

Some Prehistory of the Department of Statistics and Statistical Laboratory at Colorado State University*

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The year 2011 marks many milestones for the Department of Statistics and Statistical Laboratory at Colorado State University. Frank Graybill was hired into the Department of Mathematics at Colorado State in 1960, and in the following year he founded the statistical laboratory that now bears his name. Also in 1961, the name of the department was changed to the Department of Mathematics and Statistics, and a new PhD program in Statistics was approved. Ten years later, Graybill served as the first chair of the Department of Statistics when it split off from the Department of Mathematics and Statistics. The year 2011 is therefore the 50th anniversary of the founding of the Statistical Laboratory, the 50th anniversary of the PhD program in Statistics, and the 40th anniversary of the creation of a separate Department of Statistics.

The immediate and ongoing success of the statistics program at Colorado State University is in large part due to Graybill's efforts, his astute hiring during the 1960s, his vision for the department, his creation of the statistical laboratory, and his leadership and hard work over the years.

But it is also clear that Graybill's successes were built on a firm foundation of appreciation and support for the discipline of statistics, within the Department of Mathematics and the broader university. This is the story of how that foundation was built, going back to the

*This is a written version of a presentation given at the 2011 Graybill Conference in Fort Collins, prepared to commemorate the 50th anniversary of the Statistical Laboratory, 50th anniversary of the PhD program, and 40th anniversary of the Department of Statistics.



Figure 1: *Elwood Mead, between 1890 and 1899, shortly after his time at Colorado Agricultural College. Source: public domain image from Wikimedia Commons.*



Figure 2: *Stewart L. Macdonald, 1923. Source: CSU Archives.*

earliest days of Colorado State.

In 1879, Colorado Agricultural College opened for classes. From the start, mathematics was an important part of the curriculum, but there were no staff trained as mathematicians and no degree programs in mathematics. Instead, a variety of engineers, military officers, physicists, etc., taught mathematics. For example, Elwood Mead, a civil engineer (for whom Lake Mead was later named) served as head of Mathematics in 1883–1884.

Things began to change under the leadership of Stewart Lincoln Macdonald¹. “Professor Mac” was head of Mathematics from 1906–1942. He taught math and astronomy courses, and began to recruit trained mathematicians. In particular, Macdonald hired Andrew Giles Clark in 1923.

Andrew Clark (1900–1979) was the first member of the Department of Mathematics to

¹Macdonald was the recipient of a 1914 masters degree from Columbia University, with an essay entitled *An Historical Study in Systems of Coordinates*.

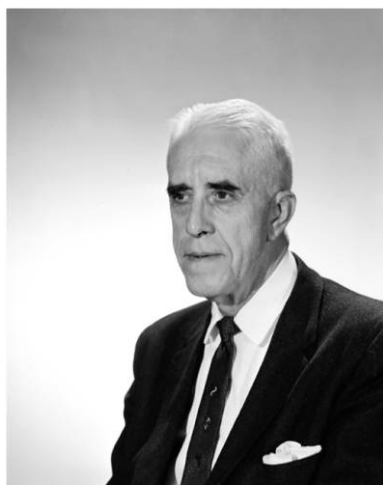
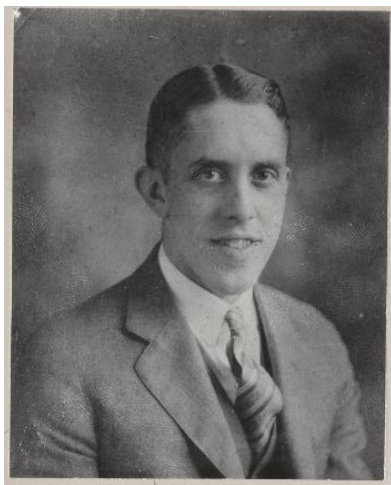


Figure 3: *Andrew G. Clark as a young faculty member at Colorado Agricultural College (1927), and later as Dean of Faculty of Colorado State University (1962). Source: CSU Archives.*

have a bachelor's and masters' of mathematics, both from the University of Colorado. In the 1925–1926 *Colorado Agricultural College Bulletin*, a new course in statistics appeared:

662.—Statistics— Designed as a help in those courses where there is a need for a more scientific way in the handling of data. Elective upon consultation, two hours attendance, two credits, second semester. Mr. Clark.

