55 Years of Harvard Statistics: Stories, Snapshots, and Statistics

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Late evening of Valentine's Day, 1957. The driver of a VW Bug, wearing his trademark leather hat with ear flaps, waited patiently at Boston's Logan Airport. Finally a pair of newlyweds stepped out of a much delayed flight from Toronto. They were not expecting a Valentine's Day party, but rather an Ivy League interview process. However, the VW Bug took the young man and his bride directly to a house on Pierce Street in Belmont, about 15 miles west of the airport. Greeting him was not a set of challenging questions, but a very lively celebratory party already in progress.

The driver was none other than Frederick Mosteller, the founding father of our department. The young man was Arthur Dempster, who was interviewed the next day for an assistant professorship. He, however, did not join the department until 1958 because, as Mosteller wrote (Annual Report, 1957–1958), "Dr. Dempster thought a year of applied work would do him good, and he went instead to the Bell Telephone Laboratories." Having one's statistical research rooted in and motivated by real-life applications became a hallmark of Harvard Statistics' outlook (or "departmentality") from very early on precisely because of the conviction and the practice of our founding generation, and those who came later.

Mosteller and his wife Virginia hosted the party because merely 2 days earlier, Harvard's Faculty of Arts and Sciences (FAS) had voted to establish a Department of Statistics at FAS. As Mosteller opened his first annual report: "Lincoln's birthday, 1957, marked the establishment of the Department of Statistics by a Faculty vote, after debate that lasted about eight minutes. But Harvard has not been as hasty as this might imply".

Indeed, the lucky number "eight" would be appropriate if we replace "minutes" by "years".

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The Early Trimesters

Mosteller joined Harvard during 1946–1947, the year when the Department of Social Relations was formed. Mosteller was recruited to this new department from Princeton as a fresh PhD in Mathematics.[1] During 1948–1949, Mosteller taught *Mathematics 190*, *Mathematical Statistics*, for the first time. It was also during that year that Harold A. Freeman, a Professor in the Department of Economics at MIT, wrote to Mosteller, proposing a joint Harvard-MIT degree in Statistics.

Freeman, like Mosteller, was a member of the Statistical Research Group, based at Columbia University,[2] where he collaborated with Abraham Wald in developing applications of Wald's groundbreaking 1943 work on sequential analysis. He also served as a consultant to the US Army and a number of other governmental agencies, and became a vice president of the American Statistical Association during 1949–1950.

This background of Freeman provides a glimpse into his motivation for a joint statistics degree, which was not given in his letter dated December 9, 1948. But his list of possible topics and courses outlined his vision: a well-balanced program integrating theory and applications. In particular, he wrote:

> We could quite nicely cover the necessary mathematics, probability, mathematical statistics, and the higher levels of stochastic processes, modern computing techniques, and we would deal with certain applications particularly in fields as electronic communication, physics, econometrics, psychology, neurology, and education.

This description is so strikingly contemporary that a future amateur historian could well mistake it as a proposal from MIT at the turn of the twenty-first century, especially considering that MIT still does not have a statistics program more than 60 years after Freeman's proposal!

Freeman's proposal seems to have been an important impetus to Mosteller's first proposal for establishing a Committee of Statistics at Harvard. Among Mosteller's many meticulously kept and chronologically ordered records, Freeman's letter and Mosteller's proposal were kept back-to-back, immediately after a ten-page document of "Early History of The Department of Statistics" (hereafter, the Document). This document listed no author, but even the most casual reasoning in Mosteller and Wallace's "*Inference and Disputed Authorship*" would lead to the conclusion that Mosteller was the author, likely aided by his life-time collaborator and assistant, Cleo Youtz (1909–2005), who was also the department historian, among many invaluable contributions she made to the department.

The document stated that "About this time Professor Mosteller wrote a proposal for a Committee of Statistics." Whereas the two-page proposal shows no date (but

[1] Much information about Mosteller's career at and contributions to Harvard (and beyond) can be found in "*A Statistical Model*" (Eds: Fienberg, Hoaglin, Kruskal, and Tanur, 1990, Springer), and in the edited autobiography "*The Pleasure of Statistics*." (Eds: Fienberg, Hoaglin, and Tanur, 2006, Springer).

[2] See Stephen Stigler's "University of Chicago Department of Statistics" in this volume.

with a penciled "Date?" on it), we can be reasonably certain that the gestation period for the establishment of Harvard Statistics, which officially started its life on July 1, 1957, is just a few months shy of 8 years. (See Stigler[3] (2008) for the pre-Mosteller's era.) The first trimester, however, seems to be an almost unnoticed one, as the document described: "During the year of 1950–1953, no notable progress was made toward the establishment of a statistics department or a committee on statistics." In his autobiography, Mosteller recalled that his proposal was declined in April 1950 by then Provost Paul Buck, who considered the field of statistics was much too narrow for Harvard (see footnote 1).

The documented evidence of the influence of Freeman's proposal came from a 1954 Report by a Visiting Committee and a 1956 Report by a Subcommittee on Statistics (of the Committee on Applied Mathematics), which was chaired by Mosteller. The 1954 Report resulted from Ford Foundation grants to five universities, one of which was Harvard, to review their behavioral sciences. That report suggested "exploring the possibility of developing statistics jointly with M.I.T." The Subcommittee Report, dated January 27, 1956 (hereafter the Report), went further, making eight recommendations (from A to H), three of which are most relevant to the current discussion. They are:

> D. that ways be found to bring two full-time statisticians to Harvard, one of senior status,
> G. that though committees on statistics have universally failed, a committee on statistics initially be established with the view that a successful program would later lead to a departmental structure,
> H. close association be maintained with Massachusetts Institute of Technology so that advantage may be taken of new developments (they also are reviewing their statistics program).

The report included a section detailing a discussion with Freeman, mostly on nine MIT courses on statistics and information theory, and their relevance for the recommendations.

