STATISTICAL LABORATORY

established 1933

annual report

July 1, 1984 to June 30, 1985

IOWA STATE UNIVERSITY, AMES

Contents

THE STATISTICAL LABORATORY
Iowa State University
1984-85 Annual Report

On Change and Continuity

On July 1, 1984 Dean L. Isaacson became acting director and acting head of the statistical center at Iowa State, the fifth person in its history to assume the leadership responsibilities. He follows George W. Snedecor, Raymond J. Jessen, T. A. Bancroft, and Herbert A. David. Isaacson will continue in this position until June 30, 1986. Before that date, the statistics faculty will meet with the university Central Administration in order to determine the future course of action. In fact, we hope for a decision by September 1985 in case the green light is given for an international search for a permanent director/head.

In addition to the position above, there are several other faculty positions that should be filled in the near future. With the establishment of the College of Business Administration at Iowa State, a need has been recognized for a new joint position between the Department of Statistics and some department in that college. Also, as you will read in this annual report, our ties with the College of Engineering are growing. This is a natural consequence of the fact that statisticians and engineers are working together in industry to solve problems involving productivity, quality, and reliability. Stephen Vardeman has changed his appointment from full-time in statistics to three-fourths time, with one-fourth time to be in industrial engineering. This change, along with the establishment of an Industry/University Affiliate Program in Productivity, Quality, and Reliability, indicates that we will soon want to fill a new position arranged jointly between the Department of Statistics and some department in the College of Engineering.

Besides filling new positions resulting from needs for statistical expertise arising in other parts of the university, we must maintain our current areas of strength in the Department of Statistics. Oscar Kempthorne, Distinguished Professor of Sciences and Humanities, starts a five-year phased-retirement program in July 1985. Therefore we will soon be looking for someone in the areas of linear models and experimental design. Ronaldo Iachan, a member of our Survey Group, has accepted a position with the Research Triangle Institute in North Carolina beginning September 1985, so we will also be interested in hiring a new faculty member who specializes in the area of survey sampling.

One of the challenges for the Statistical Laboratory, the Department of Statistics, and the statistics department of the Iowa Agriculture and Home Economics Experiment Station in 1985-86 will be deciding how to meet the needs described above. The good news is that statistics is growing as a profession and as an active area within Iowa State University. Thus the challenge consists of deciding how to expand, rather than how to cut back. You are invited to help us with this challenge by providing suggestions or recommendations for likely candidates.

Dean L. Isaacson

Personnel

A newcomer to the faculty at the start of the fiscal year, as previously announced, was Carl W. Roberts, assistant professor of sociology and statistics. He fills a vacancy left by Robert A. Johnson.

Jayanta K. Ghosh, professor in the Division of Theoretical Statistics and Mathematics, Indian Statistical Institute, Calcutta, completed a two-month assignment as visiting professor in July 1984 for research and teaching, then went to Oklahoma State University as MASUA Distinguished Foreign Scholar for a similar period before returning to India.

Visiting associate professor Yasuyuki Toyooka completed a year's stay in October and returned to Osaka University, Japan. He had worked in the Survey Section under a cooperative research agreement with the U.S. Bureau of the Census.

Shian-Koong Perng, professor of statistics on sabbatical leave from Kansas State University, spent the spring semester with the Survey Group.

Juan del Castillo, assistant professor of mathematical statistics, Faculty of Veterinary Medicine, Universidad Autonoma de Barcelona, Bellaterra, Spain, visited the Statistical Laboratory from July 7 to August 7, 1984 to observe the work of the experiment station statistical consulting group and to become more familiar with statistics as applied here to biological data.

Visiting scholar Chang C. Y. Dorea completed her two-year stay in July, and returned to the Universidade de Brasilia, where she is associate professor in the Department of Mathematics, Institute of Exact Sciences. Shiguang Zhu, lecturer in mathematics, Department of Meteorology, at Beijing Agricultural University, China, is continuing his work with Edward Pollak and faculty in genetics. After a year here, another visiting scholar, Renkuan Guo from Dalian Institute of Technology, China, has formally enrolled as a graduate student in statistics.

A former Statistical Laboratory faculty member was a short-term visitor in July: Malay Ghosh, professor in the Department of Statistics, University of Florida. C. Srinivasan, associate professor, Department of Statistics, University of Kentucky, who had been a student of J. K. Ghosh's, also came in July to collaborate with him, Malay Ghosh, and Glen Meeden on research. In April 1985, Churchill Eisenhart, now retired from the National Bureau of Standards, visited the statistical center in his capacity as chair of the American Statistical Association's committee on archives.

At the August annual meeting of the Institute of Mathematical Statistics at Lake Tahoe, Glen Meeden was elected a Fellow, cited "for important contributions to our understanding of admissibility, Bayesian and empirical Bayesian procedures, calibration, sampling from finite populations, and sufficiency." Noel Cressie was elected a member of the International Statistical Institute in November.

A profile of Herbert A. David is featured in the February 1985 issue of *Biometric Bulletin* [2:1, 3-4]. After citing honors, awards, and "significant contributions to order statistics and ranking procedures," as well as to other areas of statistics, the profile focuses on his active role in the Biometric Society over a period of more than 25 years. This period included his leadership in the establishment of the *Bulletin* during his term as president. David's tenure as director and head of the Statistical Laboratory and Department of Statistics, and Iowa State's many earlier connections with the Biometric Society are also mentioned.

William Q. Meeker, Jr., as usual, was a visiting professor and statistical consultant at AT&T Bell Laboratories, Holmdel, New Jersey, in the summers of 1984 and 1985. Herbert T. David was a visiting scientist in the Thomas J. Watson Research Laboratories, IBM Corporation, Yorktown Heights, New York, for six weeks beginning in late May 1985.

Donald Hotchkiss received a Faculty Citation, in recognition of long, outstanding, and inspiring service, at the annual awards convocation of the Iowa State University Alumni Association, June 8th. The citation reads: "Early in his career, Dr. Hotchkiss established the reputation of a fine and caring teacher. His counsel and guidance are sought often by students of all ages, and his opinions are held in high esteem. He expects high quality work from these students, and is able to encourage the very best they have to give. For his dedication, the College of Agriculture awarded him its first Outstanding Adviser Award in 1978. Dr. Hotchkiss is also responsible for the creation of Mu Sigma Rho on campus, an honor society for statistics students. Dr. Hotchkiss sets a demanding standard for scholarship in academic pursuits, meets this standard with his own activities, and delights in recognizing the achievements of others. He is a sterling example of a university professor through his commitment to the ideals of professionalism and academic accomplishment."

W. Robert Stephenson was chosen to receive a 1985 Outstanding Academic Advising Award. The Student Alumni Association will present the award on October 5 during pregame activities of the Iowa State-Drake University football game. Stephenson was also selected as the 1985 honorary faculty member of Lampos, Sciences and Humanities honorary. Dean Isaacson was initiated into Phi Kappa Phi Honor Society in March. Yasuo Amemiya was promoted from associate to full membership in Sigma Xi. Harold Baker and Avonelle Hefflefinger were inducted into the university Twenty-five Year Club at its annual meeting on March 25.

Sylvia McNulty, Survey Section account clerk, retired on January 3, 1985. Six staff promotions involving title changes were announced during the year: Richard Dorsch, promoted to programming consultant in the Survey Group effective May 1, 1984; Bud Meador, from senior data analyst to supervisor, statistical data processing, in September 1984; Kathleen Shelley, reclassified as analyst November 1; and Kathy Reinertson, Jasmine Seagrave, and Sue Verkade, all changed to data technicians effective March 8, 1985.

Frederick Lorenz was promoted to associate professor effective July 1, 1985, and W. Robert Stephenson has achieved tenure status.

Looking toward next year: Noel Cressie will be in Washington, D.C. from July 15 through December 31, 1985 as an American Statistical Association/Bureau of the Census fellow to work on spatial statistics aspects of small area estimation. Yasuo Amemiya and Robert Strahan will be on faculty improvement leave. Amemiya will spend the academic year at Stanford in the Department of Statistics. He proposes to acquire another perspective on multivariate analysis and to continue research on inference procedures for multivariate statistical relationships. During his absence, Balvant K. Kale will be a visiting professor for the academic year, presenting an undergraduate course and a graduate seminar course on statistical estimation functions in the fall, then a graduate course and a seminar course on outliers in the spring. This is a return visit for Kale: he was a member of the ISU statistics faculty from 1964 to 1967. Subsequently he went to the University of Manitoba and became professor and head of the Department of Statistics. For the last six years (and two years previously) he has been professor of statistics in the University of Poona.

Strahan plans to work for six months, beginning August 26, on developing a set of annotated computer analyses of typically-encountered research problems, for use in statistical consulting and teaching. Paul McGovern, postdoctoral research associate in the Department of Psychology with a joint Ph.D. in psychology and statistics from Iowa State, will join the

Department of Statistics part-time to teach a course normally offered by Strahan in the fall.

Tom Bubolz will be a visiting professor in the Department of Community and Family Medicine, School of Medicine, at Dartmouth College for a year, starting in August. Part of his duties, supervising the Statistical Numerical Analysis service support group, will be taken over by John Thompson, as research associate.

Statistical Laboratory Staff—Fiscal Year 1984-85 under the administrative direction of:

W. Robert Parks, Ph.D.—president of the university

Daniel J. Zaffarano, Ph.D.—vice president for research; dean of the Graduate College

William H. Kelly, Ph.D.—dean, College of Sciences and Humanities; director, Sciences and Humanities Research Institute

Lee R. Kolmer, Ph.D.—dean, College of Agriculture; director, Iowa Agriculture and Home Economics Experiment Station

Dean L. Isaacson, Ph.D.—acting director, Statistical Laboratory; acting head, Department of Statistics; acting head, Statistics Department, Iowa Agriculture and Home Economics Experiment Station

Professors

Krishna B. Athreya, joint appointment with Department of Mathematics
Theodore B. Bailey, Jr.
T. A. Bancroft, professor emeritus
C. Philip Cox
David F. Cox
Noel A. C. Cressie
Herbert A. David, Distinguished Professor in Sciences and Humanities
Herbert T. David, joint appointment with Department of Industrial Engineering
Wayne A. Fuller, Distinguished Professor in Sciences and Humanities; faculty status also in Department of Economics
Jayanta K. Ghosh, visiting
Richard A. Groeneveld
David A. Harville
Roy D. Hickman
Paul N. Hinz, faculty status also in Department of Forestry
Donald K. Hotchkiss
David V. Huntsberger, professor emeritus
Dean L. Isaacson
Oscar Kempthorne, Distinguished Professor in Sciences and Humanities
William J. Kennedy
Glen D. Meeden
William Q. Meeker, Jr.
Shian-Koong Perng, visiting
Edward Pollak, joint appointment with Department of Genetics
Vincent A. Sposito, joint appointment with Computation Center
Robert F. Strahan, joint appointment with Department of Psychology
Norman V. Strand, professor emeritus
Leroy Wolins, joint appointment with Department of Psychology

Associate Professors

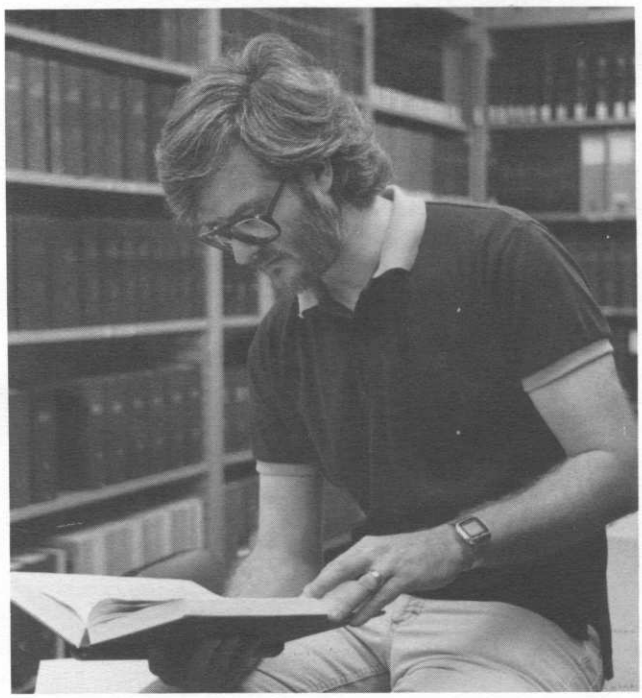
Kenneth J. Koehler
Jerome M. Sacks, USDA collaborator
Mack C. Shelley II, joint appointment with Department of Political Science
Shashikala Sukhatme
Yasuyuki Toyooka, visiting
Stephen B. Vardeman

Adjunct Associate Professor

Thomas Bubolz

Assistant Professors

Yasuo Amemiya
Harold D. Baker
Ronaldo Iachan
Frederick O. Lorenz, joint appointment with Department of Sociology and Anthropology
Mervyn G. Marasinghe
Mark R. Reiser
Carl W. Roberts
W. Robert Stephenson



Carl W. Roberts teaches courses on statistical methods for research workers, statistics in the social sciences, and research methodology under a joint appointment in statistics and sociology.

Visiting Scholars

Juan del Castillo
Chang Dorea, also visiting associate professor in Department of Electrical Engineering
Renkuan Guo
Shiguang Zhu

Resident Collaborator

Arthur D. Kuhl, USDA Soil Conservation Service, joint appointment with Department of Agronomy

Predoctoral Research Associates

Terrance P. Callanan
Carol A. Francisco

Graduate Assistants

The status of graduate students often changes. Students holding appointments as graduate teaching or research assistants in statistics for part or all of the year are listed here.

Edi Abdurachman
Douglas Andrews
Patti Ann Beasley
Stephen D. Boeh
Tammy Bondioli
Thomas A. Borders
Mark F. Bryan
Michael R. Carley
Alicia Carriquiry
Stephen Fu-Chung Chang
Jeffrey Christman
Carolyn Connor
John R. Cook
Brian Keith Cranford
Lee Ann Crowder
Stephen V. Crowder
John Eltinge
Kimberly Erland
Charles M. Farmer
Fah Fatt Gan
Gloriana Giacobello (Fulbright scholar)
Carol Gotway
Mark Gunderson
Renkuan Guo
In Hye Ha
Nancy Hasab-El-Naby
Donna Hensen
Patrick Homblé
Shun-Chuen Huang
Frederick Hulting
Ching-Chang Hwang
Brenda Ihle
Karen L. Jensen
Daniel R. Jeske
John Marcus Jobe
Yoou-Jen Kang
Byung Chun Kim
Byung Hwee Kim
Song-Ho Kim
Kenneth Kortge
Carl Moun-Shen Lee
Mong-Hong Lee
Jyh-Shiun Lin
Tsung-Hua (Thomas) Lin
Sharon K. Loubert
Chi-hsien Joseph Lu
Douglas E. McCoy
Edina Miazaki
Stephen M. Miller
Karen L. Moore
Grecia F. Morel
Thilagawathy Muththiah
Nuwan Nanayakkara
Julia Oñate
Byung Sul Park
Heon Jin Park
Michael P. Rogers
Saad Eldin M. Saad Eldin
Daniel J. Schnell
David L. Silvis
Gary Sullivan
James Symanowski
Kathleen M. Taylor
John C. Thompson
Miriam B. Tirol
Margot H. Tollefson
Steven P. Vilendrer
Franklin Winters
Danny A. Wolfgram
Dale L. Zimmerman

Supported Graduate Students

Bahtiar Abbas—International Agricultural Development Service (Rockefeller Foundation)
Danyal bin Abdul Malik—Government of Malaysia
Edi Abdurachman—USAID, Indonesia
Kevin Anderson—Engineering Research Institute, ISU
Robert J. Arnold—Engineering Research Institute, ISU
Driss Benlemrid—USAID, Morocco
Paul Brozovsky—Department of Mathematics, ISU
Cai Yilin—Southwest Agricultural College, China
Terry Caliste—Bell Communications Research
David Cassell—Department of Mathematics, ISU
Brian Keith Cranford—Department of Finance, ISU
Da Yang—Beijing Agricultural University, China
Mamadou L. Diedhiou—USAID, Senegal
Cheng-Der Fuh—Department of Mathematics, ISU
Mohammed Khan—Food and Agriculture Organization, United Nations
Anthony Lui—Computation Center, ISU
Abdelghani Mehailia—Algerian Government
Edina Miazaki—Universidade Federal de Saõ Carlos, Brazil
Jorge Morel—Veterinary Medicine Research Institute, ISU
Neerchal K. Nagaraj—Graduate College, ISU
Gilda Pareja—Hoyt Memorial Research Assistantship, ISU
Byung Sul Park—Korean Army
Juan Esteban Ramírez C.—Universidad Tecnica del Estado, Santiago, Chile
Cleve Redmond—Computation Center, ISU
Narayan S. Shankar—Department of Mathematics, ISU
Jan van Schaik—Department of Entomology, ISU
Tilaka Vijithakumara—Department of Mathematics, ISU
Wan Azah Wan Ismail—Mara Institute of Technology, Malaysia
Peh-Jen Jenny Wu—Computation Center, ISU
Byoung Chang Yoon—Korean Army
Rahmat Zakaria—World Bank (MUCIA-Indonesia)

Self-Supporting Graduate Students

Jonathan Biele
José A. Calcaño-Collazo
Seong-San Chae
Keng-tang Chien
I-Shang Jackson Chow
Eiichiro Funo
Chong Sun Hong
Chihho Hsieh
Shih Jian Hsu
Jane M. Johnson
Joo-Hwan Kim
Yu-Fen Lan
Paul McGovern
Mark McNulty (in absentia)
Cindy Lynn Martin
Reda Mazloum
George Ostrouchov (in absentia)
Di-ou Ray
Margaret Scott
Kwoklai Bonnie Shum-Ng
Yan-Ling Tsay
Michael Tveite (in absentia)
Annette Wagner
Shaw-Ling Wang (Chu)
Pei-Lan Alice Wei
Jeffrey R. Wilson (in absentia)
Peter Sze-Yan Wong
Min-Shih Chang Yang

Professional and Scientific Staff

Richard Dorsch, programming consultant, Survey Section
Mary Genalo, research associate, Survey Section
Avonelle Hefflefinger, administrative assistant
Ye-Fu Lee, research associate, Survey Section, until July 31, 1984
Hsueh-Foo (Sherry) Lin, research associate, Survey Section, beginning September 1, 1984
Bud Meador, supervisor, Statistical Data Processing Services
Deborah Reed-Margetan, programmer-analyst, Survey Section
Kathleen Shelley, analyst, Statistical Data Processing Services
Harvey Terpstra, data systems manager, Survey Section
Jauvanta Walker, information specialist

General Office Staff

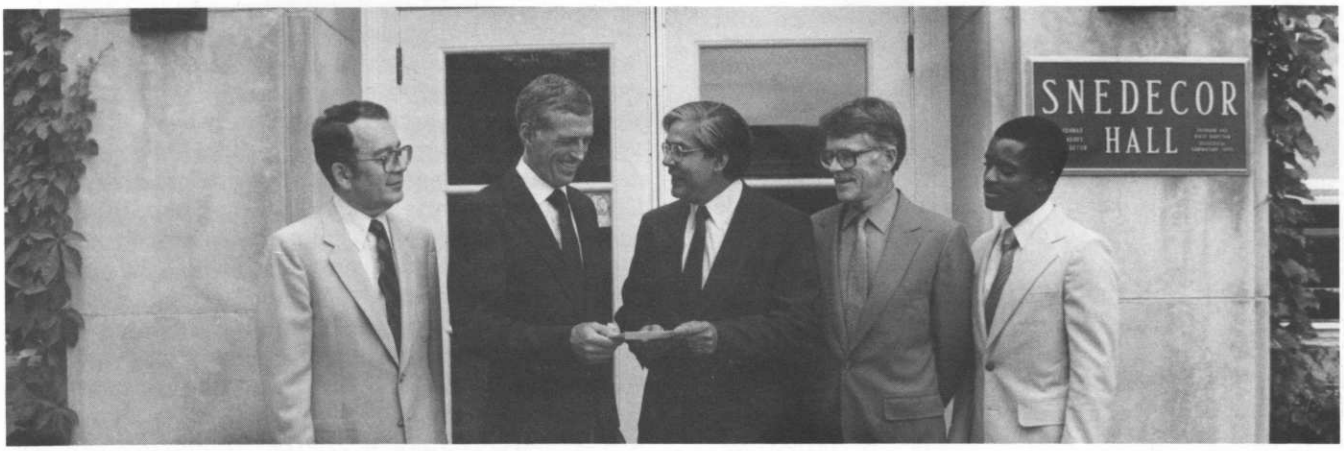
Rose Ann Anderson, secretary
Norma Elwick, secretary
Julie Honeick, clerk typist—Experimental Design Genetic Statistics Section
Jeanette Lagrange, clerk typist, beginning September 10, 1984
Donna Nelson, clerk typist
Janice Peters, account specialist
Denise Riker, secretary
Sharon Shepard, clerk typist
Darlene Wicks, clerk typist, Statistical Numerical Analysis and Data Processing Section

Survey Section Staff

Dianne Anderson, clerk
Glenda Ashley, key entry operator
Kathryn Bottorff, field interviewer
Dorothy Bousfield, field interviewer
Dorothy Edwards, clerk
Vimlesh Gupta, key entry operator
Esther Harmison, clerk (survey supervisor), until October 1, 1984
Nancy Heathman, account clerk, beginning December 18, 1984
Jo Ann Hershey, clerk typist, beginning August 1, 1984
Marcia Luze, field interviewer
Sylvia McNulty, account clerk, until January 3, 1985
Helen Nelson, secretary
Donna Omundson, clerk
Mary Rathbone, field interviewer
Kathie Reinertson, data technician
Susan Ridnour, clerk, until January 4, 1985
Jasmine Seagrave, data technician
Lisa Sharp, clerk, until July 13, 1984
Jeanne Sorenson, statistical data processor
Miriam Troyer, field interviewer
Susan E. Verkade, data technician
Marian Wallace, clerk, until January 3, 1985
Carol West, key entry operator
Karon White, key entry operator

Bellcore Gift

An unrestricted gift of $2,500 was presented by R. L. Chaddha of Bell Communications Research, Inc., on June 27 to Dean L. Isaacson for the Department of Statistics. The gift was an expression of Bellcore's continued support of the statistics program here and of interest in continued mutually beneficial associations. At present, Bellcore staff member Terry Caliste is working on an M.S. program at Iowa State under William Q. Meeker, Jr. This is part of Bellcore's Graduate Study Program, which sends trainees to selected universities for intensive study in their fields. Caliste worked as a summer intern with both Chaddha and Meeker in 1982 at Bell Laboratories before completing his bachelor's degree at Southern University of New Orleans. After graduation he rejoined Bell Labs and since divestiture has been part of the Bellcore staff. Chaddha, manager of the Field Quality and Reliability Assurance Division of Bellcore's Quality Assurance Technology Center, Holmdel, New Jersey, has been a regular visitor to the Department of Statistics in his role of Ph.D. recruiter.



Presentation of a $2,500 contribution from Bellcore to the Department of Statistics took place on the front steps of Snedecor Hall, the departmental home. L to R: H. A. David, Dean Isaacson, Roshan Chaddha, Norman Jacobson, who is Associate Vice President for Research at ISU, and Terry Caliste.

Consulting and Cooperative Research

The Statistical Laboratory has a strong tradition of service and collaborative effort in developing and applying statistical methodology to support research investigations throughout the university. Some of the joint appointments held by Stat Lab faculty reflect this concern, but our involvement in statistical consulting goes far beyond such arrangements. For over 50 years there has been a rewarding two-way flow of information between statisticians and applied research investigators at Iowa State and in federal and state agencies. This has led to joint publications, new insights, and real-life examples to strengthen the teaching and training of future statisticians and research workers.

A current area of service and collaboration that has ramifications locally, in the state, and beyond Iowa boundaries is the interface of statistics with industry and engineering sciences. Our involvement in this area is reflected in each of the main sections of the annual report that follow. However, the new Industry/University Affiliate Program for Productivity, Quality, and Reliability, described on pp. 9-10, may be of particular interest.

Agriculture and Home Economics Experiment Station

The statistics department of the Iowa Agriculture and Home Economics Experiment Station at Iowa State University provides continuing statistical consulting for research workers. Additional support and work come from the College of Veterinary Medicine. Four staff members, David Cox, Paul Hinz, Theodore Bailey, and Donald Hotchkiss, have major responsibilities in this area, but many other members of the department become involved in the course of a year. The staff is assisted by research associate Terry Callanan and by research assistants—graduate students who take part in all phases of the work, from doing direct, independent consulting to simply handling data processing tasks for one of the staff. This year these assistants were Mark Bryan, Alicia Carriquiry, Tsung-Hua Lin, Jorge Morel, Dale Zimmerman, and Dan Jeske.

Much is written about what statistical consulting should be at a university and how it should be organized and conducted. Generalizations are easy, but they never apply completely to individual problems. The consulting work of this section does not include data processing and specialized computing that lie outside the major packages of programs available to us. That work fits more logically the Statistical Numerical Analysis and Data Processing Section of the statistical center. There are often warnings about staff becoming overwhelmed with small, minor, trivial consulting work. The problem is that it is difficult to screen requests for help and select only the ones that are "interesting," whatever that means. Part of our responsibility is to assist the total research efforts of the experiment station, and that implies for some a responsibility to all who ask for assistance. Much of the consulting is carried out with graduate students from many fields in connection with their thesis work. There is no way to avoid a large component of teaching in such consulting contacts. No problem related to data summarization and interpretation in the context of a doctoral dissertation is "trivial" to the graduate student involved. Often what is routine to a consulting statistician seems incomprehensible to a biologist whose main training, for example, has been in the genetics and biochemistry of transposable elements.

Some examples emphasize the diversity and nature of our recent statistical consulting work. Terry Callanan assisted an instructor in veterinary physiology with all aspects of evaluating a study involving artificial insemination of pigs, using mixtures of semen from different males, with the goal of determining the competitive ability of particular males in their capacity to fertilize eggs. Jorge Morel worked with data taken on the activities of geese that use the DeSoto Bend Wildlife Refuge along the Missouri River during their annual migration. Alicia Carriquiry helped to summarize a large field experiment on the activities of European corn borers. Dale Zimmerman fitted and compared growth curves for freshwater drum, based on data taken in Pool 13 of the Mississippi River.