Clark was apparently learning statistics on his own, as his MA thesis, under the direction of George H. Light, was entitled *The resistance integral of Euler*. Also, a partial history of the math department refers to Clark as a “self-taught statistician”.² In addition to learning and teaching statistics, Clark also served as coach of the baseball team during this time.

It is interesting that 1925, the year of Clark's first statistics course at Colorado State, was also the year that R.A. Fisher's *Statistical Methods for Research Workers* was published. Modern statistics was just beginning to emerge as a formal discipline. Much of this development was driven by a grand scientific challenge that had emerged in the late 19th century: reconciling Mendelian genetics and Darwinian evolutionary theory. Karl Pearson, with Weldon and Galton, had founded *Biometrika* in 1901, with a heavy emphasis on biometric data and applications. Statisticians were actively collaborating with biological scientists. In 1918, Fisher had introduced analysis of variance in the context of genetics, and he spent the years

²This partial history is available to us as an anonymous typescript, with some edits marked in the text. These edits strongly suggest that the original author was Les Madison (see below), with later additions after Madison's death. We have used this typescript extensively in what follows, without further attribution.

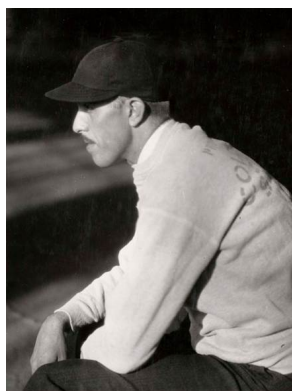


Figure 4: *Andy Clark as baseball coach. Top left: 1935. Top right: Clark, back row right, with the 1936 team. Bottom left: Clark with unidentified catcher, 1941. Bottom right: From left to right, Clark, Karl Gilbert, and George "Lefty" Adams, 1936. Source: CSU Archives.*

1919–1933 at Rothamsted Experimental Station, studying data from agricultural field trials. His 1925 book, destined to be a classic, was followed a decade later in 1935 by another classic, *Design of Experiments*.

Clark’s development as a statistician paralleled this early development of the discipline.³ Clark apparently corresponded with Fisher, though we have no records of this correspondence. (Fisher was a prolific correspondent, who regularly dictated responses to inquiries from around the world. Fisher did not keep copies of all of this correspondence, and we currently have none of Clark’s papers.) Clark became an excellent statistical consultant, regularly collaborating with geneticists and agronomists. Example papers from this time include

- Powers, L. and Clark, A. (1937). Failure of chromosome pairing as evidence of secondary diploidy in Zea Mays. *Journal of Genetics* **35**, 301–313.
- Clark, A. and Leonard, W.H. (1939). The analysis of variance with special reference to data expressed as percentages. *Agronomy Journal* **31**, 55–66.

The latter paper includes an interesting derivation of Fisher’s (then unpublished) arcsine transformation for binomial data. The paper is also interesting because it highlights a particularly successful collaboration between Warren H. Leonard (1900–1966) and Clark. Clark and Leonard published *Field Plot Technique* in 1939, described in its preface as “the outgrowth of a set of lectures on Field Plot Technique given to seniors and graduate students at Colorado State College since 1930.”

One of Colorado State’s most notable alumni, Walter T. Federer, was a student of both Clark and Leonard. Federer was a rancher and professional rodeo rider from Cheyenne, Wyoming. In 1939, he received his BS in agronomy at Colorado State. According to Federer,

“In my junior year, my major was changed to agronomy and I was under the guidance of Professor Warren E.[sic] Leonard who taught a plot technique course that included experimental design and analysis. In my senior year, I had a

³Clark’s career also paralleled the development of Colorado State, from Colorado Agricultural College in his early years, to Colorado State College of Agriculture and Mechanic Arts (Colorado A&M) in 1935, to Colorado State University in 1957.

mathematical statistics course under Professor Andrew G. Clark using a book by Kinney. Acting upon the advice of Professor Leonard, I went to Kansas State University (KSU) to do a Masters degree in plant breeding. From my two statistics courses at Colorado State University (CSU), it appeared that I was one of the most knowledgeable individuals in statistics at KSU and consequently did a lot of statistical consulting.”

- Hedayat, A.S. (2005). A Conversation with Walter T. Federer, *Statistical Science* **20**, 302–315.