The second trimester therefore showed more vital signs. However, that vitality seemed to be short-lived. In responding to the subcommittee's recommendations, then Dean of FAS, McGeorge Bundy, wrote that while he had no reason to quarrel with the subcommittee's reasoning,

> I do have a remark that I do not see how this can be done without new resources, unless one or another of our existing departments is prepared to allocate a place to statistics. I do hope, therefore, that the Committee on Applied Mathematics may explore the question of the degree of interest with existing departments have in making such a contribution.

It does not take much experience with academic politics to see that this is merely a diplomatic way to say "NO." Virtually every department fights for resources, then, now, and will in the foreseeable future. Suggesting to one's colleagues that they should consider donating departmental resources to help build another department is almost surely a sign that either the chair is tired of her/his

[3] Stigler, S. (2008) Statistics at Harvard? A toast to the Harvard Statistics Department. *American Statistician,* **62**, 246–250.

administrative duties or s/he has more administrative aspiration than the chair's chair can accommodate.

A miscarriage therefore seemed to be looming.

Prepared for Complications

Evidently, this chapter would not have existed, literally and figuratively, if Mosteller was completely unprepared for Dean Bundy's response. The details in the report, however, suggested otherwise. I will ask the reader's indulgence for quoting this report extensively, because it provides a rather holistic picture of statistics as an academic field in the United States during the critical "big bang" period, when most of the current major departments came into existence, as documented in this volume.

For example, in its two-page section on "Administrative Arrangement," the report stated:

> In the country as a whole there have been five main ways of handling statistics: (1) as a separate department (in at least one school an entire institute has been formed), (2) as a semi-independent organization attached to another department, usually mathematics, (3) no separate arrangement, the statistics staff is usually part of the mathematics faculty, (4) some sort of committee structure exists to administer programs in case the need for them arises, (5) no special provision for statistics is made, staff belong to their own departments.

The report foresaw the trend over the past half-century, that is, moving from later categories to earlier ones, when it stated that "The writer knows of no American universities that have contributed an interesting number of statisticians to the profession in recent times with setup (5). The same remark applies to setup (4)." The report went on to refute the occasional citations that the committee format had worked at University of Chicago, because "It is a department in all but name—has its own budget, space, makes its own appointments, and grants its own degrees."

Having argued that neither (5) nor (4) was a healthy setup for statistics, the report cited Princeton as a successful example of (3), and cited the main reason being "After the close of the war, John Tukey became interested in the teaching of statistics." This emphasis on the direct link between teaching and success has had a lasting impact on the development of Harvard Statistics, which has produced an impressively large list of influential graduates, despite the fact that it was and still is the smallest department among its peers. Using the same criteria, the report cited the University of Michigan as another possible example of past success but that "They are struggling now to rebuild." Similarly, for the arrangement (2), the report acknowledged Berkeley had some success with that format, but emphasized that "The trend, however, is to the department, and Berkeley is moving toward that solution."

The report then provided a list of universities that the report stated would be generally agreed to be major institutions in Statistics in the United States "from the point of view of training." It included nine institutions, all but one of which are still currently major "statistics institutions" by Mosteller's criteria: Berkeley, Chicago, Columbia, Iowa State (College), Michigan, North Carolina Chapel Hill, North Carolina State (College), Princeton, and Stanford. The report then emphasized that "All but Princeton and Michigan had the equivalent of a department, and both have a Laboratory."

With such supporting evidence, the report naturally concluded that:

> The historical evidence therefore is clear, no organization has led to nothing, committees have uniformly failed, with mathematics departments there have been success, but even these are moving toward separate adjuncts. The more uniform success has come from the department and the semi-independent unit.

At this point, a reader might be as puzzled as I was initially. Why did the report argue so clearly that "committees have uniformly failed," but then went on to make the aforementioned Recommendation G? What was the rationale to repeatedly remind a university administration that the proposal it was asked to invest resources in was something that had never succeeded?

Could it be reverse psychology to stroke the ego of Harvard's Administration, "Wow, no one can do it, so it ought be up to Harvard to show how!"?

A Brilliant Delivery

Well, not impossible—Mosteller was known to be a great poker player. But a more plausible explanation is that Mosteller had a few-steps-ahead chess strategy in place. The temporary stepping-stone nature of Recommendation G is quite clear from its wording, a point was made ever clearer later in the report:

> Departments are not constructed overnight, nor are adjuncts. Furthermore, Harvard has rather more success with Committees than do most institutions. Presumably this stems from the unstinting, indeed unremitting, committee work training given by Harvard to all faculty members from the day of appointment. It should also be noted that it is very easy to kill a proposed endeavor by inflexibility about the initial administrative arrangement of the non-existent organization.

What a witty piece! It not only lightly got the report out of the seemingly awkward position of recommending something it spent pages arguing against by playing a pun on the word "Committee," but also offered truly insightful wisdom on negotiation. That is, asking for the right wine glass only when one is certain that wine will be served!

Of course wisdom and wit alone can only carry the process so far; to accomplish the grand task Mosteller undertook, he also needed a weapon. And he did have one. Perhaps not a pure coincidence, the overall director of the aforementioned 1954 study funded by the Ford Foundation was Allen Wallis of The University of Chicago, where Mosteller spent his sabbatical during 1954–1955. Wallis was recruited by Chicago in 1946 to start a program in statistics, and by then the program was in full swing except for the formal title as a "Department." It also had interest in recruiting Mosteller as early as 1949 (see footnote 2). Indeed, as Mosteller recalled in his autobiography: “By fall I had received a most attractive offer to chair an expanding department of statistics at another university, and Virginia and I concluded that if Harvard did not want a department, I should move, much as we had enjoyed Harvard.” The offer came from none other than The University of Chicago in the fall of 1956, as the document revealed:

> On September 14, 1956, Professor Mosteller met with Dean Bundy to discuss the possibility that Professor Mosteller would leave Harvard to accept the chairmanship at the Committee of Statistics at the University of Chicago.

