STATISTICAL LABORATORY

established 1933

annual report

July 1, 1988 to June 30, 1989

IOWA STATE UNIVERSITY, AMES

Contents

THE STATISTICAL LABORATORY
Iowa State University
1988-89 Annual Report

The Kempthorne Years: A Celebration

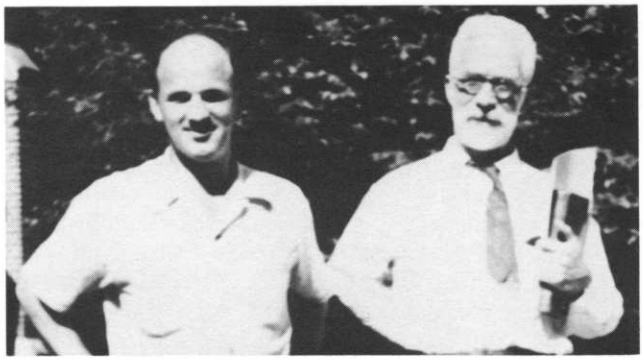
This issue of the annual report is dedicated to Oscar Kempthorne as tribute to his years of dedicated service to the statistical center at Iowa State and his continuing commitment to statistics. Last spring, his impending retirement and the related planning of a reception and conference in his honor, together with the collecting of materials for the historical portions of the American Statistical Association sesquicentennial videotape and annual meeting, made some of us especially thoughtful about Kempthorne's influence here and elsewhere.

As editor, I have drawn upon the photo archives and editor's files and the perceptive remarks made by H. A. David at the Kempthorne Conference last June. It is a pleasure to share some of this material with the former students, colleagues, and friends who were unable to attend the conference in person.

Oscar Kempthorne has been a leading figure in the endeavors at Iowa State for 42 ½ years. No other faculty member except George Snedecor has been identified with statistics here for that long a span of time. This is no trivial record. It covers the entire existence of the Department of Statistics and over three-fourths of the lifetimes of the Statistical Laboratory and the statistics department (originally section) of the Iowa Agriculture and Home Economics Experiment Station.

Kempthorne came to Iowa State in January 1947 after working for five years at Rothamsted Experimental Station in England under Frank Yates. He held B.A. and M.A. degrees in mathematics from Cambridge and was appointed research associate professor of mathematical statistics in the Statistical Laboratory and the Department of Mathematics (where the teaching in statistics was then concentrated). This filled a vacancy left by William G. Cochran.

Within Kempthorne's first year the Department of Statistics was established and he was deeply involved with its graduate program. Upon the departure of Alexander Mood and George Brown in 1948, he became the principal person actively directing graduate research in statistics; he was then 29 years old. Since that time, of course, the faculty and the program have grown; responsibilities can be more evenly shared. However, there was a period of years when he provided the essential direction. To date, 44 Ph.D. students have completed doctorates under him; 8 of these and 16 other students completed masters' programs under his guidance.



Oscar Kempthorne, already an admirer and critic of R. A. Fisher's work, met Fisher in 1951.

To quote H. A. David: "It is also clear that soon after his arrival, Kemp became immersed in the challenging demands for statistical advice made by a strong group of agricultural research workers. His vita shows quite a bit of joint research in those earlier years, and we know that joint papers are only the tip of the iceberg of consulting activities."

In 1951 Kempthorne was promoted to full professor. In 1952 he was elected a fellow of the American Association for the Advancement of Science, the American Statistical Association, and the Institute of Mathematical Statistics. His first major book, *The Design and Analysis of Experiments,* published in January, had been recognized immediately as outstanding. Also in 1952 he helped organize a 5 ½-week Biostatistics Conference cosponsored by the Biometric Society (ENAR), bringing together biologists, statisticians, and mathematicians and concluding with lectures by Sir Ronald A. Fisher. Proceedings of the conference, edited by Kempthorne, Theodore A. Bancroft, John W. Gowan, and Jay L. Lush, were published in 1954 as *Statistics and Mathematics in Biology,* and republished in 1964.

Another major book, *An Introduction to Genetic Statistics,* was published in 1957 (and republished in 1969). In 1960, Cambridge University conferred the Sc.D. degree on the basis of Kempthorne's research in the design of experiments and genetic statistics.