Also Tsung-Hua Lin helped an animal physiologist determine whether there was evidence that hysterectomy influenced the change in mitochondria size in pigs. Dan Jeske used general linear models on data from the soil sciences where the objective was to compare methods and procedures in extracting phosphorus. Mark Bryan worked with entomologists in the design of studies that use large environmental chambers where the control of temperature and humidity is usually excellent but the possibility of replication, often decidedly limited.

V. A. Sposito assisted an economist on the instructional use of a linear programming software package for the minicomputer. Scaling techniques were incorporated into the software. This package has now been made available to several universities in China.

Theodore Bailey assisted in the analysis and interpretation of a study that investigated seed yield response of three switchgrass cultivars under different management practices. The investigation involved field studies conducted in 1979 and 1980 at the Agronomy and Agricultural Engineering Research Center located near Ames. The experimental design consisted of three whole plot treatments (row spacings) in a randomized complete block design. Nitrogen treatments were then stripped in one direction, and cultivar types were assigned in random strips perpendicular to the nitrogen treatments for each whole plot. Treatment effects, and their interactions, were tested using ANOVA F-tests. For purposes of interpretation, single degree of freedom tests for linear and quadratic effects were made, and response curves were fit when appropriate; LSD values were reported for comparison of some treatment means.

Paul Hinz advised on the design of an experiment on how water at different levels of copper pollution affects the feeding behavior of bluegills. The objective is to determine if feeding behavior can be used as an early detector of water pollution. A serious restriction in this type of experiment is often that the number of experimental units is restricted because the number of tanks or ponds is limited. Another experiment with similar types of statistical problems was encountered in a study of the nutritional requirements of walleyes. The objective of this research is to develop economical ways of growing this fish species, in hopes of providing a new "crop" for Iowa.

Many of the projects the statistical consultants get involved in have international dimensions. One example of such a project concerned rotations of several different crops to maximize forage production in the northwestern section of Spain. The purpose was to compare the traditional rotations with the introduction of new species such as corn into the rotation. The experimental work was done by an agronomy graduate student from Spain. In another instance, a visiting scientist from Nigeria brought data collected 10 years ago in an experiment on the influence of nematodes on the growth and yield of corn. She hadn't previously been able to get the advice and help necessary to do a thorough analysis of the data. A student from the American University in Beirut, Lebanon, brought data from an experiment on the nutrition of chickens. Not only had he had difficulty in obtaining statistical advice, but he also had faced grave personal danger when traveling to the experimental station.

The work continues from day to day: some of it trivial and simple to the statistician and some of it baffling and complex, some of it done in a few minutes by telephone and some of it taking months. Whether it is routine and uninteresting or very specialized and exciting often depends simply on the attitudes of the people involved.

Statistical Numerical Analysis and Data Processing Section

As in past years, Bud Meador and Thomas Bubolz continue to supervise the two service support groups in the Statistical Numerical Analysis and Data Processing Section. Research, and most teaching, activities are conducted by William J. Kennedy, Vincent Sposito, and Mervyn Marasinghe.

Incorporation of microcomputers both in the section and in the Department of Statistics operations continued to receive a large amount of attention during the year. Twelve new IBM Personal Computers were acquired and installed at various locations in Snedecor Hall. Several of these machines are used solely for manuscript preparation. The others are used for research and teaching applications. Kennedy presented several short-course training sessions for statistics staff and faculty on the use of the computers. Currently most of these computers are used in a stand-alone mode. However, the university is installing a new campus-wide voice and data communications system that should allow networking of the machines, to include ready access to the large disk storage on the Computation Center's AS/9160 and six VAX 11/780 systems. (The university's mainframe AS/6 research computer has now been replaced by a National Advanced Systems AS/9160 to handle anticipated computing loads.)

The Statistical Data Processing group within the section is composed of two full-time employees, Bud Meador and Kathy Shelley, and seven graduate assistants. Two of the students, Dania Clark-Lempers and Marilyn Eichner, are supported by the Graduate College; the others—Lee Ann Crowder, Fred Hulting, Fah Fatt Gan, Thilagawathy Muththiah, and Michael Carley—by the Statistical Laboratory.

The group used the section's microcomputer equipment both as work stations for the university's mainframe research computer and as stand-alone computational equipment. The data communications link between the large and small computers enabled placement of programs, data, or both on a desired computer. Shelley, Crowder, Gan, and Muththiah made extensive use of this feature and the compatibility of VS FORTRAN between the university research computer and the IBM PC to effect new procedures and to do their work more efficiently. Hulting and Gan developed several service or support routines for the IBM PC to handle technical problems related to controlling the keyboard, screen, and disk.

The group also developed a software system for the IBM PC to handle data-entry or forms-processing applications for transcribing data. Crowder, Eichner, and Muththiah did virtually all of the development work for this program. The software is designed to handle the specific kinds of problems encountered in projects in the ISU Center for Industrial Research and Service (CIRAS). Clark-Lempers worked on several CIRAS projects, as well as on projects from agronomy, economics, and other disciplines within the university. Carley has been working on a database system for the Small Business Development Center functioning under CIRAS to provide outreach service to Iowa industries.

The Statistical Numerical Analysis group, supervised by Thomas Bubolz and including five research assistants, was also very active. Miriam Tirol and John Thompson spent most of the academic year converting the Iowa State Forest Nursery's Tree Order System to run on an IBM PC microcomputer. Four major modules are used to enter and update orders, generate invoices, run reports, and generate shipping documents to ship the orders. The conversion, programmed in BASIC and FORTRAN, showed that even a pedestrian language like FORTRAN can be made reasonably user-friendly. It also showed that databases that require more than two or three floppy disks are better served by computers that have hard disk units. Sorting proved to be an awkward function to implement on the PC, more so than any other single task. The conversion project was finished in time to allow all order processing to be done on the PC. The mainframe version was retired.

Much of the experience gained in conversion of the Tree Order System will be applied to the Cultural Practices Evaluation System of the state nursery as that

system is migrated from the mainframe to an IBM PC-AT microcomputer. Jim Symanowski has handled maintenance and conversion programming on the system throughout the year. He has begun to convert report generators to run on the PC-AT. During the coming year he will be writing programs that will implement Cultural Practices database functions on the PC-AT, making this a self-contained microcomputer system too.

Frank Winters helped to design and program a series of modules that store, update, and retrieve soil test data that were collected from seed beds at the Ames and Fort Madison nurseries. Winters has also programmed Monte Carlo analyses for research being done by Shashikala Sukhatme.

Kathy Taylor worked with the graphics package DISSPLA to generate plots that were used in introductory statistics classes. She has programmed reports, based on a large medical discharge database, that can be used by hospital administrators to evaluate their organization's performance in treating patients having certain types of diagnoses.

During the year the section installed new releases of SAS and SPSSX in the NAS/6 computer. Several microcomputer software systems for various applications were tested and evaluated. Mervyn Marasinghe was involved in evaluation of several different software systems. His report on MSUSTAT was published as a review in *The American Statistician*.

V. A. Sposito conducted a large-scale study in the summer of 1984, comparing the efficiency of IBM's MPSX (linear programming software) with IBM's new products MPSX370 and MPSX370E. These packages are extensively used by the Department of Economics and the Center for Agricultural and Rural Development (CARD), as well as the departments of Industrial Engineering and Forestry here at Iowa State University. Also during the year Sposito conducted research on and tested LINDO and GINO, linear and nonlinear software minicomputer packages built by Scientific Press. These packages are now used in Econ 530, a graduate course on applications of mathematical programming in agriculture, and in economic research aspects of a cooperative international project being conducted in Zambia by ISU on crop production, with agricultural economist Lee Fletcher as coordinator.

Thomas A. Bubolz visited the Dartmouth College Medical School, Hanover, New Hampshire, in January to consult on the design of a health data system that can be used by hospitals, insurance companies, and others for cost containment purposes. Policy analysts can compare the performance of different market areas in treating patients from a variety of case mix groupings. The system can be used to simulate treatment outcomes under differing levels of demand, facility capacity, and reimbursement schemes.

Survey Section

The Survey Section completed two interrelated epidemiologic studies of cancer incidence in white males—one of leukemia and non-Hodgkins lymphoma, and the other of multiple myeloma. Interviewing and data editing continue on a three-year study of the incidence of breast cancer in males. These studies, done in collaboration with the University of Iowa Department of Preventive Medicine and the National Cancer Institute, are described in more detail in the 1983-84 *Statistical Laboratory Annual Report*.

The section cooperated with a researcher from the Mayo Clinic, Rochester, Minnesota, in a project to update the standard for adolescents developed for the Minnesota Multiphasic Personality Inventory. This test is used to evaluate the emotional well-being of patients. The Survey Section selected a sample of household listings from telephone directories within a 50-mile radius of Rochester. The households were to be screened by telephone in order to locate adolescents eligible to be included in the standardization sample, i.e., adolescents not suffering from certain mental or physical handicapping conditions or illnesses. In addition to selecting the sample, the staff designed the field forms and conducted training for the Mayo Clinic telephone interviewers.

A study of Iowa State University faculty members was carried out for the state Board of Regents. The primary purpose of the study was to estimate the average number of hours worked per week by ISU faculty. The Survey Section was responsible for selecting the sample, designing the questionnaire, coordinating the data collection (which extended over the entire academic year), and editing, coding, and processing the data. In another project for the Board of Regents, a sample of employees of Iowa State University, the State University of Iowa, and the University of Northern Iowa was selected for the purpose of investigating the costs, in terms of salary increases, of instituting changes in job classifications at these institutions in compliance with comparable worth legislation. The data were processed and summarized by Survey Section personnel.

The ISU Department of Forestry, interested in surveying owners of forest land in northeast Iowa, requested assistance. Survey Section staff helped with the sampling procedure, conducted the telephone interviews, and edited the questionnaires. A sample of 6 out of 23 counties in the area was selected. Within the sample counties, landowners were selected from property tax assessment rolls. Telephone interviews were conducted with 238 landowners.

The section worked with University Extension Service on a study to assess the interests of Iowans in adult education courses, their use of sources of information, and their perceptions of the Extension Service. Survey Section staff selected the telephone sample, assisted with forms development, and conducted 504 telephone interviews. Extension personnel were responsible for the data analysis.

Two faculty members from the Department of Physical Education and Leisure Studies have developed materials to be used with homebound elderly individuals to provide them with some recreational and exercise activities. The researchers plan to administer a questionnaire to sample subjects both before and after instituting a 12-week visiting program, in order to determine whether any changes are effected in the leisure-time activities or emotional well-

being of the subjects. Section staff helped in the design of the questionnaire and completed pre-program interviewing.

A sample of grain storage elevators in seven midwestern states was selected for a researcher in the Department of Economics studying grain bidding procedures. Three general crop areas were defined—southern wheat, northern wheat, and corn and soybeans. Groups of counties in each area were specified, and lists of those elevators served by cooperating railroads were compiled. The sample elevators were selected from these lists with probabilities proportional to their storage capacities.

An area sample of households was selected from Cedar Rapids, Marion, and Hiawatha, Iowa for the Cedar Rapids United Way in a study to assess citizens' ideas about those community needs that United Way should be addressing. Help with designing the field forms and advice on carrying out the data collection operation were also provided.

Coding and data entry were completed for a researcher in the Cooperative Extension Service in Home Economics, who examined the relationships of two-generation farm families, and for a group of students in the Department of Community and Regional Planning, who surveyed the residents of an Iowa community regarding their needs and attitudes toward land use, zoning, housing, and retail trade.

Guidance in sampling was given to a sociology student to select a sample of rural households, using Farm and Ranch Directories as a frame, and a sample of metropolitan households, using city directories as a frame. Another student in sociology was assisted in the selection of a sample of farms in southwest Iowa, again using Farm and Ranch Directories as a frame. Assistance with questionnaire development and general study design was given to a student in the Department of Professional Studies in Education surveying film makers about techniques used in making persuasive films. Similar help was extended to three students in the Department of Community and Regional Planning—one studying programming of community meetings on public access channels, the second studying inner-city housing needs in a South Carolina city, and the third studying zoning requirements and needs in a number of communities. Researchers from the Iowa Department of Substance Abuse were helped with two different studies involving followup of individuals who had been enrolled in substance-abuse treatment programs. Members of the Survey Section also consulted with ISU administrators on a plan to survey student attitudes toward the revised telecommunications system at Iowa State.

Michael Hidiroglou, Statistics Canada, visited the department for the week of June 17. He worked with William Kennedy, Dan Schnell, Gary Sullivan, Heon Jin Park, and Wayne Fuller on developing plans for revisions of the computer program package SUPER CARP. The Statistical Numerical Analysis and Data Processing Section and the Survey Section hope to revise the program and to develop a version for the personal computer during the coming year.

Industry and Engineering Sciences

The interface of statistics with engineering and industry received considerable attention during the year. As a result a new program of collaborative and affiliate industrial research and consulting is being formulated at Iowa State to advance the application of statistical theory and methods to industrial problems.

Statistics for Quality, Productivity, and Reliability, a six-page brochure prepared by Jauvanta Walker, features the work of William Q. Meeker, Jr., and Stephen Vardeman from the Department of Statistics, Roger Berger and Way Kuo from Industrial Engineering, and Herbert T. David from both departments. Published in June 1985 as part of a series of brochures on ISU research released by the Office of the Vice President for Research, copies are available from that office (201 Beardshear Hall, Iowa State University, Ames, Iowa 50011) or from CIRAS, the Iowa State University Center for Industrial Research and Service (205 Engineering Annex). Some of the work of this five-man group is described in the following pages and in the Research Section, p. 16, of the current annual report.

W. Robert Stephenson, Stephen Vardeman, and Roger Berger designed a display, "Tools for Quality, Productivity, and Reliability," which was produced by the Engineering Research Institute for use as a joint presentation of the College of Engineering and Sciences and Humanities at the annual meeting of the Ames Chamber of Commerce held on March 22 at the ISU Scheman Continuing Education Building. Berger and Vardeman also manned the display during the meeting. On March 29 Vardeman gave a short presentation of the role of statistics in quality, productivity, and reliability at one of the Industrial Engineering Faculty-Industry Interchange Group meetings. The theme of the meeting this time was quality assurance.

Industrial Consulting

For seven weeks last summer Bill Meeker worked at the Quality Assurance Center, AT&T Bell Laboratories, Holmdel, New Jersey. Most of his time was spent consulting on and helping to develop STAR, a user-oriented computer program for the statistical analysis of reliability data. The program allows users to perform both nonparametric and parametric analyses of censored life data, and it has particularly strong graphics capabilities. He returned to Bell Labs in May 1985 to spend a similar period in consulting and research. Meeker also has consulted with reliability engineers at Sunstrand Corporation, Ames, Iowa, and IBM Corporation, Rochester, Minnesota on the analysis of life test data.

Roger Berger and Stephen Vardeman were sent by CIRAS to consult with the International Paper Company in Clinton, Iowa on April 3 regarding their in-house statistical quality control training program. Such outreach activities may be more common in the future. The departments of Industrial Engineering and Statistics have now received approval for a University/Industry Affiliate Program in Productivity, Quality,

and Reliability. Roger Berger is the coordinator, Stephen Vardeman associate coordinator. The aim is to provide industry with ISU faculty and graduate student expertise, research results, and advice, while giving ISU personnel a chance to look at existing technologies and problems, and hopefully find interesting and useful areas for research. Berger is currently working to identify potential affiliates. W. Robert Stephenson and Vardeman are working on developing a demonstration package of educational materials for presentation during site visits to affiliates.

Engineering Research Institute

Consulting on the following projects, on the part of Herbert T. David, Stephen Vardeman, Kevin Anderson, and Robert Arnold, was largely made possible through the support of the Engineering Research Institute, in the form of an assistantship held by Arnold until August 1984 and then by Anderson. The problems dealt with ranged in complexity and sophistication of statistical and probabilistic techniques and the degree of involvement of the consultants. Some problems involved extensive computations; others required only confirmation of the researchers' approaches.

The modeling of a continuous dry-bed seed separator, by a discrete Markov chain, considered by an agricultural engineer, was deemed feasible. Appropriate estimation procedures were outlined for him, and the Markov chain, with estimated transition probability matrix, successfully modeled the operation of the separator. The use of continuous-time Markov chains in constructing a reliability model of a Flexible Manufacturing System was discussed in the first phase of an industrial engineering study.

A civil engineering project to determine strength curves for fly ash concrete involved various statistical techniques. In addition to considerations of measurement error and correlated residuals, attention needed to be given to the fact that much of the data was censored, requiring careful use of maximum likelihood procedures. Another study of asphalt featured problems with missing values in ANOVA contexts. Standard regression techniques were utilized in projects from chemical and industrial engineering. These included disaccharide modeling, cost modeling for asbestos removal, and modeling of the breakdown of calcium sulphate into various calcium components. Other activities included the estimation of variance components involved in the measurement of bearing clearances, and determination of the distribution of the speed of sound through limestone, as a step in validating a newly proposed nondestructive test of strength.

Herbert T. David advised on several thesis problems in industrial engineering: (a) Monte Carlo studies of optimum scheduling through nonparametric estimation of the lower bound of a nonnegative distribution, (b) the creation of algorithms for critical-path project scheduling with resource costs, and (c) penalty formulations of multiobjective stochastic programming problems. Stephen Vardeman consulted with graduate students in engineering mechanics regarding assessment of model adequacy in nonlinear regression problems and on experimental design issues in fracture propagation research.

Nuclear Engineering and Physics

Consulting by Stephen Vardeman with a faculty member in physics concerned a problem in astrophysics that involved testing uniformity of the intensity of a Poisson process against the possibility of periodic variation. Another problem in physics led to testing equality of the slopes of several regression lines.

Herbert T. David has continued to consult with nuclear engineering faculty conducting National Science Foundation-supported research dealing with the reliability of nuclear reactors. Working with ISU's research and teaching reactor, the investigators are developing a statistical methodology to determine optimum positioning of detectors of vibrating reactive fuel rods. A part-time assistantship for Margot Tollefson, supported by the nuclear engineering grant project, was established to provide continuing assistance on statistical analysis and estimation aspects. A computer-simulated model has been used in the identification of vibrator characteristics produced by a moving neutron absorber located in a neutron reactor core. The likelihood-based methods used hold promise for estimating parameters related to the vibration of components in a nuclear reactor, even in the presence of measurement error and external noise.

Margot Tollefson works with John Sankoorikal, a research assistant in nuclear engineering, on statistical problems arising in NSF-supported research to identify the source and intensity of nuclear reactor fuel rod vibration. Here they look at instruments monitoring ISU's research and teaching reactor.

Social Sciences

A grant from the American Cancer Society to Iowa State University supports collaborative research on the long-term modification of chronic smoking behavior. Kenneth J. Koehler, as statistician, is working with the principal investigator, Harry A. Lando, from the Department of Psychology. Koehler has been developing models for comparing post-treatment smoking histories for the two major methods used to help people stop

smoking. A limited proportional failure model appears to provide a good description of the data. This model uses a Weibull distribution to model the times to recidivism, but it also contains a parameter to model the proportion of subjects who never return to smoking. A major complication in estimating the model parameters is that the treatments are given to groups of subjects. Responses for members of the same group may be correlated. A survival analysis computer program written by William Q. Meeker, Jr. has been modified to produce bootstrap estimates of the parameters and standard errors for this complicated situation. The cohesiveness of some groups of subjects was enhanced by the group facilitators, and the statistical models developed will be used to assess the effectiveness of this enhancement on the long-term abstinence rates.

Mack Shelley consults with students and faculty in economics, political science, sociology, family environment, the Graduate College, and the College of Business Administration. Special projects included an analysis of the demographic and attitudinal traits of political party preference in Greece and the analysis of data pertaining to recipients of Premium for ACademic Excellence (PACE) awards at Iowa State University.

Leroy Wolins advised on the design and analysis of a study attempting to measure a facet of personality, self concept. A graduate student in psychology asked people to describe themselves by writing down some set number of adjectives. The adjectives generated by these people were judged according to favorableness by a panel of four judges. The judges agreed well on the favorableness of the adjectives, and the average over judges for each adjective was the dependent variable. The data collection design was a partially balanced incomplete block design involving 12 groups over which the order of measurement, the time interval between measurements, and the number of adjectives permitted were varied. It was found that people used more favorable adjectives when they were constrained to the use of only three adjectives, rather than an unlimited number. Preliminary results suggest that those people who describe themselves most favorably with three adjectives, describe themselves least favorably when permitted to use an unlimited number of adjectives. These results suggest that people with low self concept are defensive when they are asked to describe themselves with three adjectives but are not defensive when permitted to use many adjectives.

Robert Strahan consulted with students and faculty in the departments of Psychology; Child Development; Professional Studies in Education; Industrial Education and Technology; Speech Communication; Hotel, Restaurant, and Institution Management; and Physical Education and Leisure Studies. He also assisted statistically in the dissertation research of students from other universities now residing in Iowa. Topics of consultation included Adlerian psychology, comparable worth in pay, parent and teacher attitudes toward day care centers, speech dysfluency, battering in women, comparison of counseling techniques, attitudes toward parenting, computer anxiety, religious attitudes, evaluation of turkey preparation methods, psychological androgyny, and political attitudes.

Frederick Lorenz continued to work primarily with graduate students and faculty in the social sciences. Two recent efforts are noteworthy. With Roberta Vann, director of the Intensive English and Orientation Program, he completed an analysis of faculty responses to foreign student written errors when the errors are embedded in discourse. The results, which were presented as a Statistical Laboratory seminar, suggest that faculty do not evaluate foreign student errors in English in such a way as to reflect the students' general intelligence or substantive knowledge. Lorenz also worked with a faculty member in education on a study of factors that predict the continued involvement of high school students in sports activities.

Other Consulting

Thomas A. Bubolz consulted with Servi-Share of Iowa on a study of inpatient hospital use commissioned by the Iowa Voluntary Cost Containment Committee. The state was divided into 48 small population areas. Within each area the numbers of discharges and patient days for over 30 surgical procedures and diagnoses from 1983 were compared to similar data collected in 1980. It was found that, although overall hospital utilization declined by about 10 percent, there was substantial variation among small areas (CV $>$ 100%) in certain diagnoses and procedures. The principal cause of such variation is thought to be a low degree of consensus among physicians about correctness of diagnoses and efficacy of treatments.

Arising from consultation with a chemical engineering graduate student, cooperative research by C. Philip Cox is proceeding on the development and comparison of efficient methods for fitting the Michaelis-Menten equation.

Noel Cressie consulted with two faculty in the Veterinary Diagnostic Laboratory on point pattern analysis of behavioral sequences observed on monkeys.

Two graduate students are involved in collaborative work under the direction of Jerome Sacks, USDA collaborator/associate professor. Mohammad Khan, supported by the USDA, is serving as statistician for an agronomy project on oats genetics. This is a greenhouse experiment testing oats varieties for their resistance to pathogens. His particular activities with the agronomy faculty involve data analysis of the oats yield components relative to the concomitant disease severity. He will also be planning the design for future experiments based on his analyses of these results. Mamadou Diedhiou is collaborating with agricultural engineering faculty in a series of uniformity trials to evaluate two new growth chambers being tested by their department. His task is to analyze the spatial distributions of light and temperature in the chambers, to try to model these distributions, and to use the models in designing future experiments. He will eventually analyze growth data to empirically evaluate the importance of the interior temperature and light variability as design factors.

Current Research

This section summarizes research supported by grants or sponsored by contracts and individual research. Funds are provided by the budgets of the Statistical Laboratory, the Iowa Agriculture and Home Economics Experiment Station (AES), the Sciences and Humanities Research Institute, and the Engineering Research Institute within the university, and several government contracts and grants. Some joint research has been described in the previous section. Papers arising from current research are in part listed in the section on Professional Activities.

AES Project 890

Oscar Kempthorne has been working on the nature and role of ancillary statistics, which appear to have a role only with regard to significance tests. There are vast obscurities in the area, but there is some basis for hoping for clarification.

AES Project 2155

The Survey Section continued its cooperative research with the U.S. Soil Conservation Service (SCS), through Project 2155 of the Iowa Agriculture and Home Economics Experiment Station, under the direction of Roy D. Hickman. Data collected for the 1982 National Resources Inventory (NRI) were used to compute estimates of acres in various land use categories, the amount of soil erosion caused by wind and water, the amount of land needing conservation treatment, and other soil-related characteristics. These estimates were presented in tabular form by states, multi-state regions, and Major Land Resource Areas, and as a national summary. In conjunction with the 1982 NRI, many states also have collected data for county or multi-county resource inventories. These data are presently being edited by Survey Section and state SCS personnel. Preliminary estimates are being computed and sent to states for review, after which final tables will be produced.

A statistical quality evaluation of the 1982 NRI was initiated in 1983. A total of 3,426 primary sampling units (PSUs) from 502 counties in the United States and the Caribbean were revisited by SCS personnel who made independent on-site field observations. That data is currently being edited and analyzed by Survey Section personnel. Results will permit an evaluation of the measurement error associated with data collection and processing procedures used for the 1982 NRI and will provide a means of identifying and evaluating potential problems in the inventory's resource database. A final report summarizing the results and making recommendations for procedural modifications will be completed in the fall of 1985.

The United States land area has been divided into 106 areas on the basis of the potential natural vegetation that would exist in the absence of human interference (e.g., grassland, deciduous forest, evergreen forest, desert, etc.). These areas, originally delineated by A. W. Küchler, are referred to as Küchler cover types. A project to assign appropriate Küchler cover-type codes to each PSU in the 1982 NRI was initiated. Küchler area boundaries were transferred from a small-scale national map to individual county maps on which the 1982 NRI sample PSUs are shown. Appropriate Küchler codes were determined for each PSU and entered into the data record. Time and resource limitations prevented carrying out the project for all 106 delineations this year. Consequently, the researchers most immediately interested in using the information consolidated the 106 specific Küchler areas into 8 general areas, and work was completed on assigning codes with respect to those 8 areas.