The document then reported that there were many telephone conversations and conferences in the following several months between Mosteller and the Dean and others, including a visit on October 18–22 by Mosteller to Chicago, and a visit to Harvard on November 4 by Wallis and James Lorie. (Lorie was an associate dean at Chicago’s Business School, where Wallis became its Dean in 1957, and Lorie was well known for his ability to recruit.[4])

The heavy recruitment pressure seemed to pay off, not for Chicago, but for Harvard. On December 7, 1956, Dean Bundy formally approved the establishment of the Department of Statistics, with funds for three appointments, one senior and two juniors.

Mosteller’s 1956 Report asked for a committee with two positions. He ended up getting a department with three positions. Offering Mosteller the chairmanship for a Committee on Statistics as a counteroffer would be ineffective, because the report already argued clearly that Chicago’s Committee was effectively a department, and that a “Committee on Statistics” had essentially zero chance to succeed! Apparently the only game-changing move available to Dean Bundy was what Mosteller’s 1956 Report was really after: a fully independent Department of Statistics.

We perhaps will never know how difficult this negotiation process was for Mosteller, but we are all grateful that he put himself on the line, literally, in order to put Harvard on the Statistics landscape. This was a profound victory for Harvard Statistics and beyond, especially considering MIT still needs to find its own Mosteller more than 60 years after Freeman’s proposal.

Education Programs: Early Accomplishments and Recent Efforts

Among the 1956 Report’s remaining five recommendations, three were primarily on graduate education:

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4 “Lorie developed Chicago Approach to management education” *Chicago Chronicle*, October 6, 2005.

C. the establishment of an advanced full course in mathematical statistics,
E. that if D is accomplished, a doctoral program in statistics be established, and
F. that additional courses appropriate to such a degree program be offered, where possible maintaining the prerequisite levels so that the courses could serve the general University as well as statistical students.

Whereas establishing a viable PhD program was the priority, Recommendation F went beyond merely training statisticians by calling for service to the entire university. This department's tradition started on day one. In its first year 1957–1958, among the nine courses offered, Mosteller himself taught two with the highest enrollments; *Statistics 122: Statistics in Social Sciences* had the highest enrollment of 134, serving "Economics, Social Relations, and Psychology."

William Cochran, recruited in 1957 from Johns Hopkins to fill the senior position of the three authorized appointments, taught three courses respectively in regression analysis, experiment design, and analysis of counts, reflecting well Cochran's expertise and the department's long tradition on teaching statistical principles for both data collection and data analysis.

John Pratt, recruited in 1957 from Chicago to fill one of the two junior positions, also taught three courses. His *Statistics 142: Non-parametric Inference* is an example of the impact of faculty research interests on curriculum. Pratt moved to Harvard's Business School when he was promoted to Associate Professor during 1960–1961, the same year Dempster was promoted to Associate Professor. (Back then promotions required availability of allocated slots; happily, the slot at Harvard's Business School helped to retain both Dempster and Pratt at Harvard.) After Pratt's move, Statistics 142 (or its graduate-level counterpart 242) was taught sporadically, with the last listing of Statistics 242 found in the 1975–1976 course catalogue.

The last of the nine courses was *Statistics 250*, *Theory of Statistical Decisions*, taught by Howard Raiffa. Raiffa was recruited by Harvard's Business School from Columbia also in 1957, but with a quarter of his time in Statistics. Raiffa is a well-known pioneer in the field of decision analysis, and hence it was fitting that not only did he bring a decision analysis course to Harvard, but also he (and his wife) did a formal decision analysis before bringing himself to Harvard. As Raiffa recalled[5] "Harvard was the clear winner. Of course, there were some dimensions where Columbia was better, so it wasn't a dominating solution, but the formalization helped us really decide that it wasn't a close call at all." How nice to see that our founding generation practiced what they preached, benefited from it, and benefited all of us with their sound decisions!

The year of 1958–1959 also saw the first PhD graduate (Joseph Arthur Greenwood) and first Masters degree recipient (Alan Barnard Howson). Since then the department has produced over 170 PhDs, over 400 AMs, and over 100 ABs; see Fig. 1 for time trends. Our alumni's many lasting contributions will undoubtedly

[5] Fienberg, S. (2008) "The Early Statistical Years: 1947–1967—A Conversation with Howard Raiffa." *Statistical Science,* **23**, 136–149.

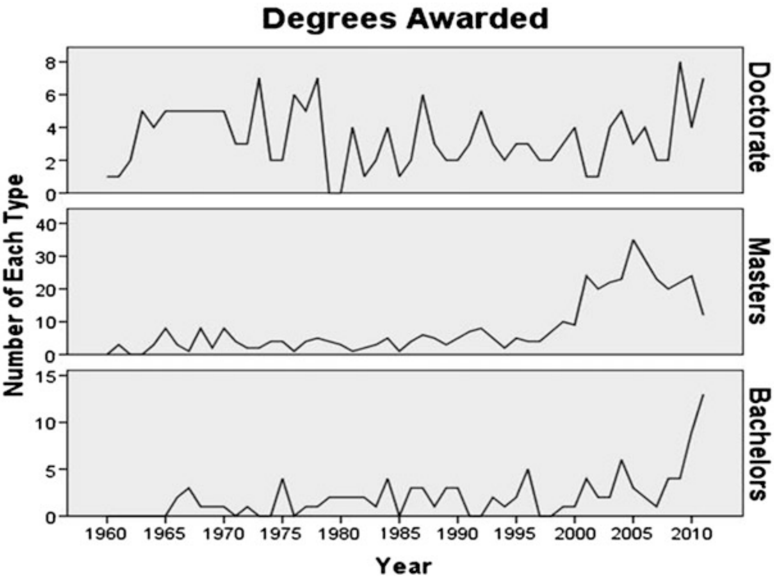

Fig. 1 Time trends in degrees awarded

take an entire book to document. But as an example of leadership in the academic world, the department has produced over three dozen (current or former) full professors at statistics, biostatistics, and other departments and schools (e.g., Education, Business) at many major universities, as well as passionate educators in leading liberal arts colleges; see the full list at the alumni tab at stat.harvard.edu.