More books and honors followed. Kempthorne edited *Biometrical Genetics,* published in 1960 as the proceedings of a 1958 international symposium sponsored by the Biometric Society and the International Union of Biological Sciences. He served as president of the Biometric Society (ENAR) in 1961 and in 1964 was named Distinguished Professor of Sciences and Humanities by Iowa State University. He was senior author of *Probability, Statistics, and Data Analysis* (1971), written with J. Leroy Folks, a former student. In 1977 Kempthorne was awarded a faculty citation for long, outstanding and inspiring service in statistics and statistical genetics.

Kempthorne was one of the founders of Mu Sigma Rho, national statistics honorary. He was instrumental in planning and arranging the International Conference on Quantitative Genetics held in Ames in 1976 (*Proceedings,* edited by Edward Pollak, Kempthorne, and Theodore B. Bailey, Jr., 1977). This was followed by the 1979 NSF-supported Mathematical Sciences Regional Conference on Population Genet-

ics presenting John Kingman as lecturer.

During all these years Kempthorne continued to teach enthusiastically, carry through a number of contractual research and grant projects†, publish a variety of applied statistics articles, and work on his basic inquiries into statistical inference. He held short-term visiting professorships at Oklahoma State, the University of Buenos Aires, Stanford, the University of Washington, Florida State, and VPI, and lectured in India, Australia, Egypt, and Brazil. He also served as a consultant with the Veterans Hospital Radioisotope Unit in Iowa City, Iowa, in the early 1950s, with Dow Chemical Company and Marathon Oil Company in the early and mid-1960s, and with Hofmann LaRoche in the 1960s and 1970s.

In 1983 Kempthorne served on the program committee for the 50th Anniversary Conference of the Statistical Laboratory. In 1984, he was honored on the occasion of his 65th birthday by a Festschrift, edited by Klaus Hinkelmann at Virginia Polytechnic Institute & State University. In 1984-1985 Kempthorne was president of the Institute of Mathematical Statistics. He served as the defense's expert witness in statistical genetics in the *Shockley v. Witherspoon* trial in 1985.

H. A. David, in his address at the Kempthorne Conference last spring, made this comment on Kempthorne's more recent writings: "As all of us here know, with him it is not only what is being said but also how it is said that makes him such an interesting and quotable author. Typically he has tackled the big issues, critically reviewing the pertinent literature and throwing light on subjects still in a controversial state . . . Kemp has had the insight and the courage to make the general statement, to praise the work of others but not to hold back with criticism."

In 1987 Oscar Kempthorne wrote a paper, "Pipe Dreams?—The Future of the Stat Lab," to suggest to the faculty why they should be seriously considering expansion of the program at ISU and development of a national center of applied statistics. When he had cardiac bypass surgery in May, he had already cut back somewhat on his energetic workload through a phased retirement program.

In 1988 he was elected an honorary fellow of the Royal Statistical Society. In 1989 he addressed the Twelfth Midwest Biopharmaceutical Statistics Workshop on his life as a statistician and his reflections on the history of statistical inference and the need for work on problems of the real world.

Kemp is widely known to be a persistent, provocative, and inquiring individual, devoted to his field, the Statistical Laboratory, his colleagues, students, and family. We celebrate the career of this self-styled Cornish farm boy and the fact that he continues to probe for the roots of statistical inference, asks searching questions at seminars and faculty meetings, and takes on new explorations—such as learning the functionings of a Zenith 386 computer and SAS* in order to test some ideas he has.

† In the 1961-62 year he was principal investigator or coinvestigator on five coexistent National Science Foundation projects as well as a Wright Air Systems Development contractual project!

1947: Statistics faculty members (L to R) Paul G. Homeyer, Oscar Kempthorne, Raymond J. Jessen, and George W. Snedecor.

Kempthorne Conference

From Observation to Inference—A Conference in Honor of Oscar Kempthorne was held on June 23, 1989, in the Scheman Building, Iowa State University, by the Department of Statistics and the Statistical Laboratory.