Federer went on to complete his MS in plant breeding at Kansas State in 1941 and his PhD in statistics at Iowa State in 1948. In that same year, he founded Cornell University’s Biometrics Unit shortly after joining the faculty there. He served as its director for 33 years. Federer died in 2008 at the age of 92.

Other early statistics alumni followed similar paths, starting in agronomy, obtaining a sound foundation in quantitative methods, then going on to graduate studies elsewhere. Two of the best-known are the Finkner brothers, Alva and Morris. Alva Finkner (1917–2010) received his BS in Agronomy from Colorado State in 1938 and his MS in Agronomy from Kansas State in 1940. He began working in the Statistical Reporting Service of the US Department of Agriculture in 1940 and served in the US Army from 1942 to 1946. He returned to the USDA in 1946 and received his PhD in experimental statistics from North Carolina State College in 1950, after which he joined the faculty at NC State (associate professor of experimental statistics 1950–1955, professor 1955–1960, adjunct professor 1960–1983). In 1960, he joined the Research Triangle Institute, retiring as a Senior Vice President in 1983. He also served as Deputy Director for Statistical Methodology and Standards with the US Census Bureau during a 1974–1977 leave from RTI.

Like his brother, Morris Finkner (1921–2008) received his BS in Agronomy from Colorado State (1943), his MS from Kansas State (1947), and his PhD in plant breeding and experimental statistics at NC State (1952). He then became the Biometrician at New Mexico Agricultural Experiment Station for New Mexico State. In 1956, he joined the Biometrical Services of the Agricultural Research Service, USDA, in Beltsville, MD. He returned to New Mexico State in 1958, where he directed the statistics center and later headed the

Department of Experimental Statistics until his retirement in 1984.

Jerzy Neyman (1894–1981) received his PhD in 1924 at the University of Warsaw. From 1925–1926, Neyman visited Karl Pearson at University College, London, and was disappointed to find him ignorant of modern mathematics. But this visit was the impetus for Neyman’s later collaborations with Egon Pearson, Karl Pearson’s son. From 1926–1933, the Neyman-Pearson theory of mathematical statistics was formally developed. In 1933, Karl Pearson retired, and his position at University College was split between R.A. Fisher and Egon Pearson. In 1934, Neyman joined Pearson in London. But over the next several years, increasing friction with Fisher and the growing threat of war in Europe led Neyman, in 1938, to accept an offer at Berkeley to develop a statistics program.

All of this is relevant to our story because Andy Clark took a sabbatical with Neyman at Berkeley from 1939–1940, hoping to complete a PhD in mathematical statistics.

The fall semester of 1939 turned out to be an interesting one for a visit. Neyman, a native Pole, watched from California as Nazi Germany invaded Poland in September 1939.

Throughout the uncertainties of autumn 1939 work in the Statistical Laboratory [at Berkeley] became ever more intensive. “We were all kind of learning statistics together—Neyman’s kind of statistics at any rate, which is the kind I think of as being real statistics,” [Berkeley graduate student Francis] Dresch says.

- Constance Reid (1982), *Neyman: From Life*

Along with Andy Clark, the Colorado Aggies’ baseball coach, others at Berkeley at the time included Larry Klein (later a Nobel laureate in economics), Julia Bowman (later the first female president of American Mathematical Society), and George Dantzig (later a member of the US National Academy of Sciences). Dantzig (1914–2005) became famous for developing the simplex method and the field of linear programming.

It seems quite possible that Clark witnessed first-hand one of the most famous stories in statistics. Like Clark, Dantzig had just arrived at Berkeley in 1939. According to Dantzig,

...during my first year at Berkeley I arrived late one day at one of Neyman’s classes. On the blackboard there were two problems that I assumed had been assigned for homework. I copied them down. A few days later I apologized to

Neyman for taking so long to do the homework—the problems seemed to be a little harder to do than usual. I asked him if he still wanted it. He told me to throw it on his desk.

- Donald J. Albers, Constance Reid, and George B. Dantzig. (1986). An Interview with George B. Dantzig: The Father of Linear Programming. *The College Mathematics Journal* **17**, 292–314.

Dantzig’s late “homework” turned out to be solutions to two famous unsolved problems in statistics, and the basis for Dantzig’s dissertation under Neyman.

Clark was not so fortunate. During his sabbatical, Clark completed research to Neyman’s satisfaction. While Clark wrote up his dissertation, Abraham Wald published identical results. Clark never again tried to complete his PhD.

