn had a steady flow of grants from the statistics division of the National Science Foundation. He remembers, though, getting a telephone call in the early 1980s from Ron Yager, then a grants officer in a new AI section in the NSF, who suggested that Glenn apply for a much larger grant from his section. Afterwards, he had much larger grants for about a decade. The grants enabled him to support colleagues and students, but they also required writing a lot of applications and reports, and this was often a significant distraction from the work he wanted to do.

In 1984 Glenn moved to the Business School at Kansas from Mathematics. The move happened after a campaign that he organized trying to launch a department of statistics at Kansas. Despite the support of all Kansas statisticians and such luminaries as Fred Mosteller of Harvard, Ingram Olkin of Stanford, and Dennis Lindley of University College London, who came to campus and took part in writing a report to support the idea, the university administration decided against it. It was easier to move Glenn to the Business School.

Right after moving to the Business School, Glenn organized a seminar attended by several fellow statisticians and a few non-statisticians including Prakash Shenoy, then Professor of Decision Sciences. Shenoy and Glenn became close colleagues working together on the computational aspects of Dempster-Shafer theory [21,26]. Part of this work was summarized in Glenn's 1996 monograph [15] (which was almost completed already in 1992).

In 1988, Glenn was appointed to the business school's Ronald G. Harper chair in artificial intelligence. Because of the growing popularity of Dempster-Shafer theory in the AI community, more and more of Glenn's intellectual contacts and speaking engagements in the 1980s had been in other fields, including computer science, engineering, and psychology. He maintained his self-identification as a statistician in these years, and argued that statistics should broaden its picture of probability; see, e.g., his [13]. After he left for New Jersey in 1992, the chair was awarded to Shenoy.

The academic year 1988–1989 was Glenn's sabbatical year at the Center for Advanced Study in the Behavioral Sciences, now part of Stanford University. The idea was to begin a book entitled *The Unity and Diversity of Probability*, another version of his great American probability book that was never completed. At the Center, Glenn met his second wife, Nell Irvin Painter, a famous Princeton historian (at this time [9] is perhaps her best known book). They were married in October 1989 in the chapel at Princeton.

5. Rutgers

In 1992, Glenn moved to New Jersey in order to join Nell, after commuting for three years between Kansas and New Jersey. In 1990 Glenn and Judea Pearl had co-edited a book [20] of readings on the different approaches to uncertain reasoning in AI, but by this time he was much more interested in probability trees and their applications, first to causality and then to game-theoretic probability. He spent part of the 1992–1993 academic year in the Department of Philosophy of Princeton University and organized a seminar on causality there. His 1996 book [14] on probability trees and causality grew out of this seminar, as he writes in the preface.

In the same year, 1992, Vladimir Vovk, a mathematician from Moscow, started correspondence with Glenn about using probability trees in the foundations and applications of probability [18, Section 11]. In May 1994 Glenn travelled to Moscow where they met, and Glenn gave a talk on probability and causality at Moscow State University on May 16, 1994. This started their collaboration that eventually has led to three joint books, [23], [27], and [24].

In June 1995 Steffen Lauritzen hosted a week-long seminar at Aalborg University to which he invited Glenn, Vovk, and Philip Dawid, the author of the prequential principle, a key component of game-theoretic probability. Other participants included Judea Pearl and Jan von Plato. This was Glenn's second visit to Lauritzen in Aalborg, the first one being a month at Aalborg in the spring of 1991. Glenn presented the main results of his forthcoming book [14], and Vovk presented an alternative language for probability trees, a kind of perfect information games. When they discussed with Lauritzen the difficulties of publishing new ideas in journals, which tend to be conservative (for a good reason), Lauritzen suggested a simple way out, writing a book. In fact, this was how he wrote his 1988 book [6]. Glenn and Vovk trace the idea of writing their 2001 book to this meeting [23, preface].

Lauritzen's advice was not the first of this kind. At one point in the 1980s, Dawid pointed out to Glenn that the book, rather than the article, was the natural mode for his thought. He should, Dawid said, publish a book every two years. Glenn took this advice to heart. But interactions with colleagues and students, together with the demands of granting agencies, inevitably led to articles. After his 1976 book it was 20 years before he published another.

In 1996 Glenn's *The Art of Causal Conjecture* [14] was published. It gave a very detailed exposition of probability trees, applied them to causality, and argued that probability trees can represent causality in a deeper and more flexible way than causal directed acyclic graphs can. This more detailed representation brings with it a computational cost that is often prohibitive, but more and more applications are becoming practical [2].

After *The Art of Causal Conjecture* appeared, Glenn put a lot of work into what he called *event spaces*, where situations or instantaneous events at different levels of refinement coexist. He gave several talks on this topic, preparing a beautiful paper, [16] (published in this Special Issue for the first time), for two of them.

In 1996–1997 Glenn, Nell, and Glenn's son Dennis spent a sabbatical year in Paris hosted by Jean-Yves Jaffray, Jean Ville's student and his successor at the University of Paris. He gave lectures on his 1996 book and started working on the 2001 book with Vovk [23]. Overall, he gave 28 talks in Europe and Tunisia that year, none of them in a department of statistics.