After opening remarks by ISU Provost Milton D. Glick, the following talks were presented:

"Oscar Kempthorne: An Appreciation," by H. A. David, Department of Statistics, Iowa State University

"Maintenance of Quantitative Genetic Variation," by W. G. Hill, Institute of Animal Genetics, University of Edinburgh, Scotland

"Confidence Intervals for Variance Components," by Franklin A. Graybill, Department of Statistics, Colorado State University

"Bayesian Perturbation Diagnostics," by Seymour Geisser, School of Statistics, University of Minnesota

"Inferential Aspects of Sample Surveys," by J. N. K. Rao, Department of Statistics, Carleton University

Festivities began on Thursday evening, June 22, at 8:00 p.m. with a mixer in the Campanile Room, Memorial Union, and closed with a banquet in the Scheman Continuing Education Building at 6:00 p.m. on Friday evening, June 23. Dean Isaacson served as master of ceremonies for the banquet; Snedecorian Singers—Harold Baker, Herbert T. David, Roy Hickman, and Donald Hotchkiss, provided entertainment; and occasional remarks were delivered by Klaus Hinkelmann (VPI), Dewey Harris (USDA), J. Leroy Folks (Oklahoma State), Arne W. Nordskog (Iowa State), and R. L. Willham (Iowa State), representing Oscar Kempthorne's doctoral students in statistics and colleagues from the agricultural sciences. A small historical exhibit of photos and books was on display.

Photos on p. 3 are identified in the back of the annual report.

A few copies of *Oscar Kempthorne—The Record 1947-1989* are still available to interested people.


IOWA STATE
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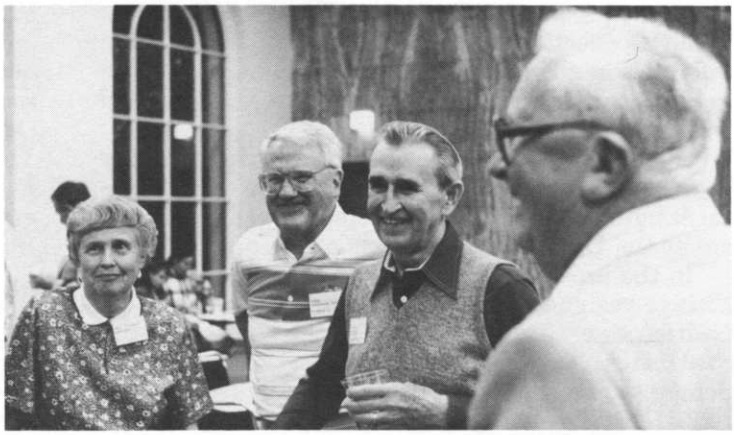
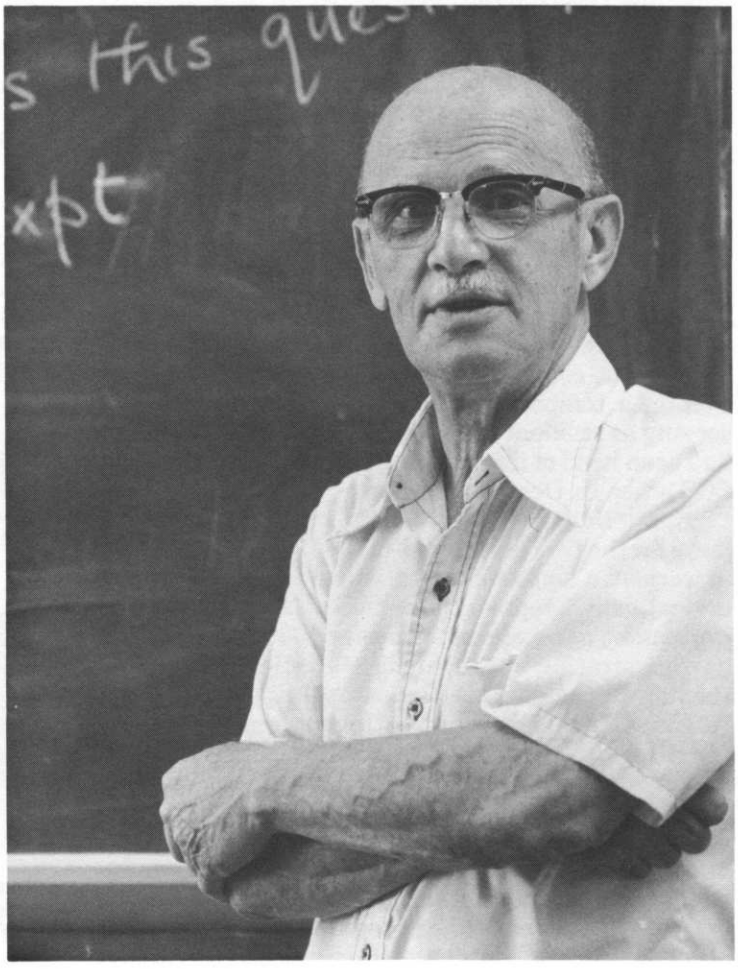
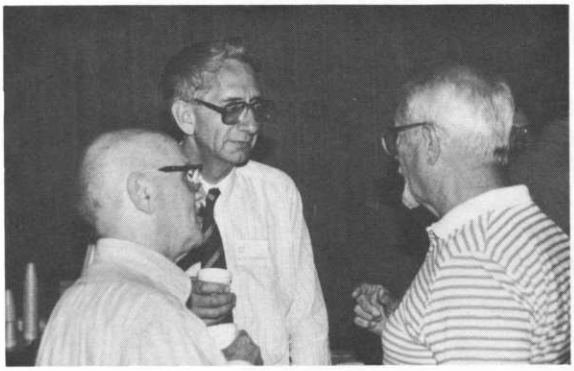