Clark became head of the Department of Mathematics in 1942. These were challenging times due to the war. In 1943, Clark reported to the State Board of Agriculture that

“...we are doing little in the way of research work at all. Travel difficulties prevent attendance and participation at professional meetings. However, we are teaching long hours and are striving our best to offer first-class instruction.”

Many of the Mathematics faculty were involved in the war effort. In 1943, Clark began working with the Army Proving Grounds on reliability issues for artillery pieces, and in 1944 he was appointed as the head statistical consultant for General Hap Arnold (1886–1950). Arnold was the commanding general of the US Army Air Forces in World War II. He had been taught to fly by the Wright brothers, and held many firsts in military aviation. As a military consultant, Clark worked with the Army Air Force on bombing techniques, and was also called on in 1945 to work on the logistics of demobilization. Clark later received a citation signed by General Arnold:

THE WAR DEPARTMENT
expresses its appreciation for patriotic
service in a position of trust
and responsibility to
ANDREW G. CLARK

for brilliant statistical studies. . .

Around this time, George Marsaglia (1924–2011) took courses in mathematical statistics from Clark. In 1946, Marsaglia received his BS in Physics, possibly because no Mathematics degrees were yet offered. Marsaglia later became a well-known computer scientist, particularly famous for his work on pseudo-random number generators. In 1968, he pointed out failings of then-common random number generators, noting that their “points are about as randomly spaced in the unit n -cube as the atoms in a perfect crystal at absolute zero.” (“Random numbers fall mainly in the planes”, *Proceedings of the National Academy of Sciences USA* **61**:25–28.) Throughout his career, Marsaglia worked on testing and improving pseudo-random number generators.

We can speculate that it was frustrating for Clark to have excellent students like Marsaglia with strong interests in probability and statistics, but no way to award them a degree in mathematics or statistics. In Clark’s April 1946 annual report to the State Board of Agriculture, he wrote

We now offer a major in mathematics in fact if not in name. Why can we not officially announce and advertise the fact? We have the necessary curriculum of courses set up and in operation. We have the sufficient student demand. We have the instructional personnel equipped to train students to take jobs in statistical or quality control work, and actuarial work. The objectives offer considerable opportunities for graduates as the work offered in mathematics by other state educational institutions is such that the only outlet is in the teaching profession.

In 1947, the undergraduate degree in Mathematics was approved. The push was now on to develop graduate degree programs, for which faculty with more advanced training were needed.

Remember Abraham Wald? In 1950, Clark’s colleague Harris Theodore Guard (1907–1955; see Figure 5) took a sabbatical with Wald at Columbia University to work on a PhD in statistics. (Guard had previously completed an MS in Mathematics from the University of Colorado in 1934, with a thesis entitled *Elliptic Integrals*.) But on December 13, 1950, Wald died in a plane crash in India. Like Clark, Guard would never complete his PhD.



Figure 5: *Left: Les Madison as a Colorado Agricultural College student, playing for the Aggies' tennis team, 1931. Middle: Mathematics staff in academic year 1939-1940: Back row, left to right: M. Leslie Madison, Harris T. Guard, Lora McDonald; Bottom row, left to right: James Staley, Dwight Gunder, Harry Williams. Right: Les Madison as chair of Mathematics. Source: CSU Archives.*

In 1952, Clark was appointed as Dean of Colorado A&M, and Harris Guard succeeded him as head of Mathematics. Clark continued to teach courses in statistics and to act as a statistical consultant. In June of 1955, Guard died suddenly, and Clark served as acting head of Mathematics until M. Leslie Madison was appointed as head in 1956.

Elmer E. Remmenga (1927-2005; see Figure 9) was hired in 1955 as half-time experiment station statistician and half-time in Harris Guard's vacant position. Remmenga had just completed his PhD in Agronomy at Purdue University in 1955, with a thesis entitled *The Nature and Magnitude of Experimental Errors in Grazing Trials*. During the late 1950's, Remmenga initiated scientific computing at Colorado State. He secured grants for IBM mainframes and taught computing classes that soon became extremely popular. He continued to consult and teach applied statistics courses throughout his long career, retiring in 2001. Remmenga passed away in 2005. In his memory, his family established the Elmer E. Remmenga Scholarship in Applied Statistics, to encourage students of statistics to develop their interests in applied statistics and statistical consulting. The scholarship was first awarded in 2005.