Today the department welcomes about 8–10 PhD and 15–20 Masters students each year, and offers about 30 courses annually, including a set of courses aimed at graduate students' professional development beyond the traditional curriculum. These include *Statistics 303: The Art and Practice of Teaching Statistics*, a one-year required course for all first year PhDs; *Statistics 399: Problem Solving in Statistics*, an all-faculty-participating course aimed at helping (mainly 2-year PhD) students to prepare for qualifying exams; and *Statistics 366: Research Cultivation and Culmination*, a course designed for those who have passed the qualifying exams to inquire the skills of developing a research idea into successful publication.

In 2008, the department's overall effort was recognized by a GSAS (Graduate School of Arts and Sciences) Dean's Prize for Innovations in Graduate Education. At students' suggestions, $1,500 of the $25,000 award was used to purchase perhaps the world's first endowed chair for graduate students: a full-body massage chair. The students provided very compelling reasons to win the dean's approval for such a purchase, including it being an effective recruitment tool for persuading prospective students because it symbolizes well the department's caring for its students and its general friendly atmosphere.

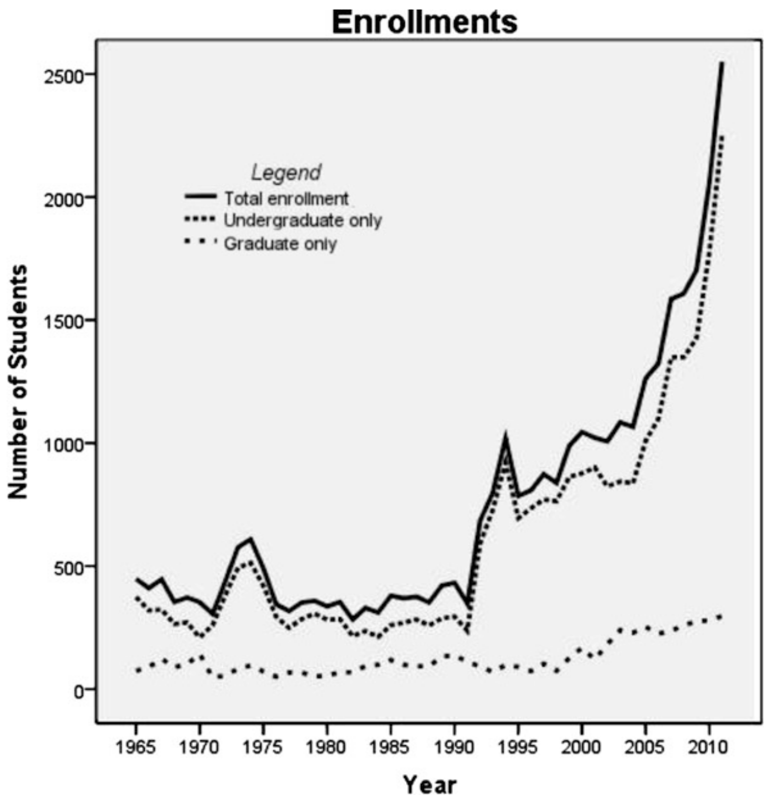

Fig. 2 Enrollment trends

The students were of course right. Much of the recent effort has been devoted to enhancing our intellectually challenging but socially caring environment. The latest installment perhaps is best highlighted by the newly established *Statistics 365*, where students and faculty gather every Tuesday evening to indulge themselves with much food for body (Chinese catering from Yenching Restaurant from Harvard Square) and food for thought (e.g., *Reading R. A. Fisher* in the fall of 2011 and *Reading D. R. Cox* planned for the fall of 2012).

The remaining two recommendations of the 1956 Report perhaps would surprise some readers because they were about *not* taking action:

A. no action with respect to elementary courses given now,
B. that no attempt be made at this time to create a bachelor's degree program in statistics.

Recommendation A displays again Mosteller's leadership skill for building a new program: to win the maximum possible support by minimizing the threats to existing programs. Besides, nothing sinks a new program more swiftly than overloading it before having an adequate navigation staff and plan. Recommendation B was made based on similar considerations, but the report left the door open for the future: "Perhaps when a course structure and staff are available, the question should be reconsidered."

And the future arrived in another 8 years. On February 11, 1964, one day before Lincoln's birthday, FAS faculty voted to approve the establishment of an undergraduate concentration in Statistics. However, effort was made as early as 1959. An article dated November 9, 1959 in *Harvard Crimson* ("*Statistics Dept. Nears Plan for Concentration*") reported the findings of a two-man committee (Cochran and Pratt), indicating that the plan would "go into effect in the fall." Unfortunately, similar to the fate of Mosteller's first proposal to establish a statistics entity at Harvard, there was no report on progress whatsoever in the next 3 years. However, unlike the endeavor for establishing the department, this time the force for breakthrough came within Harvard, and it was from a somewhat unexpected source.

It was from John Monro, Dean of Harvard College from 1958 to 1967, who was known for making unexpected moves, including giving up his Harvard deanship in 1967 for the then unaccredited Miles College in Alabama because of his passion for providing education to the unprivileged.[6] A memo from Mosteller to the statistics faculty, dated October 14, 1963, started with "Dean Monro expressed enthusiasm for the possibility of undergraduate offering in statistics," because "He feels that statistics has the advantage of a mathematical flavor that many students like and some concreteness which many of these same students find lacking in their more advanced mathematical work and it can offer an applied slant without being unduly narrow." (The memo also indicated that Dean Monro was the elder brother of Sutton Monro of the well-known "Robbins and Monro stochastic approximation".)