Work was begun on processing and editing of data for the Texas Brush Inventory. This inventory, conducted by SCS in Texas as a supplement to the 1982 NRI, is a survey of total brush cover, brush control practices, and brush cover for a number of individual plant species. Preliminary estimates of acreages of brush on pasture and rangeland by cover class have been submitted to Texas SCS personnel for review.

Survey Section staff assisted resource inventory specialists from the SCS South National Technical Center in Fort Worth, Texas, and the National Office in designing a remote-sensing pilot project. In previous national resources inventories, data were collected by SCS field personnel through on-site inspection, requiring considerable expense for travel and data collection. The pilot project was designed as a test of the feasibility of collecting data for the state of Oklahoma from aerial photos, rather than from on-site inspection. Survey Section personnel selected the sample of areas included in the test, assisted in quality control monitoring, and will perform the statistical analysis to compare data obtained by remote sensing with on-site ground-truth data.

The data from the 1982 NRI is public information and thus is being put to use by non-SCS agencies. As an example, the Survey Section assisted the Oklahoma State University Department of Forestry with a project concerning forest area and total forest biomass in Oklahoma. Data from the Department of Forestry was combined with NRI data to produce the desired estimates.

Research was conducted on the use of the multivariate components-of-variance model in the construction of estimates for small areas. This was a continuation and extension of research in Rachel Harter's Ph.D. dissertation. Harter and Wayne A. Fuller reported on this research at the International Symposium on Small Area Statistics, in May in Ottawa, Ontario, Canada.

Survey Section personnel working on resources inventory projects during the year were Fuller, Harold D. Baker, Richard Dorsch, Mark Reiser, Art Kuhl, Carol Francisco, Jeanne Sorenson, Kathie Reinertson, Sue Verkade, Sheri Lin, Dorothy Edwards, Dan Schnell, Sharon Loubert, Gloriana Giacobello, Gary Sullivan, and John Eltinge.

As part of the SCS cooperative work, the soil property and interpretations database of soil series in the United States continues to develop. Harvey Terpstra directs this work and is assisted by Deborah Reed-Margetan, Jan Seagrave, Sue Ridnour, and Jeanne Sorenson. With the addition of 2,000 new records, the database now contains over 25,000 records. The rate of updating that dynamic database remained high, with over 13,000 records updated this year. The Major Land Resource Area and woodland suitability sections of all data records were scrutinized and revised to meet current SCS requirements. Programs that produce computer-generated ratings used in data editing were revised to match current guides in the SCS *National Soils Handbook*.

In addition to adding and updating soil interpretations data, data storage and updating of soil map unit data for published soil surveys continued. The map unit file now contains data for over 2,000 soil surveys, with location and acreage information available. The database provides a link to appropriate data items in the interpretations database, thus making it possible to provide map-unit-specific soil property data to SCS and other users.

Work was completed on a set of soil interpretations records compatible with the 1982 NRI data set. As part of an effort by the SCS National Technical Committee for Hydric Soils to study U.S. wetlands, a program was developed to search soil interpretations records and select hydric soils. Various selection criteria were investigated and reviewed by the committee. Remote access of the interpretive and map unit data by SCS offices became increasingly popular. A first step in the use of personal computers was made; map unit data for the state of Kansas were reformatted, transferred to floppy disks, and sent to the Kansas SCS office for testing.

Mark Reiser conferred with Soil Conservation Service personnel in the South National Technical Center, in Texas, in December and January concerning a remote-sensing pilot project for the 1987 National Resources Inventory. He also went to Washington, D.C. in May to confer with former Survey Section member Jeffery Goebel, now with SCS, concerning NRI procedures. Roy Hickman visited Washington May 21-24 to discuss work under the current cooperative agreement with SCS.

AES Project 2383

The U.S. Bureau of the Census and the Iowa Agriculture and Home Economics Experiment Station supported joint research in measurement error models, time series, and survey design. Support from the Bureau of the Census was through Joint Statistical Agreements J.S.A. 84-2 and J.S.A. 85-1. Wayne Fuller is principal investigator. Other personnel working on the project include Yasuo Amemiya, Nancy Hasab-El-Naby, Stephen Miller, Neerchal Nagaraj, Edina Miazaki, Daniel Schnell, and Yasuyuki Toyooka.

Research continued on the effect of the response error on reported employment status and reported changes in employment status. Tin Chiu Chua of the University of South Dakota assisted in this research. A joint paper was presented at the Conference on Gross Flows in Labor Force Statistics sponsored by the Bureau of the Census and the Bureau of Labor Statistics in Washington, D.C., July 1984.

Edina Miazaki conducted research on the use of time series methods in constructing estimates for rotation surveys. Miazaki studied methods of using the autoregressive moving average model to construct improved estimates of crime rates for the National Crime Survey. Both theoretical and Monte Carlo studies suggest that the use of time series methods can lead to improvements in efficiency. Nagaraj studied time series models in which the autoregressive portion of the models contains a unit root. Toyooka continued work on the risk of generalized least squares estimators, with particular applications to time series.

Amemiya, Schnell, and Fuller continued their study of nonlinear measurement error models. Additional large-sample results were obtained and compared with Monte Carlo results. Hasab-El-Naby and Miller studied extensions of the linear errors-in-variables model. Hasab-El-Naby's numerical study suggests that large samples are required for the normal approximation when errors are strongly heteroskedastic.

Crop Production Estimation

Cooperative research with the Statistical Reporting Service, United States Department of Agriculture, continued under the direction of Wayne A. Fuller. Carol Francisco and Sharon Loubert worked on the project. Previously initiated work on methods of combining satellite information with information collected in the June Enumerative Survey continued, and variance estimation for crop estimates was studied.

Research concentrated on the construction of variance estimators for the objective yield surveys conducted by the Statistical Reporting Service. These survey are conducted in conjunction with the June Enumerative Survey and are used to construct estimates of yields for major crops. While field sampling procedures for each crop differ in terms of plot sizes and vegetative and fruit measurement techniques, all surveys rely on the same basic survey design. This design is a stratified, multistage, two phase, unequal probability sample of considerable complexity. Variance estimators for estimated production and yield were developed and their theoretical properties identified. Francisco conducted a large-scale simulation study of the estimators on a population modeled after cotton in California. On the basis of this research, an estimator was recommended to the Statistical Reporting Service.

Mathematical and Statistical Genetics

Edward Pollak conducted research in mathematical and statistical genetics under Project 2588 of the Iowa Agriculture and Home Economics Experiment Station. He continued his study of sampling

theory for finite monoecious populations that reproduce partially by selfing and partially by random mating. It was found that, if offspring are generated by multinomial sampling, the classical finite population theory for random-mating populations holds if N, the population size, is replaced by $N_e = N(1 - s/2)$, where s is the probability of reproduction by selfing.

Further research was done on the derivation of expressions for means of quantitative characters that are influenced by more than one locus. Da Yang, working under Pollak's direction, derived means for two parental populations, the F_1 generation that results from crossing them, the F_2 that arises from random mating among F_1 individuals, and the backcross of the F_1 generation to one of the parental populations. This generalizes earlier two-locus results obtained by Willham and Pollak, in that it is not assumed that there is independent assortment between the two loci in the two parental populations. In another generalization, considered by Pollak, the assumption of initial independent assortment is kept, but any number of loci, rather than just two, are assumed to influence the quantitative character. Pollak has obtained expressions for the means of the parental populations and of the F_1 generation.

Research was initiated on the derivation of an expression for the variance of the number of alleles having a frequency less than a small number q in a random sample from a finite population. This leads to a formula for the variance of Nei's indirect estimator of the mutation rate at a locus, if it is assumed that the population is unchanging in size and that all possible alleles at the locus are either neutral or not strongly selected.

Auxiliary Information, Models, Robustness, and Efficiency in Survey Sampling

The role of models that permit efficient use of auxiliary information at the design stage of sample surveys was studied by Ronaldo Iachan. Departures from such models lead quite naturally to robustness considerations. Robust sampling designs, as well as estimators, were investigated.

A different direction consists of incorporating auxiliary information at the estimation stage. A joint investigation of ratio and product estimators, of the use of the jackknife, and of the general efficient use of auxiliary variables has been carried out by Iachan, together with L. N. Upadhyaya and H. P. Singh, both at the Indian School of Mines.

Under a grant from the National Marine Fisheries Service (NMFS), various problems associated with sampling in two dimensions were studied by Iachan for a continuing project, Sampling Designs to Survey Offshore Populations. Special attention was devoted to different ways of forming stratum boundaries in the plane. Results from the NMFS bottom trawl surveys (1976-1980) seem to suggest gains due to the use of new (transformed) stratifying variables. Possibilities are the variables depth, latitude and longitude, and commercial catch, as well as available past survey data.

The periodic nature of the NMFS surveys also enables profiting from some overlap between repeated samples. The general structure of rotation sampling designs was examined under different models. The effects of spatial and temporal autocorrelations are under current investigation.

Modeling Tumor Growth

Previous mathematical models for tumor growth are mostly limited to building and solving stochastic differential equations of one-dimensional quantities, such as proportion of cancerous cells or tumor volume. Very little research has been devoted to working mathematically with the tumor as a geometric object. Current research by Noel A. C. Cressie, under a university research grant funded by the National Institutes of Health, models the tumor as a random set, and establishes a set-dynamic equation for the growth. The growth processes have been built synthetically on the computer, with the help of David Silvis, yielding realistic tumor shapes. Conversely, from shapes measured at various time instants, it is possible to estimate the growth parameters. This is an important feature when assessing the effectiveness of various treatment regimes.

In connection with this research Cressie visited the Peralta Cancer Research Institute, Oakland, California, in January to consult with the director, A. Hackett, on the biology of tumor growth and how mathematical modeling may help in its understanding.

Bayesian Statistics

For many problems in finite population sampling, Bayesians find it very difficult to choose a prior distribution because the parameter space is so large. Glen Meeden is studying various methods of incorporating prior information in a pseudo-Bayesian way for such problems. This work is supported by a grant from the National Science Foundation.

Order Statistics and Nonparametric Statistics

With support of a grant from the Army Research Office, H. A. David, principal investigator, has developed inequalities for ordered sums. Let $x_i = y_i + z_i$, $i = 1,...,n$, and write $x_{(1)} < ... < x_{(n)}$, with corresponding notation for the ordered y_i and z_i. It is shown, for example, that $x_{(r)} \geq \max_{i=1,...,r} (y_{(i)} + z_{(r+1-i)})$, $r = 1,...,n$. The results give bounds for the expected values of order statistics in certain nonstandard situations in terms of simpler expectations. In conjunction with J. K. Ghosh, visiting professor, David has studied the effect of an outlier on L-estimators of location (see p. 24). David is also collaborating with three research assistants. Michael Rogers is investigating selection by an associated characteristic through studying the probability that the k individuals out of n best on the primary characteristic survive a fixed cut-off selection on the associated characteristic. In Hye Ha worked on the use of order statistics in within-family selection, and Doug-

las Andrews is looking into new procedures for picking the best object in a paired-comparison experiment.

J. K. Ghosh, while visiting the department, also did research on the following topics: (a) proportion below sample mean for symmetric stable laws, (b) characterization of statistics—a review and new results, and (c) weak convergence of the median residual lifetime process (jointly with C. K. Mustafi).

Malay Ghosh has had the following papers, based on research for the grant project, accepted: "Berry-Esseen bounds for functionals of U-statistics" [*Sankhyā A*], "On asymptotically risk-efficient sequential versions of generalized U-statistics" [*Sequential Analysis,* joint with P. K. Sen], and "Two-sample nonparametric tests based on subsamples" [*Communications in Statistics, Theory and Methods,* joint with W. R. Stephenson].

Spatial Statistics

Methods for checking and removing nonstationarity from spatial data are being developed by Noel A. C. Cressie. Successful analyses have been performed on data from such diverse areas as crops, soils, hydrology, public health, and mining. Recent research has concentrated on the fitting of models of spatial association, the change-of-support problem, and spatial design. Effective June 15, 1985 a two-year grant was awarded to Cressie by the National Science Foundation to support further work on spatial statistics.

Sciences and Humanities Research Institute (SHRI)

SHRI funds help to support the research activities of Yasuo Amemiya, Krishna Athreya, H. A. David, Mervyn Marasinghe, and Glen Meeden.

Various problems in the area of multivariate analysis were investigated by Amemiya. For a wide class of multivariate functional and structural relationship models, properties of the goodness-of-fit tests were derived, and a test procedure for the number of relationships was proposed. A study on the maximum likelihood estimator and a bias-adjusted maximum likelihood estimator for the nonlinear functional relationship model was completed. Estimation problems for the factor analysis model with special structures were considered. Also inference procedures for a simple errors-in-variables model with no intercept were investigated.

Marasinghe presented the results of research on the application of conjugate gradient methods to analysis of variance problems at the annual meeting of the American Statistical Association held in Philadelphia. Present work includes research on outlier detection methods in linear regression, and nonadditivity in random and mixed linear models.

Meeden considered various problems in the area of Bayesian statistics. Part of this work was supported by a grant from the National Science Foundation and is reported earlier.

Work by H. A. David on order statistics has been described in the section reporting on the Army Research Office grant project.

Limit Theorems

Krishna B. Athreya's research covered the following topics: bootstrap and U-statistics asymptotics, renewal theory, strong mixing for autoregressive processes, conjugate family of priors, and the range of Markov chains. This work has led to a two-year grant from the National Science Foundation, effective June 15, 1985.

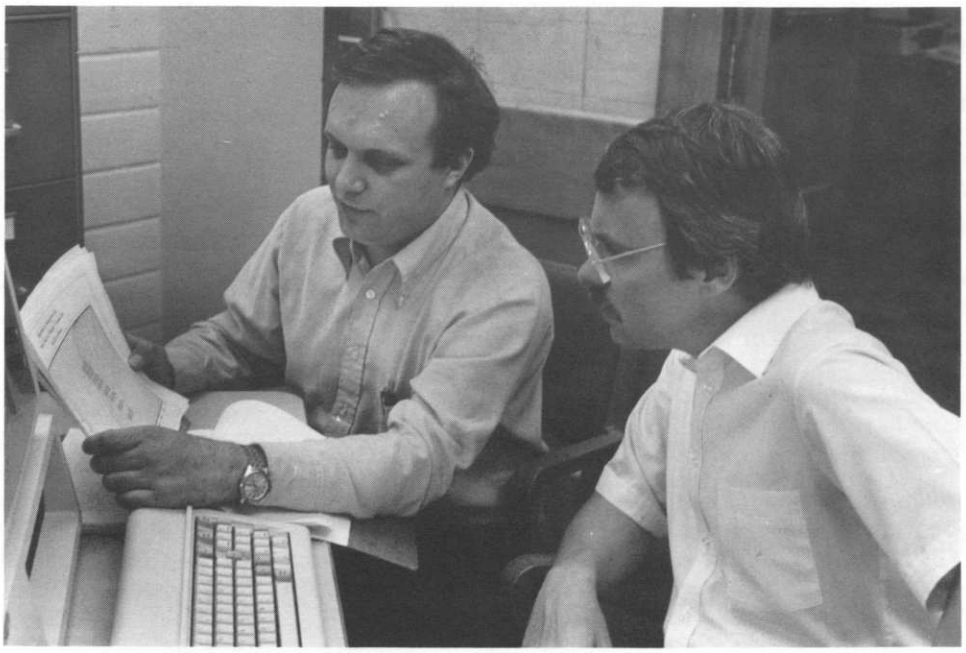
In the area of bootstrap and U-statistics asymptotics, it was shown that if $X_1, X_2, \ldots, X_n$ are i.i.d. with c.d.f. F belonging to the domain of attraction of a stable law of order x, $0 < \alpha < 2$, then the distribution of the bootstrap mean from $X_1, X_2, \ldots, X_n$ converges to an infinitely divisible law whose canonical measure comes from a Poisson random field. This is in contrast to the finite variance case where the bootstrap mean is asymptotically normal. A similar result for U-statistics is also valid where a new stable limit analog was obtained. If the bootstrap sample size m goes to ∞ but $mn^{-1} \to 0$, then the bootstrap mean has the same limit distribution as the sample mean.

In work with Kevin Anderson on renewal theory, the case of the infinite mean was studied. It was shown that when $1 - F$ is regularly varying (-1) [i.e., RV(-1)] then there exist a_t and b_t such that $(N_t - a_t)b_t$ converges in distribution to a nondegenerate limit, where N_t is the number of renewals up to time t. It was also shown that when $1 - F$ is RV$(-\alpha)$, $\frac{1}{2} < \alpha \leq 1$, and Q is RV$(-\beta)$ then $(Q^*U)(t)$ is $C \sim \widetilde{Q}(t)\, m(t)$, where $U(t) = \sum_0^\infty F^{(n)}(t)$ is the renewal function, $\widetilde{Q}(t) = \int_0^t Q(u)du$, $m(t) = \int_0^t [1 - F(u)]du$. This improves and corrects a result of Teugels (*Annals of Mathematical Statistics,* 1968). Finally, for the generalized renewal function $G(t) = \sum_0^\infty a_n F^{(n)}(t)$, weak and strong renewal theorems were established when $1 - F$ is RV$(-\alpha)$, $\frac{1}{2} < \alpha \leq 1$, a $(\bullet)$ is RV(β), $\beta \geq -1$, thus extending the work of Embrechts, Maejima, and Omey (*Annals of Probability,* 1984) and Erickson (*Transactions of the American Mathematical Society,* 1970).

In joint work with Sastry G. Pantula (North Carolina State University) on autoregressive (AR) processes, it was shown that positive recurrent Harris Markov chains are strong mixing. This was used to derive a sufficient condition for a nonexplosive AR process to be strong mixing. Also a necessary and sufficient condition for uniform mixing for AR(1) processes was obtained.

A new family of priors for the normal distribution, enlarging the usual normal-Gamma family, was obtained by Athreya. This is the family of probability distributions of (μ,σ^2) on $R_1 x R_1^+$ such that, for each π in P, the following holds: (i) the conditional distribution of $\mu \mid \sigma^2 = z$ is $N(\mu,\tau z)$, where μ and $\tau > 0$ are given constants, and (ii) the marginal distribution of σ^2 has a probability density function on $(0,\infty)$given by $f(z) = cz^p \exp[(\lambda_1 z^{-1} + \lambda_2 z)]$, with $0 < z < \infty$, $\lambda_1 \geq 0, \lambda_2 \geq 0$, $-\infty < p < \infty$.

Using Kingman's subadditive ergodic theorem, Athreya obtained a result of Chosid and Isaac on a sufficient condition for $R_n n^{-1} \to 0$, where R_n is the range of a recurrent Markov chain.



L to R: William Q. Meeker and Stephen Vardeman discuss the use of acceptance sampling software developed by Blake Abdella.

Reliability and Censored Data

William Q. Meeker, Jr. continued his research on statistical methods for collecting and analyzing censored life data. On one front, he has been studying methods of planning life tests that meet certain practical constraints and that are still statistically efficient. This work has culminated in a booklet, coauthored by Gerald Hahn (General Electric Corporate Research and Development Center), to be published by the American Society for Quality Control. In another area, Meeker and some of his students have been developing and investigating methods of making inferences from censored survival data. These efforts have concentrated on alternatives to asymptotic theory for setting approximate confidence intervals and on graphical methods for presenting cleanly and succinctly the results of statistical analyses.

Under Herbert T. David's direction, Byung Sul Park studied the sorts of binary Boolean functions appearing both in the analysis of n-component reliability structures, and in the theory of n-person simple games.

Other Research

Stephen Vardeman, Herbert T. David, and Marcus Jobe studied discrimination between and among nonstationary Poisson processes. Vardeman is working on a literature inventory for the American Statistical Association Committee on Quality and Productivity. This is intended to get statisticians "into the Q&P literature." David participated, for part of summer 1985, in the ongoing work of the statistics section of IBM's Thomas J. Watson Research Laboratories in the area of quality control of microchips and TCM modules.

Under Vardeman's direction, Stephen Crowder continues to work on applications of Kalman filtering techniques in statistical process control and optimal control theory settings. Chihho Hsieh is working on Bayesian selection of a variables acceptance sampling plan. Other students are beginning creative component work in the areas of computer-aided statistical tolerancing and experimental design for quality engineering.

Carl Roberts has been working on two research projects in the sociology of religion. With a colleague at the University of Notre Dame, he is doing a content analysis of accounts of exorcisms, as a case study that investigates how the concept of "exorcism" may have changed with its historical setting. Three hundred exorcism accounts have been sampled and then translated from Latin to English. The accounts are now being coded, in preparation for computer analysis. The general purpose of the study is to explore changes in the way that exorcism was promoted by the Catholic church, from the technique's introduction in the fourth century, through the time of the plagues (when its efficacy was brought into question), to its declining popularity toward the end of the seventeenth century. A linguistic technique for content analysis was developed that allows the translation of sentences into numbers in such a way that they can be "translated" back to sentences again. This project is in part supported by a small grant from the ISU Achievement Foundation.

The second project explores whether different psychological and/or interpersonal needs are met by different types of churches. In the fall of 1984, data were collected in a pilot study of the Ames religious community by interviewing ministers of 44 churches. On the basis of these data, four Ames churches were selected for more in-depth study. During the spring, four samples of 100 households each were randomly drawn from lists of persons, usually church members, obtained from leaders of those four churches. Analysis of data from questionnaires sent to the households will begin this summer.

Also, manuscripts based on research done before Roberts came to Iowa State have been completed or are

in press. These concern research into gender identity development, research into differences between married couples with vs. without sexual dysfunctions, and research on political generations within the U.S. public.

Current research by C. P. Cox concerns estimation with specific variance heterogeneity. Although several expository texts on data analysis understandably concentrate on the simplest, equal variance, situations, it is conjectured that, in much biological research, it is almost a "fact of life" that really different treatment or environmental regimes will, as rule rather than exception, affect parameters other than simply the first moment of distributions of observations. Research has been conducted by Cox for the examination of two population means, μ_1 and μ_2, when (a) the observations are normally distributed and (b), specifically, the population variances σ_i^2 are related to the means as $\sigma_i^2 = (c + \mu_i)^k\sigma^2$, $i = 1, 2$, where c and k are known constants. The procedure is particularly simple for $k = 1$ and 2 and, for $c = 0$, $k = 2$, is exactly applicable to relative potency estimation in direct bioassay with normally distributed tolerances. Another example shows that the procedure can have advantages over the log-transformation approach sometimes used in similar contexts. Research on some generalizations of the procedure is continuing.

Research by Mack Shelley has focused principally on applications of time series and intervention models in the social sciences. This has emphasized (1) modeling the effect of bank failures on stock portfolios, and (2) the effects of political parties and exogenous events in British elections. A related project has dealt with the use of vector autoregressive models in examining the consequences of domestic credit conditions on the agricultural sector. Other research continues on the sources of changes over time in the outcomes of U.S. legislative elections and in the policy success of conservatives in Congress.

Robert Strahan has been investigating behavioral scientists' perceptions of effect strength indices, the role of social desirability in measurement of masculinity and femininity, the distribution of a coefficient of directional correlation, and some issues in the relation between test reliability and validity.

Shashikala Sukhatme is working on application of perturbation theory in statistics and on nonparametric tests for ordered alternatives when the samples are dependent.

Frederick Lorenz's primary effort this past year has been directed at the development of reliable measures of organizational structure and environmental uncertainty for human service agencies. These measures are to be used to study barriers to coordination among human service agencies under conditions of declining federal government financial support. Other research efforts, with graduate students in sociology, include the development of a more unified theory of operative goal effectiveness for nonprofit organizations and a study of rural agricultural cooperative effectiveness. Also Lorenz and a faculty member in family environment worked on a study of structural factors that affect the strength of relationships between objective and subjective indicators of economic well being.

Professional Activities

Oscar Kempthorne became president of the Institute of Mathematical Statistics on August 22, 1984 at the annual meeting held at Lake Tahoe, California. During his year of service, there has been the usual spectrum of duties, and several unusual ones, as well as the making of plans for the 50th anniversary of the founding of IMS. Glen Meeden was appointed to the IMS Special Papers Committee to serve three years.

Iowa State University has entered into an agreement with both the American Statistical Association and the Institute of Mathematical Statistics whereby important historical papers of those organizations and some of their members will be kept in archives at Iowa State's Parks Library. Herbert T. David was appointed chair of the IMS Archives Committee, and H. A. David is vice-chair of the Committee on ASA Archives.

H. A. David has also been appointed co-chair of the American Statistical Association Committee on Filming of Distinguished Statisticians, to serve through December 31, 1987. This committee, first established in 1979 on an ad hoc basis and now a continuing committee of the ASA, is charged with the responsibility of producing tapes of distinguished statisticians for distribution to the chapters and other professionally interested groups and for retention as part of the ASA audiovisual archives.

Kenneth J. Koehler is governor of District 6 of the American Statistical Association and a member of the Executive Committee for the ASA Council of Chapters. He completed his term as president of the Iowa chapter in December; Ronaldo Iachan is serving as chapter secretary/treasurer for 1985. William Q. Meeker, Jr. is a member of the Advisory Board of the ASA Section on Physical and Engineering Sciences, while Stephen Vardeman serves on the ASA Committee on Quality and Productivity.

Theodore Bailey served as a member of an American Statistical Association committee to evaluate statistical methods being used to study the effects of acid deposition on crops, and regionalization of the crop dose response studies.

In October Jauvanta Walker was reelected second vice president of the Iowa Poetry Association for two more years; she has completed duties as acting treasurer.

Wayne A. Fuller continued to serve as a member of the Committee on National Statistics of the National Research Council and as a member of the council's Panel on Decennial Census Methodology. Meetings were held in Washington, D.C. in July and November 1984, January, February, and May 1985.

Stephen Vardeman is a part of the American Quality and Productivity Institute, a national computer network of quality control specialists headed by Myron Tribus, director of the Center for Advanced Engineering Study at Massachusetts Institute of Technology.

In July 1984 Herbert T. David and Vardeman participated in a Conference on Statistical Education for

Engineers, held in Iowa City, Iowa and cosponsored by the University of Iowa, the American Statistical Association, and the Statistical Division of the American Society for Quality Control. The mission of the conference was to address the development of desirable statistical curricula for engineers through both university and industrial in-house training. David served as group leader for one of the academic program teams.