Les Madison (1908-1996; see Figure 5), who served as head of Mathematics until September of 1968, was a home-grown product of Colorado Agricultural College. He played tennis



Figure 6:
Frank Graybill, circa 1969 and circa 19??.
Source: CSU Archives.

for the Aggies before his graduation with a BS in Chemistry in 1931. He then received his MS in Mathematics from the University of Colorado in 1934, with a thesis entitled *Number Systems*. Madison joined the faculty as an instructor of Mathematics in 1935. While not a statistician, Madison was supportive of the development of statistics and was instrumental in the hiring of many of the statistics faculty.⁴⁵

In 1957, Colorado A&M became Colorado State University, and Clark became its first Dean of Faculty (roughly, the provost). Clark and Madison were instrumental in recognizing the need for a graduate program in statistics, and both were in excellent positions to push for its development. Both tried hard to recruit a top PhD statistician, without success.

Then, in 1959, Frank Graybill attended the Institute of Mathematical Statistics (IMS) meeting in Laramie, Wyoming. Graybill was on the faculty at Oklahoma A&M, having obtained his PhD in Statistics in 1952 under the direction of Oscar Kempthorne at Iowa State University. At the IMS meeting, Graybill met Elmer Remmenga from CSU's Department of Mathematics. Remmenga informed Graybill that Clark and Madison were interested in creating a graduate program in Statistics and were looking for a suitable candidate to lead

⁴Frank Graybill, upon hearing in May 2011 about plans for putting together this history, told Duane Boes "Whatever you do, make sure you give Les [Madison] enough credit."

⁵Madison's son, James L. Madison, later joined the PhD program in Statistics at Colorado State and was one of its top students. Jim Madison died suddenly in 1966, during his second year of the program. Since 1967, the outstanding graduate student as selected by the Statistics faculty has been honored with the Madison Memorial Award. The award was later expanded to recognize Jim Madison's parents, Les and Edna Madison.

this effort. Shortly thereafter, Graybill interviewed for this position at Colorado State and received an offer to join the Department of Mathematics, which he accepted. In August 1960, he began his tenure at Colorado State University where he would stay for the next 37 years.

In 1961, Graybill founded the statistical laboratory and started the PhD program in Statistics. During the academic year 1961–1962, the Department of Mathematics changed its name to the Department of Mathematics and Statistics, with Graybill serving as director of the Statistics section. All of these developments seemed to go smoothly and rapidly with Clark as Dean of Faculty and Madison as head of Mathematics. For example, the founding of the Statistical Laboratory in January 1961 was not a hard sell. According to Graybill, he called Clark and invited him to coffee. There, he suggested that CSU should have a statistical laboratory, like the one at Iowa State. Clark agreed, and asked Graybill over to his office to type up a description, since the State Board of Agriculture was meeting at CSU that afternoon. Later that day, Clark called Graybill to tell him that CSU had a Stat Lab, and Graybill was its director.

With Clark as Dean of Faculty (through 1964), Madison as head of Mathematics & Statistics, and Graybill directing the Statistics section, CSU had terrific success in building the statistics faculty: Kenzo Seo (1961), Don Bentley (1961), George Angleton (1962), Jim Williams (1962), Paul Mielke (1964), Moinuddin Siddiqui (1964), Duane Boes (1965), Keith Craswell (1965), J.N. Srivastava (1966), David Bowden (1968), Thomas Boardman (1968), and Maurice Bryson (1969).

In 1965, the first PhD's in the mathematical sciences at CSU were awarded, in Statistics. The first class of PhD's included:

- Donald Barr, under the direction of Kenzo Seo. Don Barr is a retired professor of Systems Engineering at the US Military Academy, and past Professor of Operations Research at the Naval Postgraduate School in Monterey, CA.
- William Owen, under the direction of Frank Graybill. Bill Owen is Professor Emeritus of Mathematics from Central Washington University in Ellensburg.
- Robert Rounding, under the direction of Frank Graybill. Bob Rounding was an Air



Figure 7: *Some early photos of CSU Statistics faculty, circa 1969. Top row: From left to right, George Angleton, Thomas Boardman, Maurice Bryson. Bottom row: From left to right, J.N. Srivastava, James S. Williams. Source: CSU Archives.*