While in Paris, Glenn was able to participate in the renowned Paris seminar on the history of probability, which was meeting at that time in the Jardin des Plantes. He had been corresponding with some of its other participants, including Bernard Bru, since the early 1980s. It was a truly interdisciplinary undertaking, held together by the beloved leadership of Marc Barbut (1928–2011). When the seminar launched its *Electronic Journal for History of Probability and Statistics* in 2005, Glenn joined the editorial board. His contributions to the journal included translating many articles from French into English. In the early 2000s, inspired by conversation with Barbut, Glenn collaborated with the energetic managing editor of the journal, Laurent Mazliak, in investigating the story behind the German arrest and subsequent release of the mathematician Émile Borel in 1941. Their dive into the archives cast new light on some aspects of collaboration and resistance in the French university [7]. The electronic journal flourished from 2005 to 2013 but suffered from the fact that it did not publish enough articles to have an “impact factor” calculated by groups counting citations. The tributes to Barbut in its last issue included one by Glenn [17].

In Spring 2001 Glenn was a Fulbright fellow at the Free University of Berlin, hosted by Hans-J. Lens. He again spent quite a bit of his time speaking across the continent. He and Vovk were finishing their book, and he was spending most of his time on this. In the same year, 2001, the book was published. One of its main ideas was to replace measure with perfect-information games in the foundations of probability, essentially making Jean Ville’s martingales the new foundation of probability.

In 2002 Glenn and Nell moved from Princeton to Newark, the place of Glenn’s work and the largest and liveliest city in New Jersey, next to New York. There Glenn became more involved in university activities, while he and Nell became part of the larger community and the art scene.

In 2005 a book on conformal prediction [27] co-authored by Glenn appeared. Lauritzen’s 1988 book [6] played a role in this project as well. During the 1995 workshop he gave a copy of his book to each participant, and the central notion of repetitive structure studied in his book also played a central role in [27].

Glenn took an active part in preparing “The Splendors and Miseries of Martingales”, a special issue about martingales of the *Electronic Journal for History of Probability and Statistics* published in 2009. One of the papers that he contributed was the massive “The education of Jean André Ville”, in which he traces Ville’s life and ideas up to the time of the defence of his thesis (1939), in which Ville introduces martingales in an attempt to overcome drawbacks of von Mises’s picture of the foundations of probability. At this time Glenn and his colleagues are preparing a book based on this special issue. He and Laurent Mazliak are the co-editors. “The education of Jean André Ville” will not be in this edited book but will be part of Glenn’s biography of Ville, which he plans as his next big project.

A second book by Glenn and Vovk on game-theoretic probability, [24], was published in 2019. It started as a second edition of the first book [24], but soon it became clear that it was becoming a very different book. In particular, it incorporated some of the great work done by the Tokyo school of game-theoretic probability headed by Kei Takeuchi and Akimichi Takemura.

At this time Glenn is promoting a simple special case of the betting framework of [24] as a new foundation of statistics [19]. Despite its simplicity, it opens new opportunities, and it was the topic of one of the sessions of the ISI World Congress in the summer of 2021.

In the business school in Kansas, Glenn was in a management science group and taught statistics, probability, and decision science. When he moved to the Rutgers Business School, he joined its Department of Accounting and Information Systems. The department was interested in his work because Dempster-Shafer theory was being used in expert systems for financial auditing, and this and his other work was relevant for information systems. Glenn taught auditing, information systems, statistics, and finance and worked with doctoral students in accounting, finance, and management science.

In 1997–2000 and 2003–2010 Glenn directed the school’s doctoral program. He agreed because he wanted to improve the program to the point that it would attract students qualified to work on the more mathematical aspects of causal reasoning and game-theoretic probability. But once he started managing the program, his focus shifted to helping its existing students. Some of his colleagues felt that he was better for the students than the faculty. He reorganized the curriculum, turning the program from one where many students lingered for years and often left without degrees to one where a very large majority of students graduated in five years and obtained university positions. He also improved the admission and funding policies, increasing the number of minority students and graduates, directing funding to students who most needed it while expanding the program by allowing wealthier students to pay their own way.

From January 2011 to December 2014 Glenn was the Dean of the Rutgers Business School. He took the job on an emergency basis, following the sudden resignation of the current dean, at a time when the school was confronted with the need to expand its undergraduate teaching immensely to accommodate additional students. Many faculty members who were at first pleased that the school would be headed by an exceptionally accomplished scholar rather than a professional administrator were again less happy when he made changes that were needed to fulfil the school’s mission for the students. Nevertheless, his leadership team was able to enhance student diversity, provide more access to less privileged students, expand support for faculty research, obtain funds for new endowed chairs, begin a number of new graduate programs, and strengthen connections with the business community.

6. Sources

This biography draws on several key sources, which are usually not mentioned explicitly. An excellent source for Glenn's early life, and even the life of his ancestors and relatives before his birth, is his father's biography [25]. We often draw on [18] and [8] for Glenn's research, both articles prompted by the 40th anniversary of his 1976 book [10]. The prefaces to his books also were a useful source of information.

Acknowledgements

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