Personnel

Oscar Kempthorne completed phased retirement on June 30, 1989, after 42 years at Iowa State; he was appointed Emeritus Professor of Statistics and Distinguished Emeritus Professor of Sciences and Humanities effective July 1, 1989. (See pp. 1-2 for more information about his career.) He will keep his office in Snedecor Hall and plans to continue research and writing.

John Stufken was appointed assistant professor beginning August 21, 1988, in the area of experimental design and linear methods. He received his doctorate at the University of Illinois at Chicago.

In the area of survey sampling and design, John Eltinge resigned as of August 15, 1988, to accept a position as assistant professor in the Department of Statistics, Texas A&M University. Debapriya Sengupta was appointed, beginning August 21, 1988, to fill Eltinge's regular tenure track position. Sengupta received his doctorate at the University of North Carolina-Chapel Hill in fall 1988.

Visiting assistant professor Stephen Haslett took leave without pay to return to the Institute of Statistics and Operations Research, Victoria University of Wellington, New Zealand, in November 1988 to assume responsibilities as research statistician and lecturer. He has accepted a tenure- track appointment to fill a vacancy in the Survey Section left by Mark Reiser and will return to ISU when a visa number is available.

Arthur D. Kuhl, resident collaborator for the U.S. Soil Conservation Service, retired from SCS in December but continues to work with the Survey Section on a temporary basis. Dean Thompson began serving as resident collaborator on April 10, 1989. He had been head of the data processing staff in the state SCS office in Des Moines, Iowa.

Kenneth J. Koehler was on faculty improvement leave for the first six months of the 1988-89 fiscal year to work on a textbook on statistical methods for categorical data. Stephen Vardeman was on faculty improvement leave spring semester 1989 to work on a new-generation engineering statistics text and do reading in the engineering control literature.

Chen Zhao-Guo was a visiting professor from February 8 to March 5, 1989, to collaborate with faculty in the areas of time series and spatial analysis and stochastic process. He was on leave from the position of professor and director of the Division of Probability and Statistics, Institute of Applied Mathematics, Academia Sinica, Beijing, People's Republic of China.

Noel A. C. Cressie was recognized as a new Fellow of the Institute of Mathematical Statistics on August 17, 1988, during the annual meeting at Fort Collins, Colorado. He was cited "for significant contributions to the theory and application of statistics, in particular, spatial statistics and goodness-of-fit testing."

Stephen Vardeman was named a new Fellow of the American Statistical Association for 1988 at the joint statistical meetings in August in New Orleans. He was cited "for major contributions to the theory of compound decision processes, for important research in the use of statistics for improvement of quality and productivity, for exemplary teaching, and for outstanding editorial services."

William Q. Meeker, Jr., received the 1988 Wilcoxon Prize for the best practical applications paper in *Technometrics,* awarded by the Chemical & Process Industries Division of the American Society for Quality Control. Presentation of the $500 cash award and an engraved certificate was made at the society's 32nd Annual Fall Technical Conference held October 20-21, 1988, in East Rutherford, New Jersey. The prize-winning paper is Meeker's "Limited Failure Population Life Tests: Application to Integrated Circuit Reliability," published in February 1987.