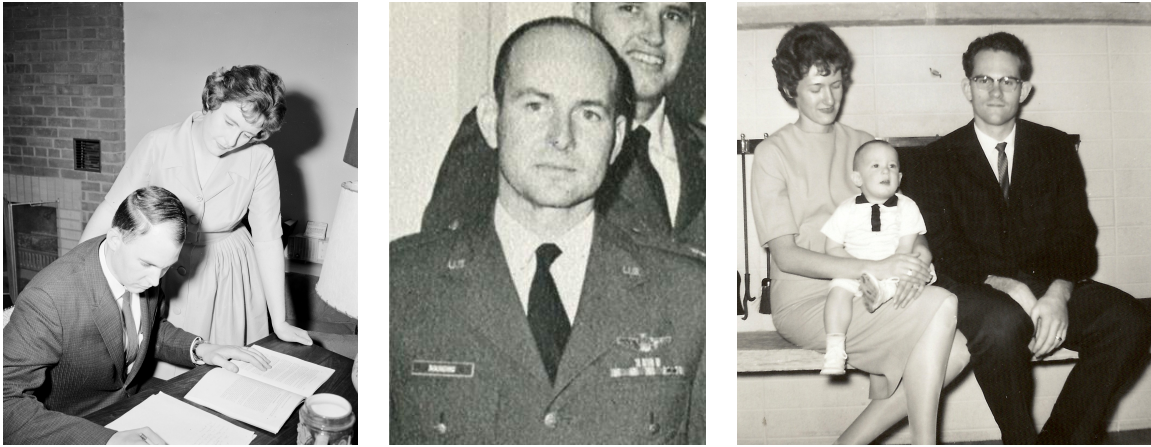


Figure 8: *Left: Donald Barr and his wife, Loudean. Middle: Robert Rounding. Right: Lois, Stan, and Scott Urquhart. Source: CSU Archives and Scott Urquhart.*

Force Academy instructor, who was killed in training prior to a tour of duty in Vietnam.

- N. Scott Urquhart, under the direction of Jim Williams. Scott Urquhart has had a long academic career with appointments at Cornell, New Mexico State, Oregon State, and Colorado State.

In 1971, the Department of Mathematics and Statistics split into two separate departments and Graybill became the head of the newly-born Department of Statistics. He served as department head until 1975.

Postscript

In 1964, Colorado State University honored Dean Andrew G. Clark by conferring the honorary Doctor of Laws degree upon him. As dean, Clark was part of the graduation program, so in order to keep the surprise the honor and corresponding citation did not appear in the program.

ANDREW G. CLARK, MASTER MATHEMATICIAN, INSPIRING TEACHER, ABLE ACADEMIC ADMINISTRATOR, whose two score years and more of loyal and dedicated service to Colorado State University have drawn three generations of students and countless faculty colleagues to him seeking advice and counsel. . .



Figure 9: *Left: From left to right, Genny Garst, Elmer Remmenga with the IBM 1620, Frank Graybill. Right: From left to right: unknown, Andrew Clark with the IBM 1620. Source: CSU Archives.*

In 1977, the social sciences building was renamed the Clark Building in his honor. Clark died in 1979 at the age of 79.

A request to our readers.

This document focuses almost entirely on the prehistory of the Department of Statistics and Statistical Laboratory. It is only the first part of a work in progress. Our plan is to expand significantly the short description of “the Graybill years” and add to the history of the department up to the present. We would greatly appreciate your feedback, stories, photos, etc. Please feel free to contact the authors through Colorado State University’s Department of Statistics.

Acknowledgements.

We would like to express our appreciation to Vicky Lopez-Terrill from Archives and Special Collections at the Morgan Library, Colorado State University, for assistance in finding and digitizing archival photographs. We also thank Jayne Hansen, Local History Archive Research Assistant at the Fort Collins Museum and Discovery Science Center. Alumnus Scott Urquhart made many useful suggestions.

About the authors.

Duane Boes is Professor Emeritus of Statistics and past department chair, from 1983–1992. He received his PhD in 1963 from Purdue University and has been on the faculty at CSU since 1965. Jay Breidt received his PhD from Colorado State in 1991, spent ten years at Iowa State, and returned to CSU where he has been a professor of Statistics since 2001. He served as department chair during 2005–2010.