Also in July and August Stephen Vardeman taught three one-week short courses, on statistics for quality and productivity, to M.S.- and Ph.D.-level statisticians and engineers of Hewlett-Packard Corporation in Corvallis, Oregon; Boise, Idaho; and Fort Collins, Colorado. A similar course was taught to B.S.-level engineers of the John Deere Company at Bettendorf, Iowa, during May 1985. Under his direction, Stephen Boeh gave a short course in January on statistical process control, for production workers at EMCO Industries, a U-bolt manufacturer in Des Moines, Iowa.

W. Robert Stephenson went to Minneapolis, Minnesota to present a one-day short course, on September 28, 1984, on nonparametric statistical methods, to the statistical section of the Pillsbury Company Research and Development staff.

David Harville, as visiting lecturer, presented "Components of Variance Models," a series of nine lectures, on May 20-31 at the University of North Carolina, in the Department of Biostatistics summer lecture series.

Herbert T. David visited the University of Minnesota on November 12-13, 1984 to serve on a review panel for its statistics program. H. A. David served as a member of an Army Research Office committee reviewing proposals for a Center of Excellence in Mathematical Sciences; for this purpose he visited Durham, North Carolina in December. William Q. Meeker, Jr. visited the Department of Mathematics, Polytechnic Institute of New York, on February 3-5, 1985 to evaluate its applied statistics Ph.D. program for the New York State Department of Education. In March, Noel A. C. Cressie was appointed reviewer in the External Review Program of the Statistical and Psychometric Research and Services Division, Educational Testing Service, Princeton, New Jersey.

Oscar Kempthorne served as expert witness for the defense in the *Shockley v. Witherspoon* trial.

J. K. Ghosh, Glen Meeden, and Krishna Athreya attended the National Science Foundation/Conference Board on Mathematical Sciences Regional Conference on Exchangeability in Statistics, held in West Lafayette, Indiana July 23-27, 1984. Athreya served as the board's official observer. He and Kevin Anderson attended the 6th Midwest Probability Colloquium, held in Evanston, Illinois October 19-20. Meeden also attended the 29th National Bureau of Economic Research and National Science Foundation Seminar on Bayesian Inference in Econometrics, held in Brunswick, New Jersey October 26-27 and an NSF-sponsored conference, Multivariate Estimation: A Synthesis of Bayesian and Frequentist Approaches, held in Gainesville, Florida January 6-11, 1985. Stephen Vardeman attended a short course on Dr. Deming's Methods for Management of Productivity and Quality, offered June 10-13 at George Washington University.

Theodore B. Bailey, Jr., served on the executive committee for the World Soybean Research Conference held at Iowa State University August 12-17, 1984. He also attended the 5th International Corn Quantitative Genetics Symposium and the North Central Region 2 Quantitative Genetics Meeting held jointly in Chicago, Illinois on March 25-28. Edward Pollak attended the international symposium, Evolutionary Perspectives and the New Genetics, held at the University of Michigan on June 17-18 and honoring James V. Neel.

Noel A. C. Cressie attended a Conference on Bootstrap, Jackknife, and Related Techniques, held in Edinburgh, Scotland, July 4-6, 1984. Then from July 9 to 20 he was a visiting professor at the Statistical Laboratory, University of Cambridge, U.K., primarily working with D. G. Kendall on random set modeling. In August Cressie consulted with faculty at the University of Wageningen, the Netherlands, who were working in spatial agricultural statistics. From May 27 to June 21, 1985 he was a visiting scientist at the Division of Mathematics and Statistics, Commonwealth Scientific and Industrial Research Organization, Melbourne, Australia, engaging in collaborative research with G. M. Laslett on spatial statistics and geostatistics.

Wayne Fuller and Roy D. Hickman visited the Mayo Clinic, Rochester, Minnesota to consult with staff on October 30, 1984 and April 11, 1985 on the planning of a baseline blood pressure study to be conducted in the Rochester area.

Roy D. Hickman attended the Convocation on Physical Dimensions of the Erosion Problem: New Perspectives from the 1982 National Resources Inventory, held in Washington, D.C. December 6-7, 1984 under the sponsorship of the National Research Council, National Academy of Sciences.

William J. Kennedy organized and chaired a session on Numerical Algorithms for the 17th Symposium on the Interface of Computer Science and Statistics, held in Lexington, Kentucky March 17-19.

At the 1984 joint statistical meetings in Philadelphia, Pennsylvania, Stephen Vardeman served as a formal discussant at a session on Statistical Quality Control Based on Economic Considerations, while Wayne Fuller chaired a contributed paper session on Variance Estimation. Vardeman was one of four speakers at a one-day workshop on the Use of Statistics in Improving Product Quality and Industrial Productivity, offered by the American Statistical Association Continuing Education Department immediately before the joint meetings.

William Q. Meeker, Jr., and co-author Gerald J. Hahn (General Electric Company) have been chosen to receive honorable mention certificates for outstanding presentation of a contributed paper at the 1984 annual meetings. Presentation will be made by the ASA Section on Physical and Engineering Sciences at the 1985 annual meetings in Las Vegas.

A number of the faculty and graduate students attended a conference held at the University of Iowa, on October 5, 1984, in honor of Robert V. Hogg's 60th birthday.

Papers Presented, Lectures, and Seminars

At the 1984 joint statistical meetings of the American Statistical Association and the Biometric Society (ENAR and WNAR) in Philadelphia, Pennsylvania:

AMEMIYA, Yasuo: "Two-stage least squares estimator for the nonlinear functional relationship";

CRESSIE, Noel A. C.: "Modeling and robust analysis of spatial relationships";

CRESSIE, Noel A. C., and Marinus Borkent: "The moment generating function has its moments";

GHOSH, Malay (Iowa State University and University of Florida), and **Glen MEEDEN:** "A new Bayesian analysis of a random effects model";

Guerrero, M. F., Stephen K. Fahrenholtz, and **H. T. DAVID:** "Buehler bounds for monotone systems and event trees";

Hung, Hsien-Ming (University of Minnesota-Morris), and **Wayne A. FULLER:** "The use of transformed data as auxiliary variables for crop estimation";

IACHAN, Ronaldo, and Christopher T. Gledhill: "Optimum stratification for clam surveys";

Jobe, J. Marcus, H. T. DAVID, and **Stephen VARDEMAN:** "Limiting error rates for the discrimination between Poisson processes";

Keller-McNulty, Sallie (University of North Carolina-Greensboro), and **W. J. KENNEDY:** "Error-free computation of the Moore-Penrose inverse";

Kim, Byung C., Mervyn G. MARASINGHE, and **William J. KENNEDY, Jr.:** "A new conjugate gradient algorithm for analysis of variance computations";

MEEKER, William Q., Jr., and Gerald J. Hahn: "Improved simple accelerated life test plans";

Sallas, William M., and **David A. HARVILLE:** "Mixed model applications of the Kalman filter";

SPOSITO, V. A., and **Mike Tveite:** "On the estimation of certain parameters used in L_1 inference procedures";

STEPHENSON, W. Robert, and **David Jacobson** (IBM Corporation, Rochester, Minnesota): "A comparison of nonparametric analysis of covariance techniques";

TOYOOKA, Yasuyuki (Iowa State University and Osaka University): "An iterated version of the Gauss-Markov theorem in GLSE";

VARDEMAN, Stephen, and **Di-ou Ray:** "Average run lengths for CUSUM schemes when observations are exponentially distributed";

Wilson, Jeffrey R., and **Kenneth J. KOEHLER:** "Testing equality of vectors of proportions for several cluster samples."

At the Eastern Regional (191st) Meeting of the Institute of Mathematical Statistics in Stony Brook, New York June 12-14:

ATHREYA, K. B.: "Bootstrapping the mean in the infinite variance case";

FULLER, Wayne A.: "Properties of residuals from errors-in-variables analyses"; also chaired a Contributed Paper session;

LEE, Carl M.-S. (Central Michigan University, Mt. Pleasant): "Constrained optimal designs for multiresponse model."

At other locations:

ATHREYA, Krishna B.: "Bootstrapping the mean in the infinite variance case," Department of Statistics colloquium, University of Wisconsin-Madison, August 31, 1984, and a joint colloquium of the departments of Mathematics and Statistics at the University of Minnesota-Minneapolis, October 12.

"On a Levy-Cramér continuity theorem for random cumulative distribution functions," Department of Mathematics colloquium, Iowa State University, November 22.

"Renewal theory in the infinite mean case," seminar presented in the Department of Mathematics and Statistics, York University, Downsview, Ontario, Canada, March 12, 1985.

"Bootstrapping the mean in the infinite variance case," seminars for the Departments of Statistics, University of Western Ontario, London, and University of Toronto, Canada, March 14 and 15.

"Bootstrap asymptotics," seminar for the Department of Probability and Statistics, Michigan State University, June 10.

Carriquiry, Alicia L.: "Estimation and prediction from a normal distribution when the variable is left-censored" and "Estimation and prediction from a multivariate normal distribution when one or more of the variables are censored"—seminars for the Department of Animal Science, Iowa State University, January 28 and February 4, respectively.

"Approximate restricted maximum likelihood estimation of variance components from a univariate or multivariate normal censored distribution," seminar for the Department of Animal Science, University of Illinois, March 20.

"Estimation and prediction from a normal censored distribution," by Carriquiry, Rohan L. Fernando, and Daniel Gianola at a meeting of the American Society of Animal Science, Midwestern Section, in Chicago, Illinois March 28.

"Recent contributions to animal breeding theory," for the Asociación de Ingenieros Agrónomos, Montevideo, Uruguay June 17.

COX, David F.: "The current use of statistical methods in summarizing and interpreting the numbers from experiments in animal physiology," at the annual meeting of the American Society of Animal Science, in Columbia, Missouri, August 8, 1984.

"Alternatives in the analyses of data produced by measuring experimental units repeatedly" and "Rules of evidence in experimental sciences"—two seminars presented for the Department of Animal Science, University of Illinois at Urbana, April 26, 1985.

CRESSIE, Noel A. C.: "Modelling with random sets," seminar for the Statistical Laboratory, University of Cambridge, U.K., July 18.

"Analysis of soil water infiltration in the presence of tillage treatments," at a symposium on Spatial Statistics in Agriculture, University of Wageningen, the Netherlands, August 3.

"Do sudden infant deaths come in clusters?" at the 16th European meeting of Statisticians, Marburg, West Germany, September 6.

"Robustness of one- and two-sample t statistics," at the International Meeting on Robust Statistics, Oberwolfach, West Germany, September 13, and as a seminar for the Department of

Statistics and Actuarial Science, University of Iowa, October 25.

"Spatial statistical analysis," seminar presented to the Center for Statistical Sciences, University of Texas-Austin, February 6, 1985 and the Department of Statistics, North Carolina State University, February 8.

"A spatial analysis of soil-water infiltration," seminar for the Department of Soil Science, North Carolina State University, February 8.

"Il kriging nonstazionario e robusto," at the annual meeting of the Società Italiana di Statistica, Taormina, Sicily, April 11.

"Metodi di stima empirico bayesiane," seminar for the Department of Mathematics, Università di Cagliari, Sardinia, April 13.

"Empirical Bayes for the binomial and Rasch models," for the Statistical and Psychometric Research and Services Division, Educational Testing Service, Princeton, New Jersey, May 21; also seminar for the Department of Mathematics, Monash University, Australia, June 5.

"Spatial statistics," seminar presented to the Statistics Society of Australia, Victorian Branch meeting, in Melbourne, Australia, June 18.

DAVID, H. A.: "Selection through an associated characteristic," by David and **W. B. Yeo** (Korea Development Institute, Seoul, Korea), at the 12th International Biometric Conference, Tokyo, Japan, September 3, 1984.

"Order statistics under nonstandard conditions," at the 112th annual meeting of the American Public Health Association, Anaheim, California, November 13.

DAVID, Herbert T.: "Buehler bounds," September 25, 1984, and "Variations on two industrial statistics themes," May 28, 1985—colloquia for the Department of Mathematical Sciences, Thomas J. Watson Research Laboratories, IBM Corporation, Yorktown Heights, New York.

"Some academic implications of SQP," at the Conference on Advances in Statistical Quality Control sponsored by the University of Manitoba, Winnipeg, Manitoba, Canada, June 5.

"From the dawn of creation to the Land of the Rising Sun—statistics through the ages," at the Systems Research Institute, IBM Corporation, New York City, New York, June 12.

FULLER, Wayne A.: "Gross change estimation in the presence of response error," by Fuller and **Tin Chiu Chua** (ISU and University of South Dakota), July 19, 1984, at a Conference on Gross Flows in Labor Force Statistics, Washington, D.C., sponsored by the U.S. Bureau of the Census and the Bureau of Labor Statistics.

"The multivariate components-of-variance model for small area estimation," by Fuller and **Rachel M. Harter** (ISU and A. C. Nielsen Company), at the International Symposium on Small Area Statistics, Ottawa, Ontario, Canada, May 24, 1985.

"Estimators of the factor model for survey data," at the University of Western Ontario, May 27 as part of its Symposia on Statistics and Festschrift in Honour of Professor V. M. Joshi.

"Regression estimation for autoregressive time series, May 30 at the Conference on Statistical Theory and Practice, Madison, Wisconsin, sponsored by the University of Wisconsin to mark the Department of Statistics' 25th anniversary.

GHOSH, J. K.: "A stochastic model for sediment deposit," by Ghosh, B.S. Mazumdar, M. Saha, and S. Sengupta, at a Conference on Stochastic Hydraulics, sponsored by the International Association for Hydraulics, July 31, 1984, in Urbana, Illinois.

"Higher order efficiency in estimation—a review," seminar for the Department of Mathematics, University of Illinois-Urbana/Champaign, July 31.

HARVILLE, David M.: "Prediction in mixed linear models and in general," seminar, Department of Statistics and Actuarial Science, University of Iowa, April 18, 1985.

HINZ, Paul N.: "Nearest-neighbor analysis," at the Symposium on Biometrical Problems in Agricultural, Forestry, and Animal Investigations—Nordic Region Meeting of the Biometric Society, Aas, Norway, June 18; also as a seminar June 14 for the Department of Statistics, University of Dortmund, West Germany.

IACHAN, Ronaldo: "Robust designs for ratio and regression estimation" and "Sampling strategies, robustness, and efficiency"—poster papers at the Simposio Nacional de Probabilidade e Estatistica, Rio de Janeiro, Brazil, on July 24 and 26, 1984.

"Robustness in finite population sampling," seminar, Department of Statistics, Universidade Estadual de Campinas, São Paulo, Brazil, August 7.

"The role of models in sampling design," seminar, Department of Community Health, Brown University, February 25, 1985.

"Sampling in space and in time," seminar, Department of Biostatistics, University of North Carolina-Chapel Hill, April 1.

"Efficiency and robustness in sample surveys," seminar, Research Triangle Institute, North Carolina, May 22.

Jobe, J. Marcus (Miami University of Ohio): "Limiting error rates for the discrimination between Poisson processes, with application to a simple renewal process," by Jobe, **H. T. DAVID,** and **Stephen VARDEMAN,** at the Applied Mathematics Conference at Central State University, Edmond, Oklahoma, April 18.

Keller-McNulty, Sallie (ISU and University of North Carolina-Greensboro): "Error-free matrix inverses and solutions to linear least squares equations," by Keller-McNulty and **William J. KENNEDY,** at the 1985 Summer Research Conference in Statistics, sponsored by the Southern Regional Education Board and the American Statistical Association, in Boone, North Carolina, June 20.

KEMPTHORNE, Oscar: "Nature and role of ancillary statistics," at the annual meeting of the Institute of Mathematical Statistics, Lake Tahoe, California, August 23.

LORENZ, Frederick O.: "A working honeymoon in Czechoslovakia," by Roberta Vann and Lorenz, International Forum, Iowa State University, October 11, 1984.

"Perceived environmental uncertainty and strategic management strategies for human service managers," by Charles L. Mulford, Lorenz, Betty L. Wells, and Daisy Kabagarama-Ruhwezi, at the Midwest Sociological Society meetings, St. Louis, Missouri, April 10, 1985; also "Environmental uncertainty, changing agency structure, and interagency relations," by Lorenz, Charles L. Mulford, and Betty L. Wells, April 11.

"Prediction of present participation from children's sex, past participation, and attitudes: A longitudinal analysis," by Dean Anderson, Lorenz, and Dale Pease, at the American Alliance for Health, Physical Education, Recreation and Dance Convention, Atlanta, Georgia, April 30.

MEEDEN, Glen: "Some admissible nonparametric and related finite population sampling estimators," seminar for the Department of Statistics, Rutgers University, October 24, 1984.

"Some admissible pseudo-Bayes estimators in finite population sampling," seminar for the Department of Statistics, University of California-Riverside, January 2, 1985.

"Bayes and admissible set estimation," seminar, Department of Statistics, University of Kentucky, May 2.

MEEKER, William Q., Jr.: "Statistical aspects of accelerated life testing," at the 1984 Statistics Symposium on National Energy Issues, Seattle, Washington, sponsored by the Pacific Northwest Laboratory and the U.S. Nuclear Regulatory Commission, October 16.

"New developments and ideas for computer programs for life data analysis," for the Statistics Group, Analysis and Assessment Division, Los Alamos National Laboratory, Los Alamos, New Mexico, February 11, 1985.

"Statistical aspects of accelerated life tests," at the 12th annual IBM Conference on Design of Experiments, Rochester, Minnesota, May 15.

POLLAK, Edward: "Some sampling theory for a population reproducing by a mixture of selfing and random mating," August 14, at the 1984 annual meeting of the Genetics Society of America, in Vancouver, British Columbia, Canada.

ROBERTS, Carl W.: "Correlates between specific feminine behaviors in boyhood and later homosexuality," by Roberts, Richard Green, Katherine Williams, and Marilyn Goodman, at the annual meeting of the American Sociological Association, San Antonio, Texas, August 28.

SHELLEY, Mack C. II: "By-elections and government stability in Britain and the United States, 1924-1983," at the annual meeting of the American Political Science Association, August 31.

"Panel discussion of the 1984 elections, by Shelley, James Hutter, and Ardith Maney, Department of Political Science Professional Seminar, Iowa State University, November 7.

Moderator of local panel, Live-Via-Satellite program, "Is the Congress Working?" sponsored by the Department of Political Science, Office of Continuing Education, College Satellite Network, and Committee on Lectures, Iowa State University, April 17, 1985.

"Effects of domestic credit conditions on the agricultural sector of West Germany," by T. A. Sanni, P. H. Calkins, and Shelley, to the staff of Deutsche Bundesbank (the Central Bank of West Germany), Frankfurt, West Germany, in May.

STEPHENSON, W. Robert: "Where was the statistician when the lights went out?"—seminar for the Department of Mathematics, College of Charleston, November 20, 1984 in Charleston, South Carolina.

"Quick and simple data analysis of field data"—seminar for the Department of Animal Ecology, Iowa State University, March 29, 1985.

VARDEMAN, Stephen: "Statistics for quality and productivity—one view of the 1984 landscape," as a colloquium talk for the departments of Statistics and Operations Research, Pennsylvania State University, October 16, 1984, and as a seminar for the Department of Statistics, Kansas State University, October 30.

"The statistician as friend of the physical scientist and engineer," seminar at Dowell-Schlumberger Inc., Tulsa, Oklahoma, May 10, 1985.

WOLINS, Leroy: "Psychological scaling: The basis of peer review," for a National Institutes of Health Staff Training in Extramural Programs Module, Issues in Peer Review, presented in Bethesda, Maryland, December 4.

Publications and Dissertation Abstracts

Abstracts of books and papers published by staff members and graduate students are included in this section, together with book review titles and summaries of doctoral dissertations and masters' theses completed here in statistics during the 1984-85 year. When research was conducted at Iowa State but the author has by publication time accepted a new position, his or her current location is listed in parentheses. Some of the publications are included in the Statistical Laboratory's Reprint Series (SLRS). These are indicated by an asterisk (*), and copies are available on request.

Principal editorial positions of faculty members are as follows:

Editor-elect William J. Kennedy became editor of *The American Statistician* on January 1, 1985. Wayne Fuller, Glen Meeden, V. A. Sposito, and Stephen Vardeman continued as associate editors. Fuller also is associate editor of the *Journal of Business and Economic Statistics*.

Krishna Athreya is an associate editor of *Zeitschrift Für Wahrscheinlichkeitstheorie* and serves on the editorial board of *Statistics and Probability Letters*.

Noel Cressie was appointed associate editor of the *Journal of the American Statistical Association* Theory and Methods Section in December 1984; David Harville also continues to serve as associate editor. Glen Meeden is an associate editor of JASA's Book Review Section.

Paul Hinz continues as an associate editor of the *Iowa State Journal of Research*.

Oscar Kempthorne is on the editorial advisory board of the *Journal of Statistical Computation and Simulation*. He is also a member of the executive committee for the *Journal of Statistical Planning and Inference*.

William Q. Meeker, Jr. is an associate editor of *Technometrics* and serves on the editorial board for *Selected Tables in Mathematical Statistics*.

Edward Pollak was appointed to the editorial board of *Mathematical Biosciences* in August 1984.

Mark Reiser is a member of the editorial board for *Sociological Methods & Research*.

Leroy Wolins continues as a member of the board of editors for *Educational and Psychological Measurement* and associate editor for *Educational Statistics*.

Books

Schmidt, Steffen W., **Mack C. SHELLEY II,** and Barbara A. Bardes. *American Government and Politics Today.* West Publishing Company (St. Paul, Minnesota) 1985. xxviii + 708 pp.

This comprehensive textbook includes chapters on new groups in politics, the mass media, and energy and environmental policy. It is part of a complete learning system aimed at the introductory under-

graduate level. The system includes an instructor's manual, a study book, computerized test files for microsystems or mainframe use, an interactive study guide for use with Apple or IBM personal computers, and an HBO videotape of the history of political campaign commercials from the 1930s through the 1984 campaign. The basic text emphasizes traditional topics in American political institutions, civil rights and liberties, and public opinion. Most chapters include liberal amounts of relevant data, and each chapter presents boxed highlights of interesting points and profiles of key individuals, as well as marginal definitions, information to stimulate personal involvement in the political process, chapter summaries, review questions, and references.

Schmidt, Steffen W., and **Mack C. SHELLEY II,** editors. *Readings and Discussion Exercises in American Government and Politics.* Ginn Custom Publishing (Lexington, Massachusetts) 1984. vi + 123 pp.

This book provides students in introductory classes in American government with current literature and accompanying discussion questions regarding issues of contemporary concern. Topics addressed include democracy, federalism, political parties, elections, ethnic politics, the presidency, bureaucracy, Congress, the Supreme Court, the economy, foreign policy, the environment, state and local government, and the ethics of policy-making.

Sukhatme, Pandurang V., [the late] Balkrishna V. Sukhatme, **Shashikala SUKHATME,** and C. Asok. *Sampling Theory of Surveys with Applications,* Third Edition. Iowa State University Press (Ames) and Indian Society of Agricultural Statistics (New Delhi) 1984. xvi + 526 p.

Revision of the second edition, by P. V. Sukhatme and B. V. Sukhatme, was underway when B. V. Sukhatme, professor of statistics at ISU, died in 1979. It was completed by S. Sukhatme and C. Asok. The third edition includes most of the principal developments in the field of sampling theory of surveys and illustrates them with examples and exercises. It also considers the application of observational errors in longitudinal studies of quantitative behavioral traits in man.

Published Research

***AMEMIYA, Yasuo.** What should be done when an estimated between-group covariance matrix is not nonnegative definite? *The American Statistician* 39:2 (1985) 112-117. SLRS 606.

Estimation of covariance components in the multivariate random-effect model with nested covariance structure is discussed. There are two covariance matrices to be estimated, namely, the between-group and the within-group covariance matrices. These two covariance matrices are most often estimated by

Shashikala Sukhatme examines a new revision of *Sampling Theory of Surveys with Applications*, which she co-authored after the death of her husband-colleague, B. V. Sukhatme.

forming a multivariate analysis of variance and equating mean square matrices to their expectations. Such a procedure involves taking the difference between the between-group mean square and the within-group mean square matrices, and often produces an estimated between-group covariance matrix that is not nonnegative definite. We present estimators of the two covariance matrices that are always proper covariance matrices. The estimators are the restricted maximum likelihood estimators if the random effects are normally distributed. The estimation procedure is extended to more complicated models, including the two-fold nested and the mixed-effect models. A numerical example is presented to illustrate the use of the estimation procedure.

ATHREYA, Krishna B., Malay Ghosh, **Leone Y. Low** (Iowa State University and Wright State University), and Pranab K. Sen. Laws of large numbers for bootstrapped U-statistics. *Journal of Statistical Planning and Inference* 9:2 (1984) 185-194.

For the bootstrapped mean, a strong law of large numbers is obtained under the assumption of finiteness of the r^{th} moment, for some $r > 1$, and a weak law of large numbers is obtained under the finiteness of the first moment. The results are then extended to bootstrapped U-statistics under parallel conditions. Stochastic convergence of the jackknifed estimator of the variance of a bootstrapped U-statistic is proved. The asymptotic normality of the bootstrapped pivot and the bias of the bootstrapped U-statistic are indicated.

ATHREYA, K. B. Discounted branching random walks. *Advances in Applied Probability* 17:1 (1985) 53-66.

Let $F(\cdot)$ be a c.d.f. on $[0,\infty)$, $f(s) = \Sigma_0^\infty p_j s^j$, a p.g.f. with $p_0 = 0, 1 < m = \Sigma_j p_j < \infty$, and $1 < \rho < \infty$. For the functional equation for a c.d.f. $H(\cdot)$ on $[0,\infty)$

$$(*) \qquad H(x) = \int_{[0,x]} f(H(\rho(x-y)))dF(y)$$

we establish that if $1 - F(x) = O(x^{-\theta})$ for some $\theta > \alpha \equiv (\log m)/(\log \rho)$ there exists a unique solution $H(\cdot)$ to (*) in the class C of c.d.f.'s satisfying $1 - H(x) = o(x^{-\alpha})$.

We give a probabilistic construction of this solution via branching random walks with discounting. We also show nonuniqueness if the condition $1 - H(x) = o(x^{-\alpha})$ is relaxed.