Dean Monro's enthusiasm proved to be most effective. The concentration started officially during the academic year 1964–1965, with six enrolled; the first two AB degrees were awarded in the following year. But more importantly, Monro's vision that statistics programs should not be restricted to a few "mathematical elites" also proved to be most effective. As Figs. 1 and 2 allude to, our undergraduate concentration remained very small until about 2005, when it began to increase with an exponential rate of 60 % per year, currently reaching 72. Not coincidently, this was about the time the department took a broader view in structuring our undergraduate curriculum, by shifting its traditional focus as an initial preparatory program for future statisticians to a much broader statistical education opportunity for future scientists, policy makers, educators, etc.

Of course excellence in undergraduate education takes tremendous collective effort, and currently we are very fortunate to have a dream team.[7] Our co-Directors of Undergraduate Studies, David Harrington and Joseph Blitzstein, have led much of the recent effort in communicating with our colleagues around the campus and with students from all backgrounds to fruitfully build a program that reflects well

[6] *The New York Times*, April 03, 2002, "John U. Monro, 89, Dies; Left Harvard to Follow Ideals".

[7] See Meng (2011) "Team Dreams and Dream Teams" *Amstat News*, November 1, 2011.

and serves amply the vastly increased interests in and demand for Statistics. Our department has also established several signature courses. Joseph Blitzstein, our first Professor of Practice, is a household name among Harvard students because of his award winning *Statistics 110: Introduction to Probability* (available at Harvard iTunes U). Michael Parzen, our first senior lecturer, coming to the department in 2010 with 17 years of teaching MBA students, attracts over 1,300 students in 2011–2012 with his *Statistics 104* (*Introduction to Quantitative Methods for Economics*) and *Statistics 107* (*Introduction to Business and Financial Statistics*).

Parzen succeeded another phenomenal teacher, Kenneth Stanley, who retired in 2010 and who represented the goodwill from our sister department, the Department of Biostatistics, which has helped us tremendously over the years by providing some of its most effective faculty instructors and educators (such as Harrington) to help us to accomplish our educational mission. Stanley's teaching was so effective that one student wrote: "Taking a course from Professor Stanley is like taking a course in Christianity, and Jesus himself is teaching."

Our first Part-Time Professor of Practice, Stephen Blyth, offers yet another signature course that reflects well both the versatility and the vitality of Statistics: *Statistics 123: Applied Quantitative Finance on Wall Street*. Being an alumnus himself, a veteran of Wall Street and now a managing director at the Harvard Management Company, Blyth offers the students a uniquely practical and rigorous program that benefits them inside and outside the classroom. In return, the students honored him as a Class of 2011 Favorite Professor, the first time he taught the course. The same honor was bestowed upon Stanley by the Class of 2009, to Parzen by the Class of 2012, and to Blitzstein by the Class of 2009 through the Class of 2012, four consecutive years!

The recognitions, of course, do not stop at those who are at the forefront of the educational line. Kevin Rader, our first preceptor, has worked tirelessly behind the scene to provide much needed teaching support, from training facilitators for the study network (an organized study group) to serving as Head Teaching Fellow. For his effort, he was awarded a David Pickard Teaching Award during the inaugural event for the David Pickard Endowment Fund and Lecture.

The David Pickard Fund, which was established in 2010 by generous contributions of alumni, under the leadership of Victor Solo (a faculty member at Harvard Statistics during 1982–1985), reflects fully the lasting impact of excellence in education and mentoring. The opening paragraph of the Fund Document summarizes this fact succinctly:

> The gifts of colleagues, students, and friends of David Pickard establish the David K. Pickard Memorial Endowment Fund. This fund celebrates the memory of David K. Pickard, who served as a junior faculty member in the Harvard Statistics Department from 1977 to 1985. Professor Pickard was known for his outstanding teaching, having won two major Harvard-wide teaching awards: the Phi Beta Kappa Prize in 1982 and the Levenson Prize in 1984. He also won the Hoopes Prize two years in a row for supervising and nominating a senior thesis. Professor Pickard had a strong influence on the Statistics PhD students at Harvard in that period. Sadly, Professor Pickard died of a brain tumor in August 1986 in Kingston Ontario, where he had moved after leaving Harvard.

Stories About and From Our Dozen Senior Faculty in 55 Years

The great teaching and mentoring of students is a perfect segue into the stories about and from our most distinguished faculty through the 55-year history, because our founding father Mosteller was well known as an effective educator and caring mentor. In particular, his course on NBC's *Continental Classroom* in 1960–1961 had over a million viewers across 170 stations. As for his caring mentorship, Stephen Fienberg, an advisee of Mosteller and who himself has received many honors including the election to the National Academy of Sciences, recounts:

> Many of us who worked with Fred benefited greatly from his comment on drafts of papers and book manuscripts. He was always able to make suggestions and comments that would improve our efforts. This was especially the case for *Discrete Multivariate Analysis*, where Fred worked over every chapter multiple times although he refused to be a co-author with Yvonne Bishop, Paul Holland, and me, even though the book would not have existed without his inspiration and hard work.