Kathleen Shelley was honored by Zenith Data Systems as a first-place winner in its Masters of Innovation Contest. She placed first in the business category of the national competition by entering information management system software developed at Iowa State to support the Iowa Small Business Development Centers and their administrative office (see p. 9). Shelley won a $5,000 computer hardware and software package for her personal use and a $5,000 package for the Statistical Numerical Analysis Section. The award presentation took place at a special banquet held by Zenith in Chicago in late April.

Edward Pollak was on leave from December 17, 1988, through January 20, 1989 to serve as a United Nations Development Program expert funded by the Food and Agriculture Organization. The statistical genetics consultancy assignment was carried out at the Indian Agricultural Statistics Research Institute, New Delhi, India, except for a two-day period at FAO headquarters in Rome, Italy.

At a farewell reception, Avonelle Hefflefinger receives a plaque and a gift from Dean Isaacson in appreciation for her service as the statistical center's administrative assistant.

Glen Meeden was on leave from January 15 to July 14, 1989 to serve as a research fellow of the American Statistical Association. He was stationed at the Bureau of Labor Statistics, Washington, D.C., to take part in an on-site research program to improve the quality of labor statistics. He has accepted a position at the University of Minnesota to begin September 1989. Soumendra Nath Lahiri has accepted an assistant professorship to fill the position left vacant by Meeden. Lahiri completed work for his doctorate in statistics at Michigan State University in summer 1989.

Deborah Reed-Margetan was promoted from programmer II to analyst III in the Survey Section in October 1988. Avonelle Hefflefinger went on medical disability leave in April 1989. She has been employed at Iowa State since 1960 and has been on the Statistical Laboratory staff since 1963. Edith Landin was appointed as administrative assistant beginning June 15.

Looking toward next year: Stephen Haslett and W. Robert Stephenson have been promoted to associate professor. Stephenson and Mack Shelley will be on faculty improvement leave. Stephenson will be teaching and consulting on quality control problems at the University of Newcastle, New South Wales, Australia, for the 1989-90 academic year. Shelley will work in Ames and Washington, D.C., fall semester to extend his earlier work on congressional influences on public policy.

Statistical Laboratory Staff—Fiscal Year 1988-89 under the administrative direction of:

Gordon P. Eaton, Ph.D.—president of the university

Norman L. Jacobson, Ph.D.—associate provost for research; dean of the Graduate College

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

David G. Topel, Ph.D.—dean, College of Agriculture; director, Iowa Agriculture and Home Economics Experiment Station

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

Professors

Krishna B. Athreya, joint appointment with Department of Mathematics
Theodore B. Bailey, Jr.
Chen Zhao-Guo, visiting
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
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
Kenneth J. Koehler
Glen D. Meeden
William Q. Meeker, Jr.
Edward Pollak, joint appointment with Department of Genetics
Jerome M. Sacks, USDA collaborator
Vincent A. Sposito, joint appointment with Computation Center
Robert F. Strahan, joint appointment with Department of Psychology
Norman V. Strand, professor emeritus
Stephen B. Vardeman, joint appointment with Department of Industrial Engineering
H. Samuel Wieand, Mayo Clinic collaborator
Leroy Wolins, joint appointment with Department of Psychology

Associate Professors

Yasuo Amemiya
Frederick O. Lorenz, joint appointment with Department of Sociology and Anthropology
Mervyn G. Marasinghe
Mack C. Shelley II, joint appointment with Department of Political Science
Shashikala Sukhatme