ATHREYA, K. B. On the range of recurrent Markov chains. *Statistics & Probability Letters* 3:3 (1985) 143-145.

Let $\{X_n\}_0^\infty$ be an irreducible recurrent Markov chain on the nonnegative integers. A result of Chosid and Isaac [*The Annals of Probability* 4 (1978) 680-687 and (1980) 1000] gives a sufficient condition for $n^{-1}R_n \to 0$ with probability 1. where R_n is the range of the chain. We give an alternative proof using Kingman's subadditive ergodic theorem [Kingman, *The Annals of Probability* 1 (1973) 883-909].

Kassel, P.C., R. E. Mullen, and **T. B. BAILEY.** Seed yield response of three switchgrass cultivars for different management practices. *Agronomy Journal* 77:2 (1985) 214-218.

Journal Paper No. J-10689 of the Iowa Agriculture and Home Economics Experiment Station, Project 2470.

Switchgrass (*Panicum virgatum* L.) is a valuable warm-season native forage grass in Midwest grazing systems; this has prompted interest in seed production to obtain adequate amounts of seed for planting purposes. However, switchgrass seed production studies have been primarily conducted in the Great Plains states. This study was conducted to evaluate seed yield response of three cultivars to three row spacings and three levels of N fertilization when grown in a more humid area of the species' natural adaptation. Seed yield and selected seed yield components were measured in 1979 and 1980. Results showed that N management and row spacing of young stands of switchgrass grown for seed production in the humid Midwest varied according to the cultivar used. Cultivar susceptibility to lodging may be the most limiting factor in obtaining high seed yields of some cultivars in such areas. More detail on the experimental design and analysis procedures used in this study appear in the Consulting Section of the annual report (see p. 6).

BANCROFT, T. A., and Chien-Pai Han. A Monte Carlo study of robustness of preliminary test estimators in pooling means. In *Impact of P. V. Sukhatme on Agricultural Statistics and Nutrition,* pp. 102-114. Prem Narain, editor. Indian Society of Agricultural Statistics (New Delhi). 1984.

Pooling data, when justified, for estimating the target mean is advantageous when the size of sample from the target population is small. In case it is doubtful whether two sets of data have the same mean, a normal test or a t-test can be used for testing the equality of the two means, depending on whether the variance is known or unknown. A preliminary test estimator is then constructed for estimating the population mean. Using a Monte Carlo study, we examine the robustness of the preliminary test estimators when certain populations are not normal, but either uniform or exponential. The relative efficiencies of the preliminary test estimators are studied. It is found that the preliminary test estimators are quite robust.

***COX, C. Philip.** Interval estimates for the ratio of the means of two normal populations with variances related to the means. *Biometrics* 41:1 (1985) 261-265. SLRS 609.

A procedure is given for estimating the ratio of the means of two populations, using the data from two independent random samples, when the observations are normally distributed with population variances that are related to the population means.

Speer, V. C., and **D. F. COX.** Estimating milk yield of sows. *Journal of Animal Science* 59:5 (1984) 1281-1285.

Journal Paper No. J-11326 of the Iowa Agriculture and Home Economics Experiment Station, Ames, Iowa, Project 2357.

The most practical and efficient way to measure the amount of milk produced by a lactating pig is indirectly by the weight gained by nursing piglets. Research was done to determine how many nursing periods were required to provide a reasonable estimate of milk production. Milk yields based on the gain in weight of a nursing litter were determined at the 14th and 20th days of lactation during nine consecutive hourly periods on 175 females. The conclusion was that reducing the number of hourly measures from nine to three provided an unbiased estimate of hourly milk yield and only slightly increased the standard error of the estimate.

CRESSIE, Noel. Solving extrema problems in statistics by weighted sums. *The Mathematical Scientist* 8:2 (1983) 103-113.

It is a well-known but hitherto unexploited fact that an extreme value of any sequence of positive random variables can be approximated by a suitably normalized weighted sum of the sequence. When inference is based on the maximum or minimum of possibly dependent and nonidentically distributed random variables, the distribution theory can be difficult. By establishing a relationship between extremes and sums, distributions of extrema can be derived via appropriate forms of the central limit theorem.

CRESSIE, N. A. C. Modelling sets. In *Springer Lecture Notes in Mathematics 1091* (Proceedings of the International Conference in Multifunctions and Integrands, Catania, Sicily, 1983), edited by G. Salinetti. New York: Springer-Verlag (1984) 138-149.

The set is about as basic a mathematical notion as there is. Its attraction is that it can be used to represent a multitude of abstract or concrete quantities. The physical world around us is full of phenomena requiring a statistical approach for understanding. The notion of a random set is thus appealing from both the mathematical and statistical points of view. It is clear that the sciences are demanding statistical analyses that go beyond the relatively well understood one-dimensional models and the rather timid two-plus-dimensional forays. This article tries to look ahead to see whether random set theory will be a fruitful path to follow. It is not altogether clear that it will be.

CRESSIE, Noel, and Gary Glonek. Median based covariogram estimators reduce bias. *Statistics & Probability Letters* 2:5 (1984) 299-304.

The usual product moment covariogram estimator of a Gaussian process can have appreciable bias. This article shows that the bias is decreased when the sample mean $\bar{X}$ in the estimator is replaced with the sample median med(**X**), provided that a mild condition on the negative covariances is satisfied. The results hold even when the Gaussian process is symmetrically contaminated. In fact, the improvement in the bias when using the median is larger for the contaminated Gaussian case than for the pure Gaussian one.

***CRESSIE, Noel,** and Timothy R. C. Read. Multinomial goodness-of-fit tests. *Journal of the Royal Statistical Society B* 46:3 (1984) 440-464. SLRS 607.

This article investigates the family $\{I^\lambda ; \lambda \epsilon \mathbb{R}\}$ of power divergence statistics for testing the fit of observed frequencies $\{X_i;\ i = 1,...,k\}$ to expected frequencies $\{E_i;\ i=1,...,k\}$. From the definition

$$2nI^\lambda = \frac{2}{\lambda(\lambda+1)} \Sigma_{i=1}^{k} X_i\{(X_i/E_i)^\lambda - 1\};\ \lambda \epsilon \mathbb{R},$$

it can easily be seen that Pearson's X^2 ($\lambda = 1$), the log likelihood ratio statistic ($\lambda = 0$), the Freeman-Tukey statistic ($\lambda = -\frac{1}{2}$), the modified log likelihood ratio statistic ($\lambda = -1$), and the Neyman modified X^2 ($\lambda = -2$), are all special cases. Most of the work presented is devoted to an analytic study of the asymptotic difference between different I^λ; however, finite sample results have been presented as a check and a supplement to our conclusions. A new goodness-of-fit statistic, where $\lambda = \frac{2}{3}$, emerges as an excellent and compromising alternative to the old warriors, I^0 and I^1.

*Kienzler, J. M., **P. F. Dahm** (Texas A&M University), **W. A. FULLER,** and A. F. Ritter. Temperature-based estimation for the time of death in white-tailed deer. *Biometrics* 40:3 (1984) 849-854. SLRS 601.

A model for the temperature of carcasses of white-tailed deer (*Odocoileus virginianus*), as a function of time since death, is developed. Estimation is complicated because multiple observations are made on a single deer, the model is nonlinear, and the data exhibit a nonhomogeneous variance structure. Point and interval estimates of time since death are developed to aid conservation enforcement personnel to determine the legality of the time of kill of deer.

***DAVID, H. A.** Order statistics under non-standard conditions. In *Biostatistics: Statistics in Biomedical, Public Health and Environmental Sciences,* edited by P. K. Sen, pp. 305-313. Elsevier Science Publishers B. V. (North-Holland). 1985. SLRS 602.

A first attempt is made to review and systematize the treatment of order statistics when these arise from non-iid variates $X_1,...,X_n$, where n is fixed. After an outline of the main general approaches available, special attention is given to the case when the X's are independent but nonidentically distributed. This situation is motivated by (a) k-out-of-n systems of unlike independently failing components and (b) robustness against an outlier. Attention is also drawn to the recent relevant literature.

***DAVID, H. A.,** and **J. K. GHOSH** (Indian Statistical Institute and Iowa State University). The effect of an outlier on L-estimators of location in symmetric distributions. *Biometrika* 72:1 (1985) 216-218. SLRS 604.

The effect is studied of an outlier that has the same symmetric distribution as the other observations except for a change in location and a possible increase in scale. We show that the median is the most bias-resistant estimator, in the class of L-statistics with symmetric nonnegative coefficients that add up to one, for a class of distributions that includes the normal, double-exponential, and logistic distributions.

Sankoorikal, J. T., R. A. Danofsky, **H. T. DAVID,** R. A. Hendrickson, and **Margot Tollefson.** Statistical estimation of vibration parameters of nuclear reactor core components. *Transactions of the American Nuclear Society* 49 (1985) 428-429.

The vibration of nuclear reactor components may eventually lead to their breakdown or malfunction. This research is directed towards using the reactor power noise produced by in-core vibrations to predict and estimate location and vibration amplitude parameters. Maximum-likelihood and confidence-set methods seem to hold promise for estimating such parameters, even in the presence of large relative external noise and measurement error.

DOREA, C. C. Y. (Universidade de Brasilia, Brazil), **H. T. DAVID,** and N. M. Werner. Uniform ε-independence and the convergence in distribution of randomly indexed sequences. *Mathematical Proceedings of the Cambridge Philosophical Society* 96:3 (1984) 533-542.

A notion of "uniform ε-independence" (u.ε.i.) is proposed for a sequence of random variables, successively indexed by the members of a sequence of positive-integer-valued random variables. The u.ε.i. property yields results other than those in the previous random indexing literature. Complementing the u.ε.i. property by suitable "approximation" one recovers these previous results.

FULLER, Wayne A., and **Tin Chiu Chua** (Iowa State University and University of South Dakota). Gross change estimation in the presence of response error. *Proceedings of the Conference on Gross Flows in Labor Force Statistics,* held in Washington, D.C. July 19-20, 1984. U.S. Bureau of the Census and U.S. Bureau of Labor Statistics (1984) 65-77.

A model for the response error associated with reported labor force classifications is developed. The model is used to construct estimators for the interior cells of the two-way gross change table of employment status obtained from the U.S. Current Population Survey. Because of reinterview bias and rotation group bias and because the number of possible parameters in the response probability matrix exceeds the number of cells available for estimation, external restrictions are required to identify the model.

GHOSH, Malay (Iowa State University and University of Florida), and **Glen MEEDEN.** A new Bayesian analysis of a random effects model. *Journal of the Royal Statistical Society B,* 46:3 (1984) 474-482.

For a typical random effects model in the one-way analysis of variance a new Bayesian analysis is offered. An exchangeable prior distribution is defined over the parameters. It is suggested that, rather than use the usual "F" test, one should consider this as an estimation problem. The posterior distribution of a function of the parameters that measures the amount of variation present is found.

GHOSH, Malay (Iowa State University and University of Florida), and **Ahmad Razmpour** (Iowa State University and University of Al-Fateh, Tripoli). Estimation of the common location parameter of several exponentials. *Sankhyā* A 46:3 (1984) 383-394.

This paper concerns the estimation of the common location parameter of several exponentials in the face of unknown and possibly unequal scale parameters. Several estimators of the common location parameter are proposed: the maximum likelihood estimator, a modified maximum likelihood estimator, and the uniformly minimum variance unbiased estimator. These estimators are compared both asymptotically and in terms of their small-sample performance.

GROENEVELD, Richard A., and **Glen MEEDEN.** Measuring skewness and kurtosis. *The Statistician* 33:4 (1984) 391-399.

The question of how to measure the degree of skewness of a continuous random variable is addressed. W. R. van Zwet [*Convex Transformations of Random Variables,* Mathematisch Centrum, Amsterdam (1964)] gives a method for ordering two distributions with regard to skewness. Here, using the concept of comparative skewness, we consider properties that a measure of skewness should satisfy. Several extensions of the Bowley measure of skewness taking values on $(-1,1)$ are discussed. How well these measures reflect one's intuitive idea of skewness is examined. These measures of skewness are extended to measures of kurtosis for symmetric distributions.

HARVILLE, David A. Discussion of "Selection of subsets of regression variables," by Alan J. Miller. *Journal of the Royal Statistical Society,* Series A, 147:Part 2 (1984) 416-417.

***HARVILLE, David A.** Decomposition of prediction error. *Journal of the American Statistical Association* 80:389 (1985) 132-138. SLRS 603.

The problem considered is that of predicting the value of an unobservable random variable w from the value of an observable random vector **y.** This problem is considered under each of four states of knowledge about the joint distribution of w and **y,** ranging from complete knowledge to "no" knowledge. A (point) predictor, or predictors, is presented for each case. Prediction error is decomposed so that each component reflects an absence of information. Under certain conditions, these components are uncorrelated and have zero means. An exact or approximate expression is given for the variance of each component.

***HARVILLE, David A.,** and **Alan P. Fenech** (Iowa State University and University of California, Davis). Confidence intervals for a variance ratio, or for heritability, in an unbalanced mixed linear model. *Biometrics* 41:1 (1985) 137-152. SLRS 610.

A procedure is presented for constructing an exact confidence interval for the ratio of the two variance components in a possibly unbalanced mixed linear model that contains a single set of m random effects. This procedure can be used in animal and plant breeding problems to obtain an exact confidence interval for a heritability. The confidence interval can be defined in terms of the output of a least squares analysis. It can be computed by a graphical or iterative technique requiring the diagonalization of an m $\times$ m matrix, or, alternatively, the inversion of a number of m $\times$ m matrices. Confidence intervals that are approximate can be obtained with much less computational burden, using either of two approaches. The various confidence-interval procedures can be extended to some problems in which the mixed linear model contains more than one set of random effects. Corresponding to each interval procedure is a significance test and one or more estimators.

Bramel, P. J., **P. N. HINZ,** D. E. Green, and R. M. Shibles. Use of principal factor analysis in the study of three stem termination types of soybean. *Euphytica* 33:2 (1984) 387-400.

Journal Paper No. J-11003 of the Iowa Agriculture and Home Economics Experiment Station, Project 2446.

The study was conducted to identify plant characters associated with seed yield in close soybean plant spacings. Lines selected from two F_6 soybean populations in the F_{10} generation segregating for degree of stem termination were grown in two locations. Traits measured included lengths of developmental stage, plant and canopy height, number of nodes, lodging at different stages, raceme lengths, and number of nodes and branch number of nodes.

One problem in analyzing data and drawing conclusions from such a study is related to the complex nature of the interrelationships of a large number of traits. Another, not unrelated, problem involves the calculation of multiple-regression equations with multicolinearities. Because of these problems, factor analysis was used to study the correlation matrix to identify sets of variables related to the same biological concept or function. The variables within sets were determined for each stem termination type, and measurements of these variables were standardized. Means were calculated by using the sum of the standardized variables for each set. Multiple regression was used to study the relationships between sets as the independent variables and yield as the dependent variable. Individual traits were selected from within each set and substituted in the multiple regression equations calculated with the mean value for each set. With use of this technique to determine multiple regression equations, the resulting equations involved measurements of different biological functions instead of repeated measurements of the same function in the plant.

It was found that, in the determinate stem type, the measurement of the seed-filling period and branch number of nodes could possibly be used to predict yield while, in the semideterminate stem type, the measurement of the "fixed capital" function and terminal raceme length were possibly useful. Finally, in the indeterminate stem type, the measurement of the "fixed capital" could be used, but it had a very low predictive value.

Dombeck, Michael P., Bruce W. Menzel, and **Paul N. HINZ.** Muskellunge spawning habitat and reproductive success. *Transactions of the American Fisheries Society* 113 (1984) 205-216.

Journal Paper No. J-10945 of the Iowa Agriculture and Home Economics Experiment Station, Project 2236.

Reproduction of muskellunge *Esox masquinongy* has failed in many waters that formerly supported self-sustaining populations. Laboratory experiments were conducted to isolate causes of such failures. Differential mortality occurred among lots of muskellunge eggs incubated in jars of unaerated lake water over substrates of sand, gravel, silt, aquatic macrophytes, wood, tree leaves, polyethylene screen, and bare glass. Mortalities were calculated as the slope of the regression of cumulative percentage mortality versus time. Regression and analysis of variance procedures ordinarily would be used to obtain standard errors and to test for significant differences among slopes (mortality rates). However, measurements made on a single jar over several days are repeated measurements and can be correlated in a way that violates the usual independence assumptions required for those procedures. The analysis was adapted to overcome this difficulty. Highest mortalities occurred over leaves and macrophytes and were attributed to low dissolved oxygen. A field survey of spawning areas in eight midwestern lakes showed a similar association between lack of dissolved oxygen and poor reproductive success in those lakes.

Marcy, J. A., A. A. Kraft, D. G. Olson, H. W. Walker, and **D. K. HOTCHKISS.** Fate of *Staphylococcus aureus* in reduced sodium fermented sausage. *Journal of Food Science* 50:2 (1985) 316-320.

Journal Paper No. J-11561 of the Iowa Agriculture and Home Economics Experiment Station, Project 2252.

A randomized block experiment using four levels of sodium chloride and two fermentation temperatures was conducted to evaluate their effect on bacteria survival in sausage in storage. Cultures were taken over seven days as a subplot factor. All sausages were made with a commercial starter culture, and certain batches received an inoculum of *Staphylococcus aureus,* strain Z-88. Representative samples were taken during the preparation, fermentation, and drying stages for microbial analysis. Results of the plate counts of lactic acid bacteria and *S. aureus* were analyzed statistically to determine effects of level of salt in fermented sausage at each of the fermentation temperatures.

Molins, R. A., A. A. Kraft, D. G. Olson, and **D. K. HOTCHKISS.** Recovery of selected bacteria in media containing 0.5% food grade poly- and pyrophosphates. *Journal of Food Science* 49:3 (1984) 948-949.

Journal paper No. J-11212 of the Iowa Agriculture and Home Economics Experiment Station, Project 2252.

A replicated experiment was conducted to determine the effects of four food-grade poly- and pyrophosphates, both heated and unheated, on the survival and colony-forming capacity of selected bacteria in laboratory media. The results were interpreted with reference to inhibition of microbial growth in cured and processed meats.

Reece, William O., H. L. Self, and **Donald K. HOTCHKISS.** Injection of iron in newborn beef calves: Erythrocyte variables and weight gains with newborn-dam correlations. *American Journal of Veterinary Research* 45:10 (1984) 2119-2122.

A split-plot experiment was conducted using newborn calves injected with varying levels of iron to determine the hematologic and iron changes in the blood, as well as calf growth over the first 28 weeks of

life. Correlations of the hematologic responses of the dams and their calves were reported. Adjustments were made in the analysis for imbalance in the breed and sex effects.

Thomas, Y. O., A. A. Kraft, R. E. Rust, and **D. K. HOTCHKISS.** Effect of carbon dioxide flushing and packaging methods on the microbiology of packaging chicken. *Journal of Food Science* 49:5 (1984) 1367-1371.

Journal Paper No. J-11149 of the Iowa Agriculture and Home Economics Experiment Station, Project 2380.

Dry-packed whole broilers, either cut up in the laboratory or left whole, were stored using three packaging methods. The chickens were stored in a display case at about 5°C and examined at intervals up to 17 days for various bacteria, odor, and slime development. Three replications were conducted, and the data were analyzed statistically by analysis of variance. Packaging with carbon dioxide flushing resulted in longest shelf life; vacuum packaging rated next, and stretch wrapping in air was determined to be least desirable. No significant differences in microbiological quality were observed as attributable to location of chicken at the top or bottom of the pack.

***IACHAN, Ronaldo.** Sampling strategies, robustness and efficiency—the state of the art. *International Statistical Review* 52:2 (1984) 209-218. SLRS 595.

Various recent developments in survey theory have focused on the choice of sampling strategy guided by auxiliary information incorporated into a model. Efficiency and robustness concepts that play a prominent role in such model-based methodology are reviewed in an attempt to integrate a number of important dispersed results. Separate consideration is given to results grounded on asymptotics and to those set in a prediction framework.

***IACHAN, Ronaldo.** Measures of agreement for incompletely ranked data. *Educational and Psychological Measurement* 44:4 (1984) 823-830. SLRS 600.

Measures of agreement between judges for ordinal scaled data are suggested that make use of the k categories with the highest ranks. The proposed measures are applied to results from the Self-Directed Search vocational test in order to evaluate their agreement with self-assessment (translation ability) or with the work environment (congruence).

IACHAN, Ronaldo. Robust designs for ratio and regression estimation. *Journal of Statistical Planning and Inference* 11:2 (1985) 149-161.

The purpose of this paper is to introduce a class of robust designs to be used with ratio estimators and extend them to regression estimators. Robustness is to be achieved against departures from a model for which the estimator is "optimal." Practical implementation of the design is indicated for both large and small samples.

***IACHAN, Ronaldo.** Plane sampling. *Statistics & Probability Letters* 3:3 (1985) 151-159. SLRS 608.

A variety of sampling designs for sampling in two dimensions are introduced with emphasis on the special classes of aligned and unaligned designs. Limiting expected variances are derived under a quite general model for the means of simple random sampling, stratified random sampling, and systematic sampling within each of these classes. A comparison of such sampling schemes is then made in terms of the limiting expected variances. Finally, asymptotic normality of the systematic sampling mean is obtained.

It is also shown that isotropic and elliptic correlation functions are included in the family of functions underlying the model.

Singh, H. P., **R. IACHAN,** and L. N. Upadhyaya. Almost unbiased ratio and product estimators based on interpenetrating subsamples. *Communications in Statistics—Theory and Methods* A14:4 (1985) 963-978.

This paper proposes two classes of almost unbiased ratio and product estimators, in the case of interpenetrating subsample designs, which include the estimators considered by earlier authors. Several other almost unbiased ratio and product estimators are given that are particular members of the proposed classes of estimators. Optimum estimators are also identified in these classes.

ISAACSON, Dean, and **Glen MEEDEN.** Better priors for Bayesian bettors. *Australian Journal of Statistics* 26:3 (1984) 263-271.

Consider the game where a Bayesian investor places a series of bets on the outcomes of a sequence of tosses of a coin with odds set by a Bayesian bookie. It is shown that at each toss the investor can have nonnegative expected winnings even though after many tosses the two posterior distributions are nearly equivalent.

Mukherjea, A., A. Nakassis, and **D. ISAACSON.** Determination of the basis of a convergent nonhomogeneous Markov chain. *Statistics & Decisions* 2:3 (1984) 363-375.

The paper considers the problem of determining the basis of the stochastic chain (P_n), when the chain is known to be convergent but one must avoid computations (often complicated) of the products $P_k \cdot P_{k+1} \cdot \cdots P_n$ (for $k < n$).

Kacker, Raghu N. (Iowa State University and AT&T Bell Laboratories), and **David A. HARVILLE.** Approximations for standard errors of estimators of fixed and random effects in mixed linear mod-

els. *Journal of the American Statistical Association* 79:388 (1984) 853-862.

Best linear unbiased estimators of the fixed and random effects of mixed linear models are available when the true values of the variance ratios are known. If the true values are replaced by estimated values, the mean squared errors of the estimators of the fixed and random effects increase in size. The magnitude of this increase is investigated, and a general approximation is proposed. The performance of this approximation is investigated in the context of (a) the estimation of the effects of the balanced one-way random model and (b) the estimation of treatment contrasts for balanced incomplete block designs.

Keller-McNulty, S. (ISU and University of North Carolina-Greensboro), and **W. J. KENNEDY.** Error-free computation of a reflexive generalized inverse. *Linear Algebra and Its Applications* 67 (1985) 157-167.

The paper develops a method from which algorithms can be constructed to numerically compute an error-free reflexive generalized inverse of a matrix having rational entries. Multiple-modulus residue arithmetic is used to avoid error that is inherent in floating-point arithmetic. Some properties of finite fields of characteristic p, GF(p), are used to find nonsingular minors of the matrix over the field of rational numbers.

KEMPTHORNE, Oscar. Statistical methods and science. In *W. G. Cochran's Impact on Statistics,* p. 287-308. Poduri S.R.S. Rao and Joseph Sedransk, editors. John Wiley & Sons, Inc. (New York). 1984.

Journal Paper No. J-10478 of the Iowa Agriculture and Home Economics Experiment Station, Project 890.

It is crystal clear that scientists of all the existent orientations have found the statistical methods that have been developed in the 20th century very useful in their attempts to build a scientific world picture. The literature of science is replete with data analysis and statistical methods such as analysis of variance and statistical tests. In the past 25 years, we have seen sustained criticism of the statistical ideas that have been used by a subgroup, somewhat heterogeneous to be sure, that is encompassed by the adjective "Bayesian." This essay is directed towards discussion of the nature of science and the quasi-inductive processes it must follow. It includes a brief critique of the work of H. Jeffreys and some of the variations of Bayesianism that have appeared. It attempts to sustain a distinction between assessment of evidence and terminal decision making, with the view that the latter involves some variety of Bayesian thinking. The essay is philosophical and calls on writings of philosophers of science and knowledge. It concludes that Cochran did indeed contribute to the processes of science, and that statistical methods that do not involve Bayesian thinking have an entirely essential and unavoidable role.

LORENZ, Frederick O., and Gary D. Nelson. Local government officials' perspectives on regional councils of governments. *Special Report 89,* Agriculture and Home Economics Experiment Station, Iowa State University (Ames). 1985. 55pp.

The report evaluates the role of regional councils of government as they assist local governments in obtaining federal grants for community development. Data were from 344 local government officials from 86 counties and 167 cities in five midwest states. The results suggest that regional councils are viewed as essentially service agencies and not active government bodies. Their popularity will decline with federal reductions in grant money.

Fletcher, Cynthia Needles, and **Frederick O. LORENZ.** Structural influences on the relationship between objective and subjective indicators of economic well-being. *Social Indicators Research* 16:3 (1985) 333-345.

The study investigated the relationship between objective and subjective indicators of economic well-being within different age, race, and sex groups over time. Stratification theory and an accommodation hypothesis were used to predict differential subjective responses to objective conditions within subgroups. Findings supported the hypothesis that the relationship would be weakest among the oldest age group compared to other age groups. Support was found for the hypothesis that predicted smaller coefficients among subgroups characterized as older, female, and nonwhite. Relationships were found to remain stable within all subgroups over time.