Mosteller chaired the department for a total of 15 years (1957–1969, 1973, and 1975–1977). He retired from classroom teaching in 1987, but remained very active in research and writing until 2003, when he left the department and moved to West Virginia to live with his daughter, passing away on July 23, 2006. He wrote much in his life, and much has been written about his life. He published over 350 papers, and more than 50 books. A complete list of his (known) publications can be found in "*The Pleasure of Statistics.*"

Like Mosteller, much has been written about Cochran, who served as acting chair in the fall of 1960 and in 1962–1963, and retired in 1976. To this date, he is still among the very few statisticians who are widely acknowledged to have made fundamental contributions in all three areas of data collection: experiment design, sample survey, and observational studies. Such accomplishments undoubtedly benefited from his involvement in astonishingly wide-ranging and large-scale studies that have had a profound impact on humanity. These include studies on World War II bombings, radiation in Hiroshima, the Kinsey Report on human sexual behavior, the Salk polio vaccine, equality in education, and, by far, his foremost contribution, the Surgeon General's Report on Smoking and Health (1964).

In addition to his applied work, he was also well known for his very influential textbooks such as *Experimental Designs* (1950, with G. M. Cox) and *Sampling Techniques* (1977), and for many theoretical and methodological contributions such as Cochran's Theorem, Cochran's Q test, and the Cochran–Mantel–Haenszel test. A good starting point for reading about his life and many contributions is the report[8] on celebrating the centenary of Cochran held by our department on

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[8] "Cochran at 100" *Harvard Gazatte*, Nov. 18, 2009. news.harvard.edu/gazatte/story/2009/11/cochran-at-100.

November 14, 2009, and his obituary in *Annals of Statistics* (1982, 1–10)—Cochran passed away on March 29, 1980, on Cape Cod.

Fortunately, there is a founding faculty member who is with us, engaging deeply in some most penetrating foundational research. Art Dempster, who served as the department chair for a total of 11 years (1969–1975, 1977–1979, and 1982–1985), is widely acknowledged as one of the deepest thinkers in statistics in the last half-century. Dempster is most cited for his extremely influential paper on the EM algorithm (*JRSSB* 1977), co-authored with Nan Laird and Donald Rubin, which is one of the top ten most-cited articles in Statistics ever. Incidentally, Nan Laird, like Rubin, was a student of the department (an advisee of Dempster), and then went on to become a faculty member (since 1975) and chair (from 1990 to 1999) of our sister department, the Department of Biostatistics. She is a great example of how alumni have helped the department, having taught departmental courses, served on its search committees, and co-organized our 50th anniversary celebration, among many other activities over nearly four decades.

Among Dempster's theoretical contributions, he is most well known for the Dempster-Shafer (DS) theory. Also known as the theory of belief functions, the DS paradigm goes beyond the Bayesian inference paradigm. A key feature of the DS theory is that ignorance, that is, "don't know" is a distinctive state with its own assigned ("belief") value after specifying the values for "yes" and "no." This development appears to stem from Dempster's emphasis on logic of statistical inferences,[9] leading to a new paradigm.

Herman Chernoff, another leading theoretician of the last half-century, is our other Professor Emeritus (since 1996). Chernoff is known for many contributions bearing his name,[10] such as Chernoff bound, Chernoff information, Chernoff's distribution, and Chernoff face. Chernoff is another example of our "departmentality" because (see footnote 10) "a lot of my ideas came out of the work I did on a contract funded by ONR, much of which involved applications." The following fascinating story from Chernoff shares some of his experience on an NRC committee to examine an FBI report that claimed to prove that President Kennedy was killed by a shot from the Grassy Knoll at Dealey Plaza:

> Although the proof depended on an elaborate statistical match between the echoes in the Plaza as recorded on the tapes of the police radio recordings, I was the only statistician on the committee. The evidence was less than convincing to the committee, but we lacked something strong with which to counter the theory until a rock and roll musician (who should be deaf) who solved our problem. The police had used two radio channels for communication. The echo analysis had been done on the tapes of one. The imputed shot

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[9] See Dempster, A. P. (1998) "Logicist Statistics. I. Models and modeling" *Statistical Science*, **13**, 248–276, and Dempster, A. P. (2008) "Logicist Statistics II. Inference" in *Classic Works of the Dempster-Shafer Theory of Belief Functions* (*Studies in Fuzziness and Soft Computing*), **219**, 761–786, Springer.

[10] See Bather, J. (1996) "A Conversation with Herman Chernoff" *Statistical Science*, **4,** 335–350, and Zacks, S (2005) "Herman Chernoff: An Appreciation" *Journal of Statistical Planning and Inference* **130**, 3–12.

> had been on a part of the tape where there was some very noisy talk. The musician had listened to both tapes, one in each ear and claimed that this talk was the same as "Hold everything secure until…" which was clear on the other tape, and had been after the fatal shot. No one had been able to decipher the noisy message before, but sound analysis showed that the musician was correct and this was the basis for rejecting the claim about the fatal bullet.

Evidently, this was not the only time that Chernoff had to deal with a difficult situation. After 22 years on the Stanford faculty, he moved to MIT in 1974, partly in hopes of building a statistics program. But that turned out to be an impossible task, leading to Chernoff's move to Harvard in 1985.

But Harvard was not without its own problems. As Chernoff recalled in his 1996 conversation with Bather (see footnote 10) that although he decided to join Harvard after sending what his wife labeled as a "suicidal" letter to MIT president (telling him how MIT should learn from Purdue University about building a statistics program), "I must admit that Harvard also has a problem. In my opinion it is much too small a department to maintain the robustness necessary to survive." Indeed, a similar sentiment was felt by Peter Huber, most widely known for his very influential work in robust statistics.[11] Huber joined Harvard Statistics in 1978 from ETH, chaired the department from 1979 to 1982, but ultimately decided to leave Harvard and joined MIT in 1988. In recollecting his concerns, he wrote to me:

> The long-range organizational challenge was to transform us into a top-rated statistics department. We certainly would not want to teach everything, but we would need to offer some neglected basics. I insisted on a course on measure theoretic probability—if only to inoculate future PhD level statisticians against mathematical charlatanry. A modest increase of the departmental faculty would go a long way. My attempt to persuade the Dean failed, just as previous attempts by Fred and Art had failed.