Assistant Professors

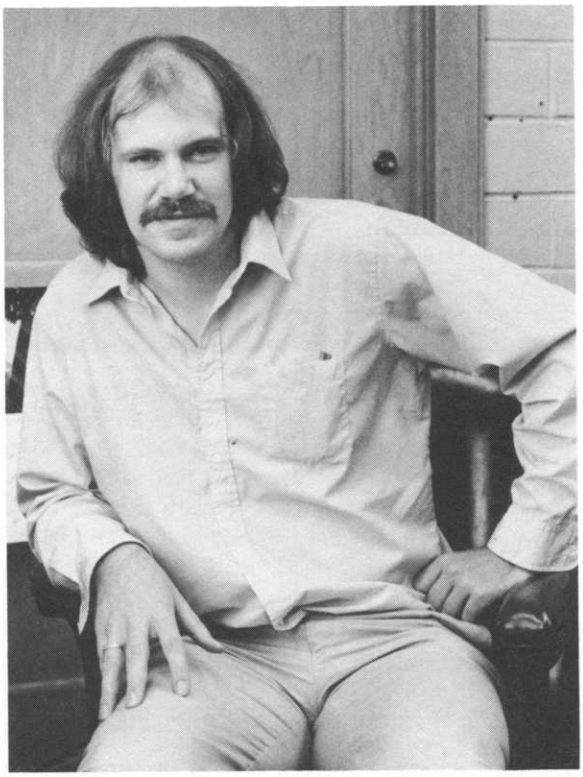
Harold D. Baker
John L. Eltinge
Stephen J. Haslett
Carl W. Roberts, joint appointment with Department of Sociology and Anthropology
Debapriya Sengupta
W. Robert Stephenson
John Stufken

Resident Collaborator

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

Visiting Research Scholar

Kwang-Hun Kim
Xiu-chi Wang



John Stufken has joined the faculty to work in the areas of experimental design and linear models.

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.

Scott Andersen (Shell Oil scholar)
Douglas Andrews
Craig Beam
Jonathan Biele
Linda Brands
Michael R. Carley
Alicia Carriquiry
Carl Castrogiovanni
Man-Lai Alice Cheng
Barbara A. Chisolm
Marie A. Coffin
Joseph Croos
Sheri L. Cutler
Mary Anne Dellva (Corning Glass scholar)
Clarice Freire
Chen-Der Fuh
Eiichiro Funo
Carol A. Gotway (Shell Oil fellow)
Martín Grondona
Renkuan Guo
Jeffrey Helterbrand (Shell Oil scholar)
Amy L. Hewitt (Corning Glass scholar)
Jeffrey D. Hofer (Corning Glass scholar)
Patrick Homblé
Chong Sun Hong
Frederick Hulting
Philip W. Iversen
Karen Jensen (Shell Oil fellow)
Song-Ho Kim
John P. Lagus
Klaus Lemke
Seung-Chun Li
Chiou-Hua Lin
Brian Lindstrom (Procter & Gamble scholar)
Jingyu Liu
Cynthia Long
Chi-hsien Joseph Lu
Stella Chueck-wah Luk
Michael J. Marcketti
David G. McDonald
Jae P. McKeown
Frederick Medak
Carol A. Meeter
Daniel Mundfrom
Nuwan Nanayakkara
Hamid R. Navvabpour
Daniel R. Newman
(Corning Glass scholar)
Heon Jin Park
Robert L. Parker (Corning Glass scholar)
Dwayne Pepper
Amanda Prestwor
Stephen L. Rathbun
James Robison-Cox (Dow Chemical scholar)
Ann C. Russey (Shell Oil scholar)
Todd M. Sanger (National Science Foundation fellow)
Sahadeb Sarkar
Mary E. Sayler
Darrell Schroeder
Hussein Shamsuddin
Dongwan Shin
David Steenhard
Gary R. Sullivan
Nae Kyung Sung
Wendy J. Swanson
James T. Symanowski
Teresa A. Takle
Brian L. Teasley
Margot Tollefson
Scott Vander Wiel
Anand Vidyashankar
Chung-Ching Morgan Wang
Kui-Jang William Wang
Steven R. Wilmarth
Rahmat Zakaria
Alan Zimmermann (Shell Oil scholar)