Vann, Roberta J., Daisy E. Meyer, and **Frederick O. LORENZ.** Error gravity: A study of faculty opinion of ESL errors. *TESOL Quarterly* 18:3 (1984) 427-440.

This study was designed to determine which sentence-level errors are judged to be most serious by an academic community and to discover what factors may influence this judgment. A sample of 164 faculty at Iowa State University ranked the relative gravity of 12 typical ESL written errors occurring in 24 sentences. Results indicate that most respondents did not judge all errors as equally grievous; rather, their judgments generate a hierarchy of errors. The study also suggests that both the age and academic discipline of faculty members may be important factors in predicting their response to certain ESL student writing errors.

MEEDEN, Glen, and **Malay GHOSH** (University of Florida). On the admissibility and uniform admissibility of ratio type estimators. *Proceedings of the Indian Statistical Institute Golden Jubilee International Conference on* **Statistics: Applications and New Direction,** held in Calcutta 16-19 December 1981 (1984) 378-390.

The paper considers the admissibility and uniform admissibility of ratio type estimators. It is shown that even though the parameter space is the N-dimensional Euclidean space, the admissibility and uniform admissibility questions can sometimes be answered by looking at subsets of the parameter space containing a finite number of points.

MEEDEN, Glen, Malay GHOSH, and **Stephen VARDEMAN.** Some admissible nonparametric estimators and related finite population sampling estimators. *The Annals of Statistics* 13:2 (1985) 811-817.

Given a random sample from an unknown distribution F, which is assumed to belong to some nonparametric family of distributions, consider the problem of estimating $\gamma(F)$, some function of F. When the loss function is squared error, admissible estimators are exhibited for a large class of γ's. A relationship between these estimators and similar ones in finite population sampling is demonstrated.

MEEDEN, Glen, and **Stephen VARDEMAN.** Bayes and admissible set estimation. *Journal of the American Statistical Association* 80:390 (1985) 465-471.

We consider the problem of set estimation of a parameter θ based on an observation X, with the goal of simultaneous control of the noncoverage probability and the expected size of the estimating set. Several notions of being Bayes for set estimates are studied, and their relationship to a natural notion of admissibility for confidence procedures is investigated.

MEEKER, W. Q., and G. J. Hahn. Planning an accelerated life test—some practical guidelines. General Electric Corporate Research and Development *Technical Information Series,* Report No. 84CRD300. Schenectady, New York. 1984. 22 pp.

Accelerated life tests provide timely information about the life distribution of materials and products. Information from tests at high levels of stress is extrapolated, through a physically reasonable statistical model, to obtain estimates of life at lower, normal levels of stress. This paper critiques an accelerated life test that was planned without careful attention to model assumptions and available methods for planning efficient life tests. After comments on the analysis of accelerated life test data, we give a table and some general guidelines for planning accelerated life tests that are both robust to moderate departures from the model assumptions and reasonably efficient when compared with theoretically optimum plans. The guidelines are then used to develop an alternative accelerated life test plan for the example.

Hahn, Gerald J., and **William Q. MEEKER, Jr.** An engineer's guide to books on statistics and data analysis. General Electric Corporate Research and Development *Technical Information Series,* Report No. 84CRD189. Schenectady, New York. 1984. 23 pp.

This material is essentially described in the following publication.

Hahn, Gerald J., and **William Q. MEEKER, Jr.** An engineer's guide to books on statistics and data analysis. *Journal of Quality Technology* 16:4 (1984) 196-218.

Engineers and scientists frequently ask, "Can you suggest a book that will give me a better understanding of statistics and data analysis?" The appropriate response depends on the questioners' mathematical maturity and previous exposure to statistics, the application area(s) of interest, and the depth of discussion desired. This guide provides an annotated bibliography, grouped into the following subject areas: general introductory books (very elementary, elementary, etc.), mathematical statistics, sixteen specific application areas (error analysis, experimental design, multivariate analysis, etc.), five special methods, and statistical tables. Each subject area is reviewed briefly, and a number of books are described. The descriptions are frequently based on quotations from the books and generally indicate the material covered and the assumed background of the reader.

***Nagaraja, H. N.** (The Ohio State University). Some nondegenerate limit laws for sample selection differential and selection differential. *Sankhyā* A 46:3 (1984) 355-369. SLRS 605.

Selection differential and *sample selection differential* are defined. In the random sample case, some nondegenerate limit distributions for the sample selection differential are established. The asymptotic distribution of the selection differential is obtained for the case when the sample observations are independent but not necessarily identically distributed. The asymptotic results depend on the relation between the number selected and the total sample size. Finally, some applications of the results are discussed.

Pantula, Sastry G. (Iowa State University and North Carolina State University), and **Wayne A. FULLER.** Mean estimation bias in least squares estimation of autoregressive processes. *Journal of Econometrics* 27:1 (1985) 99-121.

Estimation of the parameters of an autoregressive process with a mean that is a function of time is considered. Approximate expressions are derived for the bias of the least squares estimator of the autoregressive parameters that is due to estimating the unknown mean function. For the case of a mean function that is a polynomial in time, a reparameterization that isolates the bias is given. Using the approximate expressions, a method of modifying the least squares estimator is proposed. A Monte Carlo study

of the second-order autoregressive process is presented. The Monte Carlo results agree well with the approximate theory and, generally speaking, the modified least squares estimators performed better than the least squares estimator. For the second-order process we also consider the empirical properties of the estimated generalized least squares estimator of the mean function and the error made in predicting the process one, two, and three periods in the future.

***POLLAK, Edward.** Gamete frequencies at two sex-linked loci in random mating age-structured populations. *Mathematical Biosciences* 70:2 (1984) 217-235. SLRS 598.

Journal Paper No. J-11261 of the Iowa Agriculture and Home Economics Experiment Station, Project 2588.

A study is made of the change with time of frequencies of gametic types with one or two sex-linked loci in an infinite random-mating age-structured population. Recurrence equations for these gamete frequencies are derived under the assumptions that all matings of adults are equally fertile and the number of matings at any time is proportional to the number of mature females at that time. These equations generalize others in the literature. It is shown that gamete frequencies approach their limiting values at geometric rates in the long run. This implies that the asymptotic behavior of the gamete frequencies is like what it is in populations with discrete generations if the unit of time is replaced by an appropriately chosen generation interval. With either one locus or two loci, the generation interval is bounded below by an analogous measure from standard demographic theory. This result also holds when there are two autosomal loci. In the numerical examples from both the present paper and a previous one by Pollak and Callanan, the lower bound is a good estimate of the generation interval.

LoPiccolo, Joseph, Julia R. Heiman, Douglas R. Hogan, and **Carl W. ROBERTS.** Effectiveness of single therapists versus cotherapy teams in sex therapy. *Journal of Consulting and Clinical Psychology* 53:3 (1985) 287-294.

Sixty-five sexually dysfunctional couples were randomly assigned to treatment by a single male therapist, a single female therapist, or a dual-sex cotherapy team. Treated dysfunctions included male erectile failure and premature ejaculation and female primary and secondary orgasmic dysfunction. Assessments of marital and sexual satisfaction and functioning were made at initial intake, at the start of therapy, immediately following therapy, and at a 3-month follow-up. The assessment battery included the Locke-Wallace Marriage Inventory, the Sexual Interaction Inventory, patient global ratings, and measures of symptom remission. Repeated measures analysis of variance and post hoc comparisons failed to reveal any differences in effectiveness of single therapists versus cotherapy teams. Furthermore, in cases treated by single therapists, a matching of sex of therapist with sex of the dysfunctional member of the patient couple did not lead to better outcome than for nonmatched cases. Overall, sex therapy was generally effective, although greater gains were shown in patient global ratings of satisfaction and in the psychometric measures of adjustment than in actual symptom remission.

SCOTT, Dan M. (Rose-Hulman Institute of Technology), and James S. Fritz. Model for chromatographic separations based on renewal theory. *Analytical Chemistry* 56:9 (1984) 1561-1566.

A simple but reasonably realistic model is formulated for describing the behavior of chromatographic peaks. Our approach is based on statistical concepts and completely avoids the physically nonexistent "theoretical plates" of classical theory. This work complements the "rate theory" of chromatography in that we provide a more detailed look at the "resistance to mass-transfer process" (what we call the "interphase process"). The model is a stochastic one; because molecular level processes are random in nature, we feel that this is a natural approach. Although a variety of stochastic models have been proposed previously, they have been damaged by the necessity of assuming a particular mechanism. The present theory is largely immune from this criticism. The paper makes use of results from the theory of renewal processes, but the *results* should be comprehensible to anyone with only a modest acquaintance with statistical notions.

Gelfand, Alan E., and **W. Robert STEPHENSON.** An examination of U.S. appellate court opinions. Pp. 37-45 in *Proceedings of the Second Workshop on Law and Justice Statistics,* edited by Alan E. Gelfand—proceedings of a workshop sponsored by the American Statistical Association Continuing Education Department and the Bureau of Justice Statistics and held in Toronto, Canada, August 13-14, 1983. Bureau of Justice Statistics, U.S. Department of Justice, Report No. NCJ-93310. June 1984.

This article examines data collected on written opinions from the U.S. District Courts of Appeal between the years 1962 and 1976. Summary statistics on types of cases, decisions, and "physical" characteristics of the written opinions are presented. Subsequent citation is used as an indication of the influence, or precedential importance, of opinions. The effectiveness of an administrative rule is then analyzed using the precedential importance of opinions before and after implementation of the rule in the Fifth Circuit Court.

VARDEMAN, Stephen, and **Herbert T. DAVID.** Statistics for quality and productivity: A new graduate-level statistics course. *The American Statistician* 38:4 (1984) 235-243.

The growing popular realization that American product quality and productivity are no longer with-

out challenge for world leadership presents an opportunity for the American statistical community to make stronger contributions to sound industrial practice than it has in the past. Management consultants, such as Deming and Juran, are promoting philosophies that contain strong statistical components and are being heard by top U.S. executives. There are thus growing opportunities for industrial statisticians. Upon reviewing the content of typical graduate-level statistical quality control courses and books in the light of the present situation, we find them to be inadequate and in some cases to suffer from inappropriate emphases. In this article we discuss our perceptions of what is needed in the way of a new graduate-level course in statistics for quality and productivity (SQP). We further offer for discussion a syllabus for such a course (which is a modification of one used at Iowa State in the 1983 spring semester), some comments on how specific topics might be approached, and also a partially annotated list of references for material that we believe belongs in a modern SQP course.

VARDEMAN, Stephen, and **Di-ou Ray.** Average run lengths for CUSUM schemes when observations are exponentially distributed. *Technometrics* 27:2 (1985) 145-150.

Page [*Biometrika* 41 (1954) 100-114] originally noted that it is possible to find an integral equation whose solution gives average run lengths for one-sided cumulated sum (CUSUM) schemes. Lucas and Crosier [*Technometrics* 24 (1982) 199-205], for the case of normally distributed observations, have obtained numerical solutions to Page's integral equation and used these in their study of so-called fast-initial-response CUSUM charts. In this article we show that for the case of exponentially distributed observations, the Page equation can be solved without resorting to approximations. We then provide some tables of average run lengths for the exponential case and comment on an application of exponential CUSUM charts to controlling the intensity of a Poisson process.

Book Reviews, Etcetera

COX, C. Philip. Vector geometry and statistics—Letter to the editor. *The American Statistician* 38:4 (1984) 331.

COX, D. F. *Statistical Procedures for Agricultural Research* (2nd ed.), by Kwanchai A. Gomez and Arthur A. Gomez. New York: John Wiley, 1984. xvi + 680 pp. $39.95. Reviewed in *Journal of the American Statistical Association* 80:390 (1985) 486.

CRESSIE, Noel A. C. *Statistics on Spheres,* by Geoffrey S. Watson. New York: John Wiley, 1983. x + 283 pp. $21.50 (paperback). Reviewed in *Journal of the American Statistical Association* 79:387 (1984) 733.

DAVID, H. A. *Neyman—From Life,* by Constance Reid. New York: Springer-Verlag, 1982. vi + 298 pp. $19.80. Reviewed in *Journal of the American Statistical Association* 79:387 (1984) 728-729.

KEMPTHORNE, Oscar. President's Column. *The Institute of Mathematical Statistics Bulletin* 14:1-4 (1985) 1-3, 57-58, 129-130, 165-166.

MARASINGHE, Mervyn. *MSUSTAT, MS/PC-DOS and CP/M-80 Version 2.20,* by Richard E. Lund. Research and Development, Inc., Montana State University, Bozeman, Mont. 59717-0002. $187.50 (university and multiple-copy discounts available). Statistical Computing Software Review in *The American Statistician* 39:1 (1985) 72-74.

MEEDEN, Glen. *The Chronological Annotated Bibliography of Order Statistics, Volume I: Pre-1950,* by H. Leon Harter. Columbus, OH: American Sciences Press, Inc. iv + 515 pp. $89.95 (paperback). Reviewed in *Journal of the American Statistical Association* 79:387 (1984) 734.

MEEKER, William Q., Jr. *Optimization in Statistics with a View Toward Applications in Management Science and Operations Research* (Vol. 19—Studies in Management Sciences), edited by S. H. Zanakis and J. S. Rustagi, North-Holland Publishing Company, 1982, x + 333 pp., $48.00. Reviewed in *Technometrics* 27:2 (1985) 207-208.

POLLAK, Edward. *Evolution in Age-structured Populations,* by Brian Charlesworth. New York: Cambridge University Press, 1980. xiii + 300 pp. $44.50 ($13.50 paperback). Reviewed in *Journal of the American Statistical Association* 79:387 (1984) 743.

SHELLEY, Mack C., II. *Social Impact Assessment Methods,* edited by Kurt Finsterbusch, Lynn G. Llewellyn, and C. P. Wolf. Beverly Hills: Sage Publications, 1983. 318 pp. $29.95, cloth. Reviewed in *The American Political Science Review* 79:1 (1985) 289-290.

Tveite, Michael (St. Olaf College). *The Nuclear Numbers Game: Understanding the Statistics Behind the Bombs,* by the Radical Statistics Disarmament Group. London: Radical Statistics, 1982. 95 pp. £1.50 (paperback). Reviewed in *Journal of the American Statistical Association* 79:388 (1984) 963-964.

VARDEMAN, Stephen. *Graphical Methods for Data Analysis,* by J. Chambers, W. Cleveland, B. Kleiner, and P. Tukey. Copyright 1983 by Bell Telephone Laboratories, Inc., Murray Hill, New Jersey. Published by Wadsworth International Group, Belmont, CA, 1983. 396 pp. Reviewed in *Journal of Quality Technology* 16:3 (1984) 177-178.

WOLINS, Leroy. *Wines: Their Sensory Evaluation,* by Maynard A. Amerine and Edward B. Roessler. New York: W. H. Freeman and Co., 1982. xv + 432 pp. $19.95. Reviewed in *Journal of the American Statistical Association* 80:390 (1985) 484-485.

Thesis Abstracts

Abdella, Blake Randall. SAMPAC: An analysis package for attributes acceptance sampling plans. M.S. thesis, Iowa State University Library. August 1984.

A unified approach to attributes acceptance sampling (AAS), which simplifies analysis, is summarized. A set of algorithms and a BASIC language implementation are developed using this unified approach. The analysis performed includes operating characteristic, average sample number, average outgoing quality, and average total inspected curves. A table of UMVUE values of the process proportion defective is also generated. The above analysis can be performed for any "reasonable" AAS plan.

Arnold, Robert James. Optimal stochastic paths. Ph.D. thesis, Iowa State University Library. August 1984.

A shortest-route algorithm for finite networks is modified for application to path-dependent finite networks and to stochastic networks. The type of stochastic network considered has a "capture" probability associated with each node.

The problem of finding a path of minimum expected value on a countable infinite stochastic network is discussed. Conditions are presented under which countable paths have the same minimum expected value as permutation paths.

A continuous analog of the countable network, consisting of a hazard function on the plane and curves in the plane, is developed. Two optimality criteria are investigated: stochastic ordering and minimum expected value. Necessary conditions are given for paths to be optimal under the two criteria.

Chang, Stephen Fu-Chang. Error-free computations in solution of linear systems and linear programming problems. Ph.D. thesis, Iowa State University Library. December 1984.

Many computer applications in statistics require computation of a generalized inverse A^- of a given matrix A. Computation of A^- using floating-point arithmetic on digital computers sometimes produces results that contain substantial amounts of error in some or all of the matrix elements. Error is introduced because floating-point arithmetic is not exact. Multiple modulus residue arithmetic and finite segment p-adic number arithmetic, however, are capable of producing exact results in many cases with only the assumption that the matrix has rational entries. Methods that use multiple modulus residue arithmetic and finite segment p-adic number arithmetic are developed to compute a reflexive generalized inverse for an arbitrary rectangular matrix. The methods are then applied to find exact solution to linear programming problems. Comparisons are made for these two methods; the relative advantages of each method are pointed out. Since large amounts of memory and execution time are needed for performing with these two methods, a procedure that extracts the exact solution of the linear system $a\underset{\sim}{x} = \underset{\sim}{b}$ from its computed floating-point approximation is developed as an alternative. The error bounds of the computed solution and det(A) are derived. Also, an overall error-free computational procedure is proposed for solving the linear system of equations. Algorithms are developed and implemented that compute the exact solution for matrix inversion, linear programming problems, and linear systems.

Guerrero, Margarita F. Optimal confidence bounds. Ph.D. thesis, Iowa State University Library. August 1984.

Optimal confidence bounds proposed by Buehler [*Journal of the American Statistical Association* 52 (1957) 482-493], primarily for functions of the parameters of distributions on finite sample spaces, are investigated in several directions. These investigations include consideration of: questions of existence and construction, order-restricted optimal regions, simultaneous confidence bounds for sets of parametric functions, Bayes adaptations, and strong optimality for monotone likelihood ratio families. They include, as well, the exploiting of special features of parametric functions that are terminal-event probabilities of event trees and of parametric functions that express the reliability of monotone systems.

Jobe, John Marcus. Error rates for Poisson process discrimination. Ph.D. thesis, Iowa State University Library. August 1984.

This research addresses the question of how one's ability to discriminate between two Poisson processes is affected by the relative behavior of their respective intensity functions. One approach involves observation of the process up to the k^{th} occurrence time. Another is to observe the process up to a fixed time T. The error probabilities for these two approaches are analyzed as k and T, respectively, tend to infinity. Several types of relative behavior of the two intensity functions are considered.

Additional work involves application of invariance theory to discrimination between two classes of Poisson processes.

Kim, Byung Chun. A conjugate gradient algorithm for analysis of variance computations.

Matrix-oriented least squares or regression algorithms require substantial amounts of computer storage in order to solve analysis of variance problems. However, iterative methods exist that are capable of reducing the storage problem. These employ well-known balanced analysis of variance computations that do not require computer storage. The normal equations corresponding to a linear model with unbalanced data can be expressed in terms of the design matrix X for the cell means model. This fact can be used to construct algorithms that require a balanced analysis of variance problem to be solved in each iteration. A rule for constructing a generalized inverse of X'X that is positive definite and lower

triangular is given. An iterative algorithm based on the modified conjugate gradient method to obtain the parameter estimates of an analysis of variance problem without storing X or X′X is developed, using that inverse. This algorithm reduces the number of iterations required, as compared to algorithms given previously. Further, the algorithm does not require reparameterization of the X matrix. An iterative method is also developed for calculating directly the sum of squares for testing a linear hypothesis in the original overparameterized model. Programs are implemented that compute the analysis of variance table and parameter estimates for linear models with unbalanced data, using the above algorithms.

Lee, Carl Moun-Shen. Constrained optimal designs. Ph.D. thesis, Iowa State University Library, December 1984.

Let $f_1(x), ..., f_k(x)$ be k given linearly independent and continuous real-valued functions on a compact set χ, the experimental region. A random variable $Y(x)$ is defined such that $E(Y(x)) = f'(x)\beta$, where $f'(x) = (f_1(x), ..., f_k(x))$ and β is a $k \times 1$ unknown parameter vector. A design measure is a probability measure defined on the Borel field generated by the open subsets of χ. The corresponding information matrix is $M(\xi) = \{m_{ij} \mid m_{ij} = \int_x f_i(x)f_j(x)\xi(dx)\}_{i,j=1}^{k}$.

The ordinary optimal design problem is to find a design measure that minimizes a given function of $M(\xi)$, an optimality criterion, over all possible design measures.

In general, several optimality criteria are relevant to the investigator. It is often the case that a design which is best with respect to one criterion is extremely poor with respect to another criterion, or, at worst, useless. It is appropriate, then, to require a minimal quality of design with respect to one or more criteria, and then to determine the design that is optimal with respect to a particular criterion within the class of designs that achieve at least that minimal quality. This leads to a constrained optimality problem, and takes account of several criteria simultaneously.

Several specific constrained criteria are suggested and discussed in detail. The performance and efficiencies of optimal designs for these constrained criteria are discussed. Analytic solutions are obtained by use of canonical moment theory.

The directional derivative approach and Lagrangian theory are utilized to attack the general constrained problem. Necessary and sufficient conditions for a design to be optimal for the general constrained problem are developed. These conditions are applied to solve some specific constrained problems.

McGovern, Paul Gerard. Two statistical analysis procedures applied to multivariate smoking cessation data. Ph.D. thesis, Iowa State University Library. December 1984.

The field of smoking cessation research is plagued by inconsistent findings, caused in part by inadequate methodological or statistical analysis procedures. These problems are more serious in the case of smoking cessation treatments administered to groups of individuals.

The effectiveness of two treatments is compared: an aversive smoking procedure followed by a maintenance phase (AM); and a nicotine fading procedure followed by the same maintenance phase (NM). Also, the benefits of being randomly selected to treatment (RS) versus self-selecting treatment (SS) are compared. Treatment was administered to groups of individuals, and groups differed in size from 2 to 17 participants. Information on subjects' subsequent smoking status (abstinent or smoking) was collected at several follow-up times.

Preliminary analysis indicated that group effects were measureable but small. Also, since the outcomes of married persons who attended the program together were closely related, one spouse was chosen at random and deleted from consideration in subsequent data analysis.

Two statistical analysis procedures are applied to these data. Repeated-measures analysis of variance (ANOVA) was carried out using as the unit of analysis the proportion of subjects abstinent at each of the several follow-up intervals. Survival analysis was carried out using individual subject's time to return to smoking as the unit of analysis.

Results using the ANOVA methods revealed no significant differences between the two treatments or the methods of selection to treatment. In contrast, a survival analysis procedure using a limited failure population Weibull model, while not demonstrating any difference in effectiveness between the AM and NM treatments, did reveal a significant difference between the methods of selection to treatment in favor of self-selection to treatment. However, other differences (such as historical ones) between the RS and SS methods make interpretation of this finding difficult.

Several factors point to the greater appropriateness and statistical power of the survival analysis methodology over that of analysis of variance. However, there is a need to adapt survival analysis methodology to take account of the possible presence of group effects. Possibilities such as bootstrapping are discussed.

In the psychological arena, both the oversmoking and nicotine fading treatment strategies appear equally effective. The indications that self-selection of treatment is beneficial are potentially important and invite further study. It also appears that future improvements in success rate will depend on improved relapse prevention.

Martin, Cindy Lynn. Applications of the distance measures between the prior and posterior distributions. Ph.D. thesis, Iowa State University Library. December 1984.

In a typical inferential problem, the conclusion reached by a Bayesian statistician depends on three components: the prior distribution, the likelihood function, and the observed sample data. These components are combined in the form of the posterior

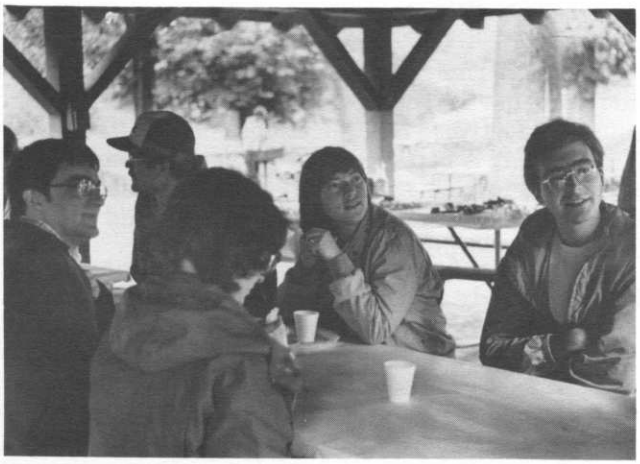
distribution, which updates the information in the prior by merging it with the information in the likelihood function. Assuming that the likelihood function is correct, we evaluate the consonance between prior beliefs and the observed data by calculating the distance between the prior and posterior distributions of the parameter of interest. We use the squared Hellinger's distance and the Kullback-Liebler divergences.

If the distance measure is very large, then this could indicate either a misspecified prior or a "surprising" data value. Considering the first possibility, we show how the distance measure can be used to specify more robust prior distributions. If the prior is assumed to be correct, we indicate how the measure can isolate disconsonant sample values.

If we have a sample $\underset{\sim}{x} = x_1,...,x_n$, then the posterior distribution of θ given $x_1,...,x_{n-1}$ is the prior distribution for the observation x_n. Calculating the distance between the posterior distribution of θ given $\underset{\sim}{x}$ and the posterior distributions with each x_i deleted, gives an ordering of the sample values, and establishes a Bayesian technique for the detection of outliers. We show that for the general linear model, the distance is a function of a classical measure of the influence of the i^{th} value on the estimation of regression parameters.

We define a new measure of the amount of information obtained from an experiment. The measure is a convex combination of the information in the posterior and the information in the likelihood function, with weights given by an appropriate form of the distance function.

We apply the distance idea to the question of which subset of the independent variables in the general linear model should be included when predicting a future y value. We calculate the distance between the predictive density with all variables included, and the predictive densities derived from reduced models that include only a fixed subset of the variables. We decide to use that model for which the distance is minimum. We show that, with a uniform prior, the distance is a function of the classical reduction-in-sum-of-squares statistic.