Although Huber's effort to expand the department did not bear fruit, his effort to enhance the interaction with other departments in FAS did, and is well remembered by his students. David Donoho, another alumnus who has received numerous honors including the election to the National Academy of Sciences and a MacArthur Fellowship, wrote the following account about his PhD advisor:

> During 1979–1982, Huber finished his book on robust statistics. He also obtained a large grant from the Office of Naval Research to work in graphical methods for data analysis, and set up a team to develop the software package PRIM-H for visualization of high dimensional data on a high-tech graphics unit of the day, the Evans and Sutherland Picture System 2. The graphics research led to plenty of interactions with other Harvard faculty. For example, astronomers Margaret Geller and John Huchra's work discovering walls and voids in galaxy catalogs was spurred by Margaret's seeing PRIM-H in action on the Smithsonian redshift catalog. I think that seeing their data in PRIM-H inspired them to approach their data analysis in a new way.

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[11] See Buja, A. and Kunsch, H. (2008) "A Conversation with Peter Huber". *Statistical Science*, **23,** 120–135.

Interaction with other faculty indeed has been a part of our "departmentality." The arrival of Donald Rubin in 1984 further enhanced this tradition. Rubin spent a decade at Educational Testing Service before becoming a Professor of Statistics and of Education at University of Chicago in 1982, and at Harvard he has worked closely with a number of leading psychologists, economists, etc. Motivated by a large array of real-life problems, Rubin has made many methodologically influential and practically impactful contributions, for which he has received numerous honors, most recently the election to the National Academy of Sciences. The edited volume[12] in honor of his 60th birthday documents well his contributions up to early 2000. A book review[13] of this volume perhaps best summarizes Rubin's influence and impact:

> … Donald Rubin, who may well be the most influential contributor to applied statistics in the past three decades. Consider, for example, the EM algorithm, multiple imputation, the potential outcomes framework for causation, propensity scores, and matching methods. Rubin has also been instrumental in championing an "if it works" approach to empirical Bayesian statistics, which has gone far in creating a détente between frequentists and Bayesians, at least insofar as the application of statistics to real data is concerned.

Rubin also chaired the department for a total of 13 years (1985–1994, 2000–2004), and served as a great mentor to many graduate and undergraduate students, winning the aforementioned Hoopes Prize four times (1999, 2002, 2003, and 2010).

But after the founding generation, the formal interaction with other departments did not start until the arrival of Carl Morris in 1990, who held a 50–50 split joint appointment between Statistics and Health Care Policy at the Medical School. Morris arrived with such a joint appointment because of his well-known work in both theory and methodologies (e.g., hierarchical and empirical Bayes, and natural exponential families) and substantial experience in real-life applications, including his earlier experimental design work in the RAND Health Insurance Experiment. In recalling his experience with this joint appointment and how it impacts his current teaching, Morris wrote:

> I joined Harvard's department because it always has been exemplary in the interface of application and theory, and that tradition continues. My five year split appointment with Harvard's Health Care Policy Department provided an ideal opportunity to develop applications and theory together, including developing hierarchical models for profiling medical units and for meta-analyses. When teaching in Stat, these values involve choosing theoretical topics that matter for applications.

During his chairmanship in 1994–2000, Morris took a critical leadership role to sustain our undergraduate introductory courses, at a time when the department was severely understaffed and hence there was a serious consideration that it might

[12] Gelman, A. and Meng, X.-L. (2004) *Applied Bayesian Modeling and Causal Inference from Incomplete-Data Perspectives*. Wiley and Sons.

[13] Smith, H. (2007) Book Review of Gelman and Meng (2004), *Sociological Methods & Research*, **36**, 140–143.

Photo 1 Founding generation, taken on May 22, 1959, at 2 Divinity Street, Cambridge. *Front left* to *right*: Pratt, Cochran, Mosteller. *Back left* to *right*: Raiffa and Dempster

have to focus on PhD training only. Indeed, in 1999–2000, the department only had five ladder faculty, with Dempster, Morris, and Rubin as the three senior faculty.

Luckily, just about that time, Rubin was heavily recruited by another university. Like Mosteller, Rubin used the opportunity skillfully to expand the department, resulting in a clustered hiring that ultimately brought in Jun Liu and Wing Wong as full professors in 2000, and Sam Kou (as assistant professor) and myself in 2001. To continue the interface tradition, Wong's appointment was jointly between Biostatistics and Statistics, with a larger percentage in Biostatistics. This reflected Wong's moving his research focus to computational biology, where he has made path-breaking contributions, just as he did with his earlier work on statistical theory (e.g., the theory of partial likelihood) and computation (e.g., the Data Augmentation Algorithm). Although Wong only stayed at Harvard until 2004, he recounts the importance of these 4 years in his research transition:

> I was Professor of Statistics and Professor of Biostatistics from 2000 to 2004, a period of explosive growth in genomics that was then my research focus. I got my first NIH grant in 2000 to build up an interdisciplinary bioinformatics lab, and (with Cheng Li) developed a popular method for analyzing microarrays. It was not an easy switch from pure statistical research to interdisciplinary genomics research, but the transition was eased by the rich

> Harvard environment, where we had access to world-leading collaborators in almost any biomedical topics.

Like Wong, Liu has made fundamental contributions in many areas of computational biology and bioinformatics, and is also widely known for his work in Markov chain Monte Carlo and related areas. But unlike Wong, who moved to Stanford from Harvard, Liu moved—or more precisely, returned—in the opposite direction, as he recalls:

> I first came to Harvard Statistics Department as Assistant Professor in 1991, at which time there were 6 faculty members including me. Because I got my PhD degree in Statistics from University of Chicago in only three years, I knew very little real statistics at that time. So my first two years at Harvard were really time for my re-education. I sat in almost all major courses taught by Don, Carl, and Art, and Herman. Persi Diaconis was a professor at the Harvard math department at that time, and I also took some courses from him. It was an amazing time, and I learnt a great deal in two years, ranging from causal inference to missing data analysis, hierarchical models, and group theory.