Relaxing at the traditional spring breakfast in Brookside Park: from the left, counterclockwise, John Eltinge, Carol Francisco, Stephen Miller, Beth Eltinge, and Stephen Crowder.

Mazloum, Reda Ibrahim. Admissibility in choosing between experiments with applications. Ph.D. thesis, Iowa State University Library. August 1984.

Suppose that a statistician is faced with a decision problem involving an unknown parameter. Before making a decision he or she can observe, possibly at random, one of k possible experiments. For this problem, a decision procedure for the statistician is a pair $(\underset{\sim}{\gamma},\underset{\sim}{\delta})$ where $\underset{\sim}{\gamma} = (\gamma_1,...,\gamma_k)$, $\underset{\sim}{\delta} = (\delta_1,...,\delta_k)$; γ_i is the probability of observing experiment i; and δ_i is the decision function to be used in connection with experiment i. When $\underset{\sim}{\gamma} \in \Gamma$, the class of all probability distributions on $\{1,...,k\}$, a characterization of the class of admissible pairs relative to Γ for the problem was given by Meeden and Ghosh [*Annals of Statistics* (1983)]. This thesis deals with the problem in the case when, for some reason like cost or time limitations, the statistician is restricted in choosing among those experiments. That is, a characterization of the class of admissible pairs $(\underset{\sim}{\gamma}\,\underset{\sim}{\delta})$ relative to an arbitrary subclass of Γ is given.

This characterization is then used to give some uniform admissibility results for some problems in finite population sampling. Other applications in nonparametric problems are also discussed.

Following Meeden and Ghosh [*Annals of Statistics* (1981)], an admissible estimator of a population U-statistic is constructed. This estimator turns out to be a constant times the corresponding sample U-statistic where the constant is some positive number less than one.

Miazaki, Edina Shisue. Estimation for time series subject to the error of rotation sampling. Ph.D. thesis, Iowa State University Library. May 1985.

The use of repeated surveys to estimate the population mean of a variable over time is approached as a time series problem. A survey carried out at time t yields an estimate Y_t of the population mean X_t. We write $Y_t = X_t + u_t$, where u_t is the survey error of estimation. If X_t follows a stochastic model, the problem of estimating X_t becomes one of estimating a time series observed subject to measurement error. In this work X_t is postulated to be an autoregressive process.

In rotation sampling designs, the measurement error u_t can be modeled as a moving average process. An efficient estimation method, based upon the properties of the least squares estimators of an autoregressive moving average, is developed for the parameters of the X_t process. A Monte Carlo study examining the estimation method was conducted. The distributional properties of the estimators showed reasonable agreement with the asymptotic theory for samples of 30 or more observations from the first-order autoregressive process.

Application of time series estimation techniques to the National Crime Survey is considered. One set of estimates suggests that the use of time series procedures produces sizable gains in efficiencies for estimates of yearly victimization level constructed in the first three months of the following year.

Ostrouchov, George. Large sparse least squares computations. Ph.D. thesis, Iowa State University Library. December 1984.

Orthogonal Givens factorization is a popular method for solving large sparse least squares problems. Row and column permutations of the data matrix are necessary to preserve sparsity, and reduce the computational effort during factorization. The computation of a solution is usually divided into a symbolic ordering phase, and a numerical factorization and solution phase. Some theoretical results on row ordering are obtained using a graph-theoretic representation. These results provide a basis for a symbolic Givens factorization. Column orderings are also discussed, and an efficient algorithm for the symbolic ordering phase is developed. Sometimes, due to sparsity considerations, it is advantageous to leave out some rows from the factorization, and then update only the solution with these rows. A method for updating the solution with additional rows or constraints is extended to rank-deficient problems. Finally, the application of sparse matrix methods to large unbalanced analysis of variance problems is discussed. Some of the developed algorithms are programmed and tested.

Pareja, Gilda Piaggio. Fitting a logistic curve to population size data. Ph.D. thesis, Iowa State University Library. August 1984.

A stochastic logistic process $\{N_t\}$ is viewed as a homogeneous birth and death process with population birth and death rates

$$\lambda_n = (a_1 - b_1 n)n$$

and

$$\mu_n = (a_2 + b_2 n)n,$$

respectively, where $a_1, a_2 > 0$; $b_1, b_2 \geq 0$; $a_1 \neq a_2$; $b_1 + b_2 > 0$; and n is the population size, a realization of N_t.

The mean value and the covariance function of the stochastic logistic growth were estimated using computer simulations. The stochastic mean at time t was found to be extremely close to the deterministic mean, $K/(1 + Ce^{-rt})$, where $r = a_1 - a_2$ is the intrinsic individual growth rate, $K = r/(b_1 + b_2)$ is the carrying capacity, and $C = K/N_0 - 1$, N_0 being the initial population size (fixed). The covariance function was found to be dependent not only on time, order of the covariance, N_0, r, and K, but also on a_1, a_2, b_1, and b_2.

An approximating function for the covariance was developed using search techniques on the estimated covariance from the simulations. The variance and the covariance of the first order were computed theoretically from the transition probabilities for one case, and they were found to agree with the corresponding values of the approximating function.

The approximating function found for the covariance function was used in an attempt to apply a quasi-maximum likelihood criterion in the estimation of the parameters of the logistic process. This and other methods of fitting the logistic curve to population size data were discussed, and they were compared in a Monte Carlo study. Linearization methods of fitting were found to be biased, and some of them presented serious problems of estimation.

Finally, the problem of goodness of fit was addressed, and the distribution of a χ^2 statistic for goodness of fit was studied.

Park, Byung Sul. n-person simple games and n-component reliability structures. Ph.D. thesis, Iowa State University Library. May 1985.

Characteristic functions of (0,1) n-person simple games and structure functions of n-component reliability structure systems are studied as "dyadic functions." The latter functions may belong to a number of categories, which are characterized and interrelated. These categories include the class of Boolean dyadic functions, monotone dyadic functions, superadditive dyadic functions, subadditive dyadic functions, and inessential dyadic functions. It is helpful in this connection to introduce certain concepts and constructs new to both games and systems, and to interpret certain concepts in terms of the area other than that of their origin. Additional constructs are reexamined in the context of the entire domain of dyadic functions. Among the latter are certain "generating vectors" and "veto vectors," for which appropriate generating algorithms are introduced.

The Shapley form of an n-person game is studied over the entire domain of dyadic functions, and a version of the Shapley form for monotone dyadic functions, based on generating vectors, is shown to be equivalent to the minimal path representation of system theory. Further, the uniqueness of the Shapley value is considered for dyadic and more general functions. To this end, a set of revised Shapley axioms is introduced. Finally, several methods for expressing and relating characteristic or structure functions are surveyed, as well as several indices for measuring the importance of a player or a component. Given the area of game theory and the area of reliability theory, emphasis is placed on interpreting indices arising in one of these two areas, in the language of the other.

van Schaik, Jan William Jozef. Bradley-Terry models for paired comparisons incorporating judge variability. Ph.D. thesis, Iowa State University Library. May 1985.

The problem of modeling choice behavior has received considerable attention. The simplest choice situation is a paired comparison experiment in which items are compared two at a time. The Thurstone-Mosteller and Bradley-Terry models are the most commonly used models for such experiments. Underlying both these models are the assumptions that the choice probabilities associated with a comparison are the same for all judges and that all comparisons are performed independently of one another. Two models, that are based on the Bradley-Terry model approach,

are introduced in which these assumptions are relaxed. For both of these models, methods of parameter estimation and hypothesis testing are presented. The method of pseudo-maximum likelihood estimation is discussed and extended to the case of a product multinominal distribution. Also, a Wald statistic is derived that performs tests of hypotheses using the pseudo-MLEs. The various parameter estimation and hypothesis testing techniques for four different paired comparison models are applied in two examples. Listings of the computer programs that performed the calculations for the models are given in appendices. Finally, the models are compared to one another and discussed in terms of their ease of application and relative influence on the sensitivity of goodness-of-fit tests.

Wilson, Jeffrey Rupert. Statistical methods for frequency data from complex sampling schemes. Ph.D. thesis, Iowa State University Library. August 1984.

Statistical methods are developed for comparing vectors of proportions among several subpopulations when the data are obtained from complex sampling schemes. For example, for two-stage cluster sampling an independent sample of clusters is obtained from each of the subpopulations and individuals are randomly selected from each of the sampled clusters. The true proportions of individuals belonging to the various categories may vary among clusters in the same subpopulation, and this variation must be incorporated into the test for the equality of the vectors of proportions. Several alternative testing procedures are considered. Wald statistics provide a general method of obtaining approximate chi-square tests, but the most general Wald statistic requires the estimation of covariance matrices for the specific sampling scheme used to obtain the data. This variance estimation generally requires a large number of clusters. Specifying a model for the population is a method of reducing the sample size required for variance estimation. The Dirichlet-Multinomial model is considered as a model for two-stage cluster sampling. The Dirichlet-Multinomial model assumes that the covariance matrix under two-stage cluster sampling is a multiple of the covariance matrix under simple random sampling. Several methods are considered for estimating the parameters of the Dirichlet-Multinomial and for testing the fit of the model.

In special cases, the chi-square test for the equality of the vectors of proportions is shown to be, essentially, a linear combination of Pearson chi-square statistics.

Various testing and estimation methods are compared through the analysis of several data sets. For two-stage cluster sampling the numbers of clusters sampled from the subpopulations have a substantial impact on the performance of the test statistics. The examples also illustrate the fact that the incorrect application of the Pearson chi-square statistic based on simple random sampling can produce misleading results when the frequencies are obtained from a more complex sampling scheme.

Department of Statistics

The Department of Statistics, the teaching arm of the Iowa State University statistical center, offers coursework leading to the degrees of Bachelor of Science, Master of Science, and Doctor of Philosophy with major in statistics. These degrees are conferred by the College of Sciences and Humanities and the Graduate College. A student may also receive a degree jointly with another department. The most common undergraduate co-major is computer science; the most common graduate co-major is industrial engineering for a joint emphasis on operations research.

In addition, the undergraduate curriculum in biometry administered by the Department of Statistics now offers two options—agricultural statistics and information management. The baccalaureate degree is conferred by the College of Agriculture. The unique part of the biometry curriculum is the concentration of courses in technical agriculture and biology that provides the graduate with a broad base from the biological sciences in which to utilize his/her statistical training.

As before, the agricultural statistics option emphasizes the application of statistical techniques to designed experiments and sample surveys. Supporting coursework from computer science and mathematics or statistics often leads to a minor in those areas. The new information management option will include more computer science and business management coursework. This option concentrates on techniques for efficiently storing and manipulating large volumes of data, which are later retrieved as reports or projected trends that assist business managers with inventory control and crucial management decisions.

Graduate students in statistics may specialize in probability, general theory, general methods, linear models, experimental design and analysis, survey design and analysis, statistical computing, operations research, or an area of application such as biostatistics, genetic statistics, psychometrics, econometric statistics, or engineering statistics. An M.S. candidate may choose either a thesis or a nonthesis option. About 95 percent of our candidates in recent years have chosen the latter, which requires completion of four additional credits, including a "creative component" representing at least two credits of independent work. The doctoral program is research-oriented and requires completion of a dissertation based on independent, creative work. More information appears in the brochure, "Iowa State University—Graduate Program in Statistics, July 1985," available from the department.

In the fall semester, approximately 90 graduate majors in statistics, 33 undergraduate majors in statistics, and 5 students in biometry were enrolled.

Enrollment in the introductory undergraduate courses continued to rise this year, especially in Stat 227, Introduction to Business Statistics; beginning

with fall semester 1985 that course will be changed from four to five credits. A follow-up course in applied business statistics will be raised to the 300-level for undergraduates and opened to graduate students for minor credit.

David Cox and Paul Hinz provided seven lectures for the course Agronomy 526X in the 1984 fall semester. This was an experimental course designed to give agronomy students instruction in some special topics in quantitative methods. The subjects discussed by Cox and Hinz were missing values, mean comparisons, multiple regression, and cluster analysis.

Under Stat 590B, Special Topics in Statistical Methods, David Cox presented a one-credit workshop in statistics in Iowa City as part of Iowa State University's off-campus program for the degree of Master of Agriculture.

A weekly one-credit seminar course on Robust Statistics was organized by Noel Cressie for spring semester. Half of the 14 seminars were presented by Cressie; the remainder, by W. R. Stephenson, H. A. David, Vincent Sposito, Ronaldo Iachan, and guest speakers Peter Lachenbruch and Robert V. Hogg from the University of Iowa and Peter Green from the University of Wisconsin-Madison.

Also in the spring Yasuo Amemiya offered an advanced special topics course, Measurement Error Models, which was based on a book manuscript by Wayne Fuller.

Through the ISU Extension Office of Continuing Education, Mack Shelley taught Stat 401 as an off-campus credit course in Mason City, Iowa, spring semester. His students were mostly employed in industry or government while working on graduate programs or toward Bachelor of Liberal Studies degrees.

Stephen Vardeman was a member of the organizing committee and a session chair for the College of Engineering Symposium on Deming and Taguchi Methods for Quality, Productivity, and Competitive Position, which was offered on campus November 30 and December 1. William Q. Meeker, Jr., with Way Kuo in industrial engineering, presented an Engineering Extension Service short course on engineering reliability March 21-22, 1985. Other short courses are mentioned in the Professional Activities Section, p. 18.

The faculty in the departments of Statistics and Industrial Engineering voted to open up for joint listing the graduate course on inventory theory and product scheduling that Herbert T. David has been teaching in the Department of Industrial Engineering for several years. Stat 540, Operations Research Methods and Economic Analysis, already listed jointly by the Department of Economics, also will be listed by Industrial Engineering. Both of these courses are part of the program available to students interested in operations research or industrial statistics.

As part of the rethinking and updating of courses in quality control and related areas, initiated earlier by Stephen Vardeman, Stat 431, Statistical Methods in Quality Control, is changing from two to three credits, and Stat 531 was renamed Statistics for Quality and Productivity. More information on this subject appears in a recent article by Vardeman and Herbert T. David (see pp. 30-31).

During the year the Department of Statistics acquired six IBM Personal Computers for secretarial word processing capabilities and three others for graduate student and faculty use for word processing and statistical computation. That acquisition has been discussed in a broader context on p. 6 of this annual report.

Course offerings for the 1984-85 academic year and the 1985 summer session are listed below. The summer session for 1984 was covered in the last annual report.

1984-1985 Course Offerings in Statistics

Courses for Undergraduate Students Only

100	Orientation in Statistics and Biometry	R	F	Stephenson
101	Principles of Statistics	4	F,S	Cressie McCoy Stephenson Strahan
104	Introduction to Statistics	3	F,S,SS C. P. Cox Hotchkiss Ihle J-S. Lin G. Morel	Nagaraj Pollak Sukhatme Zimmerman
105	Introduction to Statistics	2	F,S	Boeh Iachan Sukhatme Vardeman
227	Introduction to Business Statistics	4	F,S,SS Cranford Farmer Hensen Huang Ihle Isaacson	Jensen J-S. Lin Meeker G. Morel Nanayak-kara
228	Applied Business Statistics	3	F,S	Kennedy Meeker Silvis
231	Probability and Statistical Inference for Engineers	4	F,S	Homblé Meeden Pollak
305	Engineering Statistics	3	S	Vardeman
341	Introduction to Theory of Probability and Statistics	3	F,S	Groeneveld Stephenson
342	Introduction to Theory of Probability and Statistics	3	S	Groeneveld

Courses for Graduate Minors and Undergraduates

401	Statistical Methods for Research Workers	4	F,S,SS Bailey C. P. Cox D. F. Cox Groeneveld Hickman Hotchkiss Reiser Roberts Shelley Wolins	
402	Statistical Design and the Analysis of Experiments	3	S	D. F. Cox & Hinz Marasinghe Strahan
403	Nonparametric Statistical Methods	2	F	Groeneveld
404	Statistics for the Social Sciences	3	F	Lorenz
405	Applied Econometric Statistics	3	S	Hickman
407	Methods of Multivariate Analysis	2	F	Hinz
421	Survey Sampling Techniques	3	S	Baker
431	Statistical Methods in Quality Control	3	F	Vardeman
436	Genetic Statistics for Research Workers	3	F	Bailey
446	Statistical Theory for Research Workers	2	F	Amemiya
447	Statistical Theory for Research Workers	4	S,SS	Amemiya H. A. David
451	Applied Time Series	3	S	Meeker
480	Statistical Application of Digital Computers	3	F	Marasinghe
481	Computer Processing of Statistical Data	3	S	Bubolz & Marasinghe
490	Independent Study	Var	F,S,SS	Hotchkiss Iachan Meeker Reiser
490H	Independent Study: Honors		F	Hotchkiss

Courses Primarily for Graduate Students, Major or Minor

500	Statistical Methods	4	F	Koehler
501	Multivariate Statistical Methods	3	S	Koehler
511	Theory and Application of Linear Models	3	S	Kempthorne
512	Design of Experiments	3	F	Harville
513	Response Surface Methodology	3	S	Harville
521	Theory of Sample Surveys I	3	S	Iachan
531	Sequential Product and Process Control	3	S	Vardeman
535	Biological Statistics	2	SS	C. P. Cox
538	Econometric Statistics	3	F	Fuller
539	Game Theory	3	F	H. T. David
540	Operations Research Methods and Economic Analysis	3	S	Sposito
542	Theory of Probability and Statistics	3	F	Meeden
543	Theory of Probability and Statistics	3	S	H. A. David
546	Theory of Nonparametric and Asymptotic Methods	3	S	Sukhatme
579	Introduction to Computer Hardware and Software Systems for Statistical Computing	1	F	Bubolz & Marasinghe
580	Statistical Computing	3	F	Kennedy
590	Special Topics A. Theory	Arr	F,S,SS Amemiya Athreya H. A. David Fuller Meeden Pollak Vardeman	
590	Special Topics B. Methods	Arr	F,S,SS Cressie Hinz Kennedy Koehler Marasinghe Meeker Reiser Sacks Shelley Sposito Stephenson Vardeman	
	C. Design of Experiments		S,SS	Hinz Hotchkiss Marasinghe Sacks
	D. Design of Surveys		F,S,SS	Iachan Reiser Sacks Sposito
590A	Robust Statistics	1	S	Cressie
590B	Workshop in Statistics	1	F	D. F. Cox

Courses for Graduate Students, Major or Minor

611	Advanced Linear Model Theory	3	F	Kempthorne
639	Stochastic and Abstract Programming	3	SS	Sposito
642	Measure Theory and Probability	3	S	Athreya
643	Theory of Estimation and Testing of Hypotheses	3	F	Cressie
647	Multivariate Analysis	3	F	Amemiya

648	Seminar on Theory of Statistics and Probability (Measurement Error Models)	3	S	Amemiya
699	Research	Var	F,S,SS	

Athreya	Kennedy
Cressie	Koehler
H. A. David	Marasinghe
H. T. David	Meeden
Fuller	Meeker
Harville	Sposito
Isaacson	Vardeman
Kempthorne	

Graduate Students

Fifteen Ph.D. degrees and 21 M.S. degrees were earned in the Department of Statistics during the fiscal year. Two of these (one Ph.D. and one M.S.) were for joint majors. Abstracts of Ph.D. dissertations and a master's thesis appear in the Publications Section. All but one of the masters' degrees were conferred on a nonthesis basis, with candidates each completing a creative component based on independent study. Employment or further educational plans of the degree recipients are indicated insofar as possible. An asterisk identifies students who chose to remain at Iowa State to work toward doctorates in statistics.

M.S. Recipients

Bahtiar Saleh Abbas (Spring 1985, under William Q. Meeker, Jr.) is working toward a doctorate in industrial engineering at Iowa State University, concentrating on operations research and management science.

Blake Randall Abdella [Summer 1984 in statistics and industrial engineering (operations research), under Stephen Vardeman and Eric Malstrom] is a management information systems consultant with Arthur Andersen & Co., Minneapolis, Minnesota.

Tammy Sue Bondioli (Summer 1984, under Wayne A. Fuller) is an associate engineer, Reliability Availability Serviceability, IBM Corporation, Rochester, Minnesota.

Carolyn Patricia Connor (Fall 1984, under Kenneth J. Koehler) joined Procter & Gamble, Inc., as marketing analyst in the Management Systems Division, Cincinnati, Ohio.

***Nancy Ann Eyink Hasab-El-Naby** (Spring 1985, under Wayne A. Fuller).

Donna Celeste Hensen (Spring 1985, under Mack C. Shelley II) is seeking permanent residency with employment in Florida.

***Patrick Rene Homblé** (Summer 1984, under Krishna Athreya).

Shun-Chuen Huang (Spring 1985, under Paul N. Hinz) has married Ye-Chang Tsai; she is planning to work in forecasting for Electronic Data System Corporation, a subsidiary of General Motors, in Southfield, Michigan.

***Byung Hwee Kim** (Summer 1984, under Glen Meeden).

***Mong-Hong Lee** (Fall 1984, under William J. Kennedy, Jr.).

Anthony Yuk-Leung Lui (Summer 1984, under Mervyn Marasinghe) is working toward a master's in computer science at Iowa State.

Abdelghani Mehailia (Summer 1984, under Ronaldo Iachan) is working toward a Ph.D. in mathematics at Iowa State.

***Stephen Mitchell Miller** (Summer 1984, under Wayne A. Fuller).

Di-ou Ray (Spring 1985, under Stephen Vardeman) is remaining in Ames, Iowa while his wife completes an advanced degree in mathematics.

Margaret Ellen Scott (Summer 1984, under Edward Pollak) has remained at Iowa State University for a year as instructor in the Department of Mathematics and now has accepted a similar position at Indiana State University-Terre Haute.

***Miriam Bridget C. Tirol** (Fall 1984, under Kenneth J. Koehler) is working on a joint Ph.D. program in statistics and industrial engineering here.

***Margot Helena Tollefson** (Spring 1985, under Yasuo Amemiya), after marrying Clay Conard, resumes study toward a Ph.D. in statistics at Iowa State this fall.

Tilaka Nandani Vijithakumara (Fall 1984, under Ronaldo Iachan) remained in Ames, Iowa until her husband completed a doctorate. She joins the Department of Mathematical Sciences, University of Minnesota-Duluth, September 1 as instructor.

Annette Evelyn Wagner (Summer 1984, under William Q. Meeker, Jr.) is a research statistician with A. C. Nielsen Co., Northbrook, Illinois.

***Danny Allan Wolfgram** (Spring 1985, under Kenneth J. Koehler).

***Rahmat Syahni Zakaria** (Spring 1985, under Noel A. C. Cressie) is working toward a joint Ph.D. in statistics and industrial engineering here.

Ph.D. Recipients

Robert James Arnold (Summer 1984, under Krishna Athreya and Herbert T. David) is a statistician in the Hewlett-Packard Corporation, Waltham, Massachusetts; his position involves organizing statistics courses for the employees.

Stephen Fu-Chung Chang (Fall 1984, under William J. Kennedy) continues as assistant professor in the Department of Mathematics, California State College at Bakersfield.

Margarita Fuentecilla Guerrero (Summer 1984, under Herbert T. David) returned to the University of the Philippines at Los Banos to become an assistant professor in the Institute of Mathematics, Statistics, and Physics.

John Marcus Jobe (Summer 1984, under Stephen Vardeman and Herbert T. David) is an assistant professor in the Department of Production and Decision Science, Miami University of Ohio.

Byung Chun Kim (Fall 1984, under Mervyn Marasinghe and William J. Kennedy) returned to Seoul, Korea to become an assistant professor in the Department of Applied Mathematics, Korea Advanced Institute of Science and Technology.

Carl Moun-Shen Lee (Fall 1984, under Oscar Kempthorne) continues as assistant professor in the Department of Mathematics, Central Michigan University.

Paul Gerard McGovern (Fall 1984 in psychology and statistics, under Robert Strahan) has continued work on a smoking research project at Iowa State University, as a postdoctoral re-

search associate in the Department of Psychology supported by a grant from the National Cancer Institute.

Cindy Lynn Martin (Fall 1984, under Glen Meeden) is an assistant professor in the Department of Mathematics, College of Charleston, in Charleston, South Carolina.

Reda Ibrahim Mazloum (Summer 1984, under Glen Meeden) returned to Cairo University, UAR, to become an assistant professor in the Department of Statistics, College of Economics and Political Science.

Edina Shisue Miazaki (Spring 1985, under Wayne A. Fuller) returned to Brazil to teach, as assistant professor, in the Departamento de Computacão e Estatística, Universidade Federal de São Carlos.

George Ostrouchov (Fall 1984, under William J. Kennedy) continues as a member of the research staff, Mathematics and Statistics Research Department, Computer Sciences Division, Oak Ridge National Laboratories, in Oak Ridge, Tennessee.

Gilda Piaggio Pareja (Summer 1984, under Oscar Kempthorne) has been a visiting assistant professor in the Department of Statistics and Actuarial Science, University of Iowa.

Byung Sul Park (Spring 1985, under Herbert T. David) is a lieutenant colonel in the Republic of Korea Army; he has been reassigned to work as researcher at Army Headquarters, in Seoul.

Jan William Jozef van Schaik (Spring 1985, under Kenneth J. Koehler) has joined the Upjohn Company, Kalamazoo, Michigan, as mathematician (senior statistician) in its Information Services Section.

Jeffrey Rupert Wilson (Summer 1984, under Kenneth J. Koehler and Wayne A. Fuller) continues as visiting assistant professor in the Department of Statistics, Oklahoma State University.

M. S. Candidates

Abbas, Bahtiar S.
bin Abdul Malik, Danyal
Andrews, Douglas M.
Beasley, Patti Ann
Benlemrid, Driss
Boeh, Stephen D.
Bondioli, Tammy
Borders, Thomas A.
Bryan, Mark F.
Cai, Yilin
Calcaño-Collazo, José
Caliste, Terry E.
Carley, Michael R.
Chae, Seong-San
Chien, Keng-tang
Chow, I-Shang Jackson
Christman, Jeffrey D.
Connor, Carolyn
Cook, John R.
Diedhiou, Mamadou L.
Erland, Kimberly
Giacobello, Gloriana
Gotway, Carol A.
Gunderson, Mark
Guo, Renkuan
Ha, In Hye
Hensen, Donna C.
Hong, Chong Sun
Hsieh, Chihho
Huang, Shun-Chuen
Hulting, Frederick
Hwang, Ching-Chang
Ihle, Brenda
Jensen, Karen L.
Johnson, Jane M.
Kang, Yoou-Jen
Khan, Mohammad I.
Kim, Joo-Hwan
Kortge, Kenneth J.
Lan, Yu-Fen
Lin, Jyh-Shium
Lui, Anthony Yuk-Leung
McCoy, Douglas E.
Mehailia, Abdelghani
Moore, Karen L.
Morel, Grecia F.
Park, Heon Jin
Ray, Di-ou
Redmond, Cleve R.
Scott, Margaret
Shankar, Narayan
Shum-Ng, Kwoklai Bonnie
Sullivan, Gary R.
Taylor, Kathleen M.
Thompson, John C.
Tollefson, Margot H.
Tsay, Yan-Ling
Vijithakumara, Tilaka
Vilendrer, Steven P.
Wagner, Annette
Wan Ismail, Wan Azah
Wang (Chu), Shaw-Ling
Wei, Pei-Lan Alice
Winters, Franklin
Wolfgram, Danny A.
Wu, Peh-Jen Jenny
Yang, Min-Shih Chang

Ph.D. Candidates

Abdurachman, Edi
Anderson, Kevin K.
Arnold, Robert J.
Beam, Craig A. (in absentia)
Biele, Jonathan
Brozovsky, Paul Victor
Callanan, Terrance P.
Carriquiry, Alicia
(joint animal science-statistics)
Cassell, David L.
Chang, Stephen Fu-Chung
Cranford, Brian Keith
Crowder, Lee Ann
(joint statistics-industrial engineering)
Crowder, Stephen V.
Da Yang
(joint statistics-animal science)
Eltinge, John L.
Farmer, Charles M.
Francisco, Carol A.
Fuh, Cheng-Der
(joint mathematics-statistics)
Funo, Eiichiro
Gan, Fah Fatt
Hasab-El-Naby, Nancy Eyink
Homblé, Patrick
Hsu, Shih-Jian
Jeske, Daniel R.
Jobe, John Marcus
Kim, Byung Chun
Kim, Byung Hwee
Kim, Song-Ho
Lee, Carl Moun-Shen
Lee, Mong-Hong
Lin, Tsung-Hua (Thomas)
Loubert, Sharon K.
Lu, Chi-hsien Joseph
McGovern, Paul
(joint psychology-statistics)
McNulty, Mark (in absentia)
(joint agricultural economics-statistics)
Martin, Cindy Lynn
Mazloum, Reda
Miazaki, Edina
Miller, Stephen M.
Morel, Jorge
Muththiah, Thilagawathy
Nagaraj, Neerchal K.
Nanayakkara, Nuwan
Oñate, Julia
Ostrouchov, George (in absentia)
Pareja, Gilda
Park, Byung Sul
Ramírez C., Juan Esteban
Rogers, Michael P.
Saad Eldin, Saad Eldin M.
Schnell, Daniel J.
Silvis, David L.
Symanowski, James T.
Tirol, Miriam B.
(joint industrial engineering-statistics)
Tveite, Michael (in absentia)
van Schaik, Jan
Wilson, Jeffrey R. (in absentia)
Wong, Peter Sze-Yan
(joint mathematics-statistics)
Yoon, Byoung Chang
Zakaria, Rahmat Syahni
Zimmerman, Dale L.

Under a cooperative internship agreement between Weyerhaeuser Co. and the Statistical Laboratory, Mark Gunderson spent the fall semester and Frederick Hulting is spending the spring semester and part of the summer as trainees at the company's Forest Paper Products center in Hot Springs, Arkansas.

Tsung-Hua Lin was initiated into Phi Kappa Phi Honor Society in March.

Iowa STAT-ers

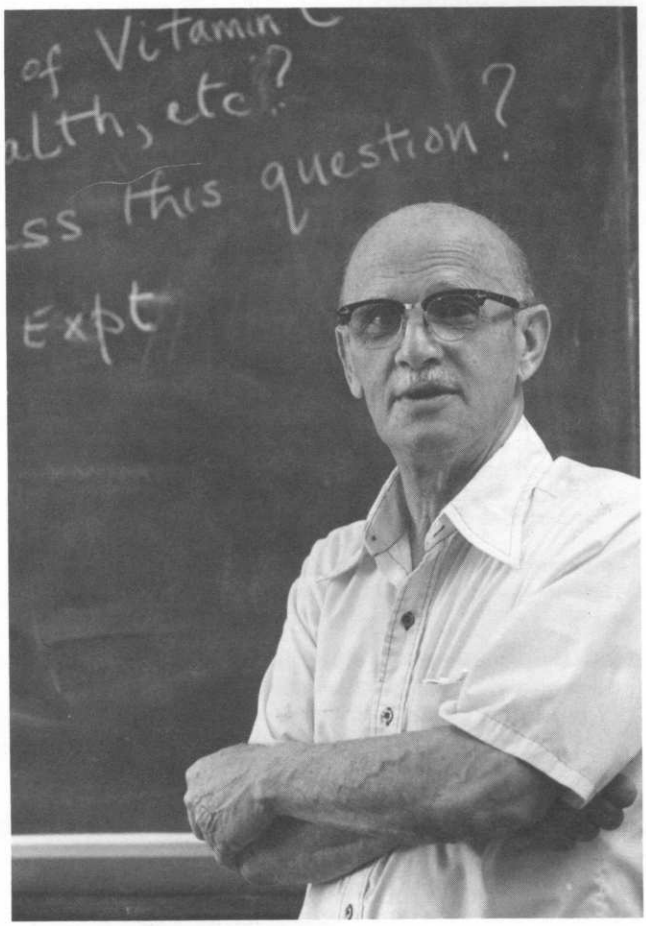
The Iowa STAT-ers graduate student club took an active role in promoting professional activities and fellowship among graduate students. Mike Rogers, Steve Miller, and faculty member Noel Cressie organized and promoted a series of Consulting, Methods, and Data Analysis (CAMADA) seminars with the goals of providing statistical assistance to people outside the Department of Statistics and exposing graduate students to current research that lends itself to statistical analysis and methods. Persons presenting material at CAMADA seminars are listed on p. 44.

The club continued the tradition of providing financial support for the annual Mu Sigma Rho lecture and organized a luncheon for students to meet with James Gentle, this year's invited Mu Sigma Rho speaker. Iowa STAT-ers also provided rolls and coffee for people taking part in masters' examinations and Ph.D. prelims.

The annual fall and spring pizza parties were, as usual, among the most popular of Iowa STAT-ers' activities. The fall party welcomes new statistics graduate students to Ames. The spring pizza party, hosted by students having passed M.S. or Ph.D. exams during the previous year, provides another opportunity for socializing. This spring's party was attended by a group of over 100 statistics faculty, staff, students, and their families.

Iowa STAT-ers officers and committee members for the year were Neerchal Nagaraj, president; Carol Francisco, vice president; Dan Schnell, secretary; Steve Miller, treasurer; Patrick Homblé, faculty meeting representative; Terry Callanan, Charles Farmer, Shih-Jian Hsu, Karen Jensen, Thomas Lin, Grecia Morel, and Dale Zimmerman. Kenneth Koehler serves as faculty adviser.

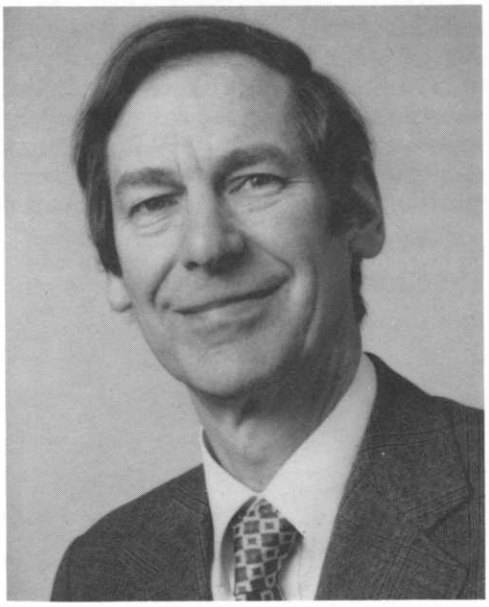
George Zyskind Memorial Lecture



IMS president Oscar Kempthorne

The tenth Zyskind Memorial Lecture was presented by Oscar Kempthorne on October 24. He spoke on "George Zyskind and statistical ideas he pursued." Kempthorne, Distinguished Professor in Sciences and Humanities and professor of statistics at Iowa State, is currently president of the Institute of Mathematical Statistics. The lecture series honors the late George Zyskind, professor of statistics here from 1959 to 1974.

Snedecor Lecture



Peter Armitage

The third George W. Snedecor Lecture was given in March by Peter Armitage, professor of biomathematics at Oxford University, United Kingdom. His topic was "Student's soporifics revisited." Armitage is well known for his contributions to biological statistics and recently completed terms as editor of *Biometrics* and as president of the Royal Statistical Society. The Snedecor Lecture program is "a series of occasional lectures recognizing further George Snedecor's pioneering contributions to statistics in general and the Stat Lab in particular."

Snedecor and Bancroft Awards

Stephen Mitchell Miller was chosen as recipient of the 1985 George W. Snedecor Award, as the most outstanding Ph.D. candidate in the Department of Statistics. He received a year's membership in the Institute of Mathematical Statistics and a cash prize. Established in 1954, the award honors the late George W. Snedecor, founder and first director of the Statistical Laboratory and an internationally recognized pioneer in applied statistics.

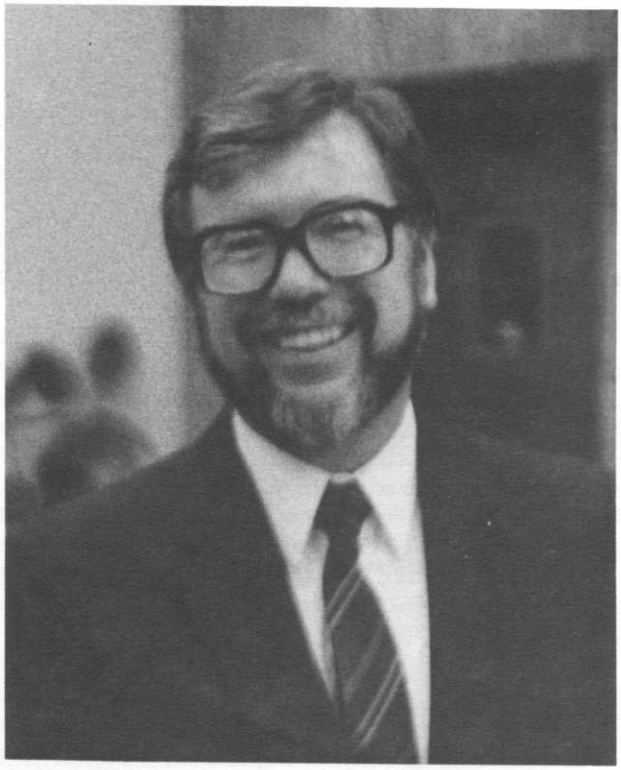
Miller received a B.S. degree in applied mathematics at the University of Virginia and came to Iowa State in 1982 after spending a summer as mathematician on the Missile Division research staff at Analytic Services, Inc., Arlington, Virginia. He completed the M.S. degree in statistics here last year and is working toward a doctorate with research interests in measurement error models.

The 1985 T. A. Bancroft Award was presented to Kendall Raye Lamkey, a graduate student in plant breeding and cytogenetics. He was selected on the basis of outstanding performance as a doctoral candidate minoring in statistics. Lamkey is a research associate on the staff of the ISU corn breeding research project, active in data analysis, statistical consulting, and computer software. He came here in 1982 after completing B.S. and M.S. degrees in agronomy

at the University of Illinois-Urbana. In 1984 he was awarded the C. R. Weber Award of Excellence in Plant Science at ISU on the basis of scholarship and research publications.

The Bancroft award consists of a cash prize and a subscription to a statistically-oriented journal of the awardee's choice. It honors T. A. Bancroft, professor emeritus and former director and head of the Statistical Laboratory and the Department of Statistics.

Mu Sigma Rho



James E. Gentle

The annual lecture sponsored by Iowa Alpha chapter, Mu Sigma Rho statistics honor society, was presented by James E. Gentle, manager of Research and Design at IMSL, Inc., Houston, Texas. His talk, entitled "Monte Carlo methods in statistics," was preceded by the annual banquet and spring meeting of the Iowa-Alpha chapter. This year's attendance was considered one of the best in the chapter's history. Gentle was a faculty member in the statistical center here from 1974 to 1979, active in the statistical computing section, before he joined International Mathematical and Statistical Libraries.

Twenty-four new members were initiated into Mu Sigma Rho at a ceremony that followed the banquet: four undergraduates, nineteen graduate students, and staff member Toni Genalo. Officers elected for the 1985-86 academic year are Daniel Schnell, president; Kathleen Taylor, vice president; Susan McCann, secretary-treasurer. Robert Stephenson is the new faculty adviser.

The 1985 Mu Sigma Rho Award for academic excellence and service to the organization and the Department of Statistics was given to Michael Rogers.

Undergraduates

Undergraduates received a number of awards and recognitions during the year. Wendy Iverson and Susan McCann were chosen as members of Mu Sigma Rho at the annual banquet on April 16. Jean Wells received a Laura Vernon Scholarship at ceremonies during Veishea. At the Scholarship Recognition Dinner on April 23, Mary A. Dellva and Craig R. Kollman, both freshmen, were recognized as standing in the top 2 percent of their class by gradepoint. Eric Grau was recognized at the Scholarship Recognition Dinner on April 24 as the highest graduating senior in the curriculum of biometry by scholarship. He graduated in the university's honors program, after completing an honors project on the graphics option in SAS. A poster presentation of that project was given on April 24; project advisers were Donald Hotchkiss and Steven Jungst, associate professor of forestry.

Eight students received B.S. degrees in biometry or statistics during the period July 1, 1984 to June 30, 1985—five with majors in statistics, two with majors in biometry, and one with a joint major in statistics and computer science.

John William Ellingrod (Spring 1985, statistics) begins studies in actuarial science at Drake University in August.

Eric Anderson Grau (Spring 1985, biometry) is continuing in the graduate program in statistics at Iowa State.

Holly Jean Hoegh (Spring 1985, statistics)

Wendy Sue Iverson (Spring 1985, statistics) has accepted a job with Electronic Data Systems, starting as a systems analyst trainee in their Chicago, Illinois, offices in October.

Orrin Ewart A. Moses (Fall 1984, biometry), after working as statistical analyst in the university's Seed Testing Laboratory, returned to Guyana to accept a position in the newly organized National Agricultural Research Institute. He is located at the Central Agricultural Station, Mon Repos, East Coast, Demerara.

Somphone Rasavanh (Spring 1985, statistics) is taking a position as statistician in October with the Bureau of Mines, U.S. Department of Interior, in Washington, D.C.

Kwoklai Bonnie Shum-Ng (Summer 1984, statistics) is currently a graduate student in statistics at Iowa State.

Lay-Ying Song (Spring 1985, computer science and statistics) is moving to Fayetteville, Arkansas when her husband, Yu-Han Hou, completes his doctorate; she begins a graduate program in horticulture at the University of Arkansas on August 29.

Jay Meyer, a junior, is working during the summer 1985 with the U.S. Bureau of the Census in Washington, D.C. Also Jean Wells, a senior, is a statistical assistant for the summer with the Iowa Department of Public Safety in Des Moines.

Continuing as academic advisers for undergraduate students were Richard Groeneveld, Donald Hotchkiss, William Meeker, W. Robert Stephenson, and Shashikala Sukhatme.

Statistics Club

The Statistics Club was organized to promote interest among undergraduates in the field of statistics.

The 1984-85 academic year was a busy one for the club, with many events and several off-campus visitors. It opened with a barbecue in September, hosted by faculty member Donald Hotchkiss. There was an excellent turnout with a number of new statistics majors attending.

The meeting in October dealt with summer jobs. Holly Hoegh, club president, discussed her experiences at the Iowa State Commerce Commission in Des Moines. Eric Grau talked about his internship at Weyerhaeuser in Hot Springs, Arkansas. Grau spent the 1984 spring semester and part of the summer working for Weyerhaeuser. Both students discussed how they obtained their summer employment, and gave helpful suggestions.

During the winter months there were several visitors. Cathryn Dippo, in addition to conducting job interviews, spoke to the club in November about the Bureau of Labor Statistics in Washington, D.C. In January, a group of about 20 undergraduate statistics and mathematics majors heard Derek Guyton, an actuary with Allstate Insurance, discuss actuarial careers. Several of our graduating seniors attended a presentation on Quality Assurance Careers given by a representative of Pillsbury Foods in March.

The latter part of the spring semester was spent preparing for this year's Veishea Open House display. Visitors to "Take the Stat Challenge" could participate in a triangle taste test between Diet Coke and Diet Pepsi. Those who could discriminate between the two products were asked to state their preference. Besides the taste test, visitors could find out about what statisticians do and what job opportunities are available.

Elections were held in April. The 1985-86 officers are:

president: Jay Meyer
vice president: Jae McKeown
treasurer: Scott Groth
secretary: Julie Haubrich

Jean Wells is the recipient of a Laura Vernon Scholarship funded jointly by the Sciences and Humanities Council and the Statistics Club. Jay Meyer and Susan McCann will be co-recipients of the 1985-86 Statistics Club Scholarship. W. Robert Stephenson serves as faculty adviser to the club.

Seminars

During the fall of 1984 a Colloquium between Biologists and Mathematicians was held, organized jointly by Noel Cressie (Department of Statistics), William Ireland (Veterinary Anatomy), and Wolfgang Kliemann (Mathematics). The purpose was to bring together biologists, mathematicians, and statisticians for a discussion of mathematical and statistical modeling in biology. Ten speakers in all spoke on a variety of topics ranging from modeling Vitamin A kinetics to analyzing behavioral sequences of monkeys. The series included the following from the Statistical Laboratory:

November 15 The rules of evidence in experimental science, David F. Cox

The program of regular weekly noncredit seminars offered by the Statistical Laboratory and the Department of Statistics for the 1984-85 year was planned by Noel Cressie and Wayne Fuller. Topics and speakers follow.

Statistical Laboratory Seminars

Summer 1984

July 2 Admissibility in choosing between experiments, with applications, Reda Mazloum
3 Error rates for Poisson process discrimination, John Marcus Jobe
11 Two-stage James-Stein estimators, Malay Ghosh, University of Florida
13 Optimal stochastic paths, Robert J. Arnold
18 Constrained optimal designs, Carl Moun-Shen Lee
20 Applications of the distance between the posterior and prior distributions, Cindy Martin
30 Error-free computations in solution of linear systems and linear programming problems, Stephen Chang

Fall 1984

September 5 Earning a graduate degree in statistics, Dean L. Isaacson
12 A conjugate gradient algorithm for analysis of variance computations, Byung Chun Kim
19 Assigning probabilities to the outcomes of horse races or other multi-entry competitions, David A. Harville
26 Computational aspects of certain L_p-norm estimators, Vincent A. Sposito

October 3 Bootstrapping the mean in the infinite variance case, Krishna Athreya
10 Use of models in survey design—sampling in space and time, Ronaldo Iachan
17 Estimation for time series subject to the error of rotation sampling, Edina Miazaki
24 [See Special Lectures and Seminars]
31 Some properties of skewed distributions and the measurement of asymmetry, Richard A. Groeneveld

November 7 A biostatistician's role in the evaluation of coronary artery bypass surgery, Lloyd C. Fisher, Medical Research Statistics, Mayo Clinic (cosponsored by the Iowa chapter, American Statistical Association)
November 14 Tranformations and weighting in nonlinear regression, Raymond J. Carroll, Mathematics Research Center, University of Wisconsin-Madison (on leave from University of North Carolina at Chapel Hill)
28 Faculty responses to foreign student written errors, Frederick O. Lorenz

December 5 Changes in regime in regression models, John M. Irvine, Central Intelligence Agency, Washington, D.C.
12 Modeling with random sets, Noel A. C. Cressie

Spring 1985

January 16 Game theory—Rationale and rationality, Herbert T. David
23 Ordered sums, Herbert A. David
30 EPA recreational fresh water standards, Jerome M. Sacks

February 6 Improving the maximum likelihood estimator for the nonlinear functional relationship, Yasuo Amemiya
13 Incorporating a judge effect into the Bradley-Terry model for paired comparisons, Jan van Schaik

20 Latent structure analysis with generalized linear models, Mark Reiser

27 Selected short subjects from the Survey Section, Harold Baker, Toni Genalo, and Roy Hickman

March 6 A survival analysis package for the IBM-PC, Peter A. Lachenbruch, Department of Preventive Medicine and Environmental Health, University of Iowa

20 Sequential analysis with fixed sample size and variable follow-up, Peter Armitage, Department of Biomathematics, Oxford University, U.K.

27 Nearest-neighbor analysis, Paul N. Hinz

April 3 Recent research in adaptive robust estimation, Robert V. Hogg, Department of Statistics and Actuarial Science, University of Iowa

17 Methods for multidimensional scaling, James E. Gentle, IMSL, Inc., Houston, Texas

22 The use of variance component model methods for small area estimation, N. G. Narasimha Prasad, Department of Mathematics and Statistics, Carleton University, Ottawa, Canada

24 Smoothing approaches to the analysis of field experiments, Peter J. Green, Department of Mathematics, University of Durham, U.K., and Mathematics Research Center, University of Wisconsin-Madison

May 1 Design effects of two-stage sampling, Christopher J. Skinner, Department of Social Statistics, University of Southampton, U.K., and Mathematics Research Center, University of Wisconsin-Madison

2 The multivariate components of variance model for small area estimation, Wayne A. Fuller

6 Model identification and estimation in regression analysis of survey data, Danny Pfeffermann, Department of Statistics, The Hebrew University of Jerusalem, Israel, and Department of Biostatistics, University of North Carolina at Chapel Hill

8 The admissibility of some generalized and stepwise Bayes estimators, Byung Hwee Kim

15 n-Person simple games and n-component reliability structures, Byung Sul Park

Summer 1985

May 29 Maximum likelihood and classification: A comparison of three approaches, John A. Williamson, Department of Mathematics, University of Colorado [a paper by Peter G. Bryant and Williamson]

June 19 Some renewal theorems when the first moment is infinite, Kevin Anderson

26 Goodness-of-fit statistics for location-scale distributions, Fah Fatt Gan

Special Lectures and Seminars

October 24 10th George Zyskind Memorial Lecture: George Zyskind and statistical ideas he pursued, Oscar Kempthorne, Statistical Laboratory and Department of Statistics, Iowa State University

December 11 Joint Mathematics-Statistics Colloquium: On nonsingular renewal kernels with applications to transition kernel semigroups, Seppo Niemi, Department of Mathematics, University of Helsinki, and Department of Mathematics, University of Wisconsin-Madison

January 29 Mathematics Colloquium cosponsored by Department of Statistics: Fluctuations in multistage cancer models, Federico Marchetti, National Institutes of Health, U.S., and University of Rome, Italy

March 21 3rd George W. Snedecor Lecture: Student's soporifics revisited, Peter Armitage, Department of Biomathematics, Oxford University, U.K.

April 11 Interdisciplinary Lecture: Are you wasting your time: The future of technology in the Orient, Don Clausing, Xerox Corporation (sponsored by the American Society of Metals, Institute of Industrial Engineering, Society of Automotive Engineers, Society of Manufacturing Engineers, Engineers Week Committee, the departments of Statistics and Mechanical Engineering, the colleges of Engineering and Business Administration, the Graduate College, and the Committee on Lectures)

April 16 Mu Sigma Rho Lecture: Monte Carlo methods in statistics, James E. Gentle, IMSL, Inc., Houston, Texas

Graduate Student Seminar Series

September 14 Learning basic statistics: Through example, Donald K. Hotchkiss and W. Robert Stephenson

November 5 Election polls, Ronaldo Iachan

30 The role of the statistician in the pharmaceutical industry, Craig Beam, Abbott Laboratories, Abbott Park, Illinois

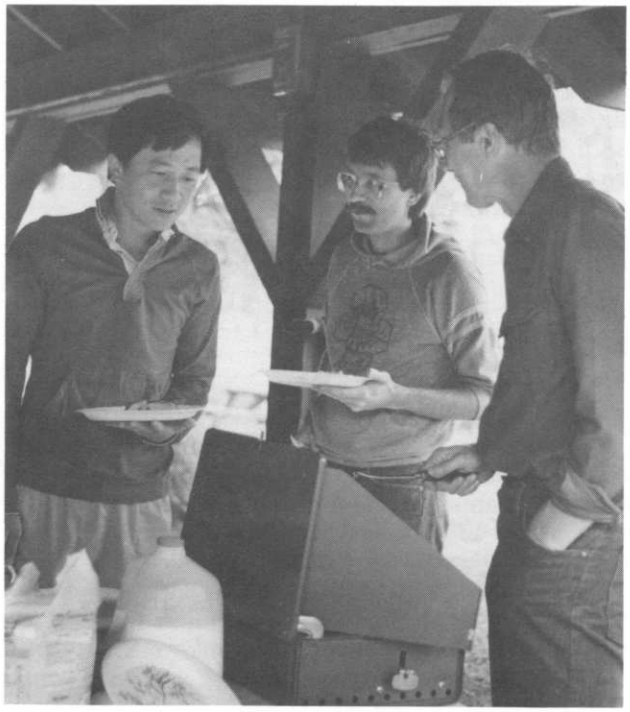
CAMADA Seminar Series

November 2 The design of an experiment to assess the effects of accent on comprehension, Kenneth J. Koehler

16 Measurement of fertility in male pigs, Terry Callanan

December 14 Variability of soil temperature observations, William M. Klittich, Department of Agronomy

February 19 Estimation of survival rates for animals fitted with radiotelemetry transmitters, Jim Kienzler, Iowa Conservation Commission



L to R: Thomas Tsung Hua Lin and Kevin Anderson wait for Paul Hinz to flip sourdough pancakes at the spring breakfast.

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