Liu's experiences of learning a great deal certainly echo my own, being a PhD student of the department myself (1986–1990), under the supervision of Rubin. For example, for my first 30-min post-qualifying presentation in the department, I xeroxed my 30-page post-qualifying paper onto 30 transparencies. I even practiced, and convinced myself that I could *read* one page per minute. But before I finished reading the first slide, Chernoff asked a question. I mumbled something and tried to press on. Chernoff stopped me again: "Xiao-Li, you are not answering my question."

In my chair's role since 2004, I have had the great fortune to work with my colleagues and experts from Harvard's Bok Center for Teaching and Learning to improve our students' communication skills. Whenever people asked me where my passion for such training came from, Chernoff's "stop sign" always appears as the initial impetus. Much of what we do as statisticians is to help answer complex questions posed by nature and by mankind, and in such a process effective communication is of critical importance, especially as statisticians are increasingly called upon to take on leadership roles in scientific inquiries.

We are therefore fortunate to have Sam Kou on our faculty, an exemplary model of future leaders of our field. Since his graduation from Stanford in 2001, Kou has made fundamental contributions to methodological, computational, mathematical, and interdisciplinary statistics through his work on Bayesian and Monte Carlo methods, nonparametric methods, stochastic inference in biophysics, and stochastic modeling in finance and economics. The speed of Kou's promotion in 2008 to full professor is a great testimony to his being a "complete package": a great researcher, an effective teacher, and a dedicated citizen. It was the fastest one: it took only 11 days (normally 3–6 months) from the day his dossier was submitted to the day I received the news that that his promotion was approved by President Drew Faust. It is also the "slowest" one: the last successful internal promotion to full professor was Dempster in 1963–1964.

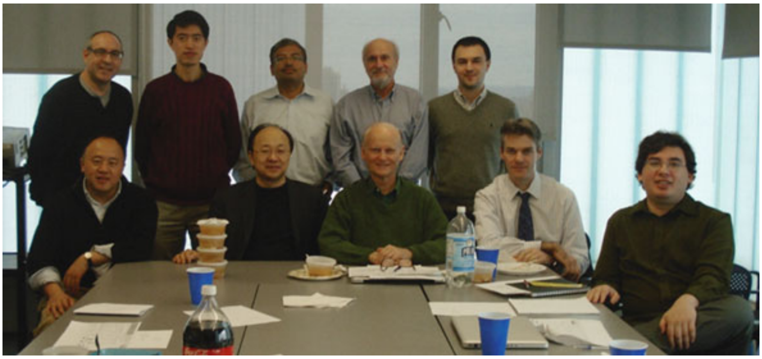

Photo 2 Current faculty, taken on January 17, 2012, at 1 Oxford Street, Cambridge (Junior search meeting over catering from Yenching). *Front left* to *right*: Jun Liu (Professor), Xiao-Li Meng (Professor and Chair), Carl Morris (Professor), Stephen Blyth (Professor of Practice (part-time)), and Joseph Blitzstein (Professor of Practice, co-Director of Undergraduate Study). *Back left* to *right*: Michael Parzen (Senior Lecturer), Samuel Kou (Professor, co-Director of Graduate Study), Tirthankar DasGupta (Assistant Professor, co-Director of Graduate Student), Donald Rubin (Professor), and Edo Airoldi (Assistant Professor). *Not pictured*: David Harrington (Professor of Biostatistics, co-Director of Undergraduate Study), and Natesh Pillai (Assistant Professor)

We yet have another extremely fast senior appointment in the department to speak to the excellence of our faculty. Joseph Blitzstein, a phenomenal teacher and innovative educator, fondly recalls his Harvard experiences so far:

> Just after graduating in 2006, I came to Harvard as an Assistant Professor, and after an extremely busy, interesting, and engaging 5 years, I was promoted to Professor of the Practice in 2011. In my work here, I have followed a principle of reconciliation, aiming to interweave research and pedagogy, theory and application, probability and statistics, and Bayesian and frequentist approaches. As Co-Directors of Undergraduate Study, Dave Harrington and I have helped the concentration (major) grow from 8 to 72 in the last 6 years, promoting a vision of Statistics as a field which is intellectually exciting, aesthetically beautiful, and intensely useful.

Indeed, the intellectual excitement, esthetic beauty, and vast applicability are what make Statistics as a scientific discipline flourish, from being considered much too narrow for Harvard half a century ago, to a field featured in *New York Times* with titles such as “For Today’s Graduate, Just One Word: Statistics” (August 5, 2009) and “What Are the Odds That Stats Would Be This Popular?” (January 26, 2012). As a small reflection of the dramatically increased presence of Statistics on the scientific stage and beyond, our department has been authorized to conduct a clustered hiring with the potential of recruiting five faculty members in the next few years. As a matter of fact, as I am closing this chapter today (2/2/2012), I met with our first candidate, and I will meet four more between now and the Valentine’s Day. It took the last 55 years to recruit a dozen senior faculty members for the department, but I certainly believe the reader will not need to wait another

55 years to hear the stories about and from the next dozen senior faculty members in Harvard's Statistics Department.

Thank you, Mosteller.

Acknowledgments I thank all my current and ex-colleagues and fellow alumni for helping me to write about our history, and more importantly for making the history. This chapter would not exist without the tremendous assistance from our staff members (Betsey Cogswell, Steven Finch, Dale Rinkel, Maureen Stanton, and Ellen Weene) and Krupa Patel from the Office of Senior Vice Provost Judith Singer (also an advisee of Mosteller). I also thank Alan Agresti, Ingram Olkin, and Stephen Stigler for historical insights and constructive comments. All errors and omissions are mine.