Supported Graduate Students

Abdoulaye Adam—USAID-Niger
Maria Theresa Agatep—USAID, PIET
Ahmad M. A. Al-Mahmoud—Yarmouk University, Jordan
Munther Ali Al-Zaid—Kingdom of Saudi Arabia
Victor P. Brescia—National Institute of Agricultural Technology, Argentina
Mark F. Bryan—Department of Entomology, ISU, and U.S. Bureau of Labor Statistics
Paula Lasack Davis—Department of Entomology, ISU
Djamal—Republic of Indonesia
Abdullah Fagih—Kingdom of Saudi Arabia
Fredolin Tangang @ Tajudin Mahmud—National University of Malaysia
Christian Garrigoux—Instituto Tecnologico y de Estudios Superiores de Monterrey, Mexico
Joel D. Halvorson—College of Business Administration, ISU
Stanley Hoge—U.S. Department of Agriculture
Ihsan Karabulut—Gazi University, Turkey
Abdul Majid Khan—USAID-Pakistan
Alice S. Lay—College of Business Administration, ISU
Sueli A. Mingoti—Federal University of Minas Gerais and CAPES, Government of Brazil
Yvon Nininahazwe—USAID-Burundi
Sarah M. Nusser—Center for Agricultural and Rural Development, ISU
Peter Peterka—Engineering Research Institute, ISU
Sallem Remadi—USAID-Tunisia
Muhamad Sabran—Government of Indonesia
Astini Salihima—MUCIA-AID-Indonesia
Theresa L. Scheetz—Department of Mathematics, ISU
Chii-Jyh Michael Shyu—Department of Child Development, ISU
Blake A. Smith—Department of Mathematics, ISU
Kai-One Sriplung—Center for Agricultural and Rural Development, ISU
Suharno—MUCIA-AID-Indonesia

Ibrahim Talib—Kingdom of Saudi Arabia
Muhammad A. Tiro—MUCIA-AID-Indonesia
Jay Ver Hoef—Department of Botany, ISU
Mark A. Wellman—Department of Industrial Engineering, ISU
Ann Weltevreden—Veterinary Medicine Research Institute, ISU
Abera Wouhib—UN Food and Agriculture Organization
Ching Ching Yang—Department of Child Development, ISU
Ibrahim S. Yansaneh—AFGRAD-USAID
Seongmo Yoo—Electronics & Telecommunications Research Institute, Chung Nam, Korea

Self-Supporting Graduate Students

Chao-Yin Chen
Ching-Ju Diane Chen
Shih-Neng Chen
Yu-Ming Chen
Jia-Chyi Chiu
Tae-Kyoung Cho
B. Keith Cranford (in absentia)
Shiow-Lan Gau (in absentia)
Richard Griffiths
Geun Shik Han
Mu-Yeh Huang
Taekyu Hwang
Seoung-Gon Ko
Bojein Kuo
Kye-Don Lee
Kyung Hee Ghang Lee
Ming-Yu Lee
Yung-Seop Lee
Chia-Lin Li
I-Ming Liu
Dze-Hwei Lyan
Pamela Marsh
Todd E. Melander
Dennis J. Murphy
Chongsun Park
Kwan Soo Park
Sangun Park
Pei-Ying Sun
Steven J. Wall
Shu-Chia Joanna Wang
Susan Wettstein
Shu-Yuan Yen
Yunn-Hwu Yu

Professional and Scientific Staff

Dianne G. Anderson, research associate, Survey Section
Marvin S. Beck, programming consultant, Survey Section, joint appointment with Computation Center
Lee Chu, research assistant, Survey Section
Richard Dorsch, programming consultant, Survey Section
Mary Genalo, research associate, Survey Section
Avonelle Hefflefinger, administrative assistant
Edith Landin, administrative assistant, beginning June 15, 1989
Bud Meador, supervisor, Statistical Data Processing Services
Deborah Reed-Margetan, programmer-analyst, Survey Section
Janet L. Schultz, programmer, Survey Section
Kathleen Shelley, specialist, Statistical Numerical Analysis Services
Melissa J. Swanson, programmer, Survey Section
Harvey Terpstra, data systems manager, Survey Section
Douglas L. Tschopp, programmer, Survey Section
Jauvanta Walker, information specialist

General Office Staff

Rose Ann Anderson, secretary
Norma Elwick, secretary
Janice Franklin, account specialist
Brenda Hewitt, clerk typist
Jeanette La Grange, clerk typist
Denise Riker, secretary
Sharon Shephard, clerk typist
Margaret Wheelock, clerk typist
Darlene Wicks, clerk typist, Statistical Numerical Analysis and Data Processing Section
Laura Yeager, secretary, until August 11, 1988

Survey Section Office Staff

Glenda Ashley, key entry operator
Lee Chu, research assistant
Dorothy Edwards, statistical clerk
Carol Egger, survey clerk
Sharon Erbach, survey clerk
Vimlesh Gupta, key entry operator
Nancy Heathman, account clerk
Helen Nelson, secretary
Christine Olson, clerk typist
Kathie Reinertson, data technician
Jasmine Seagrave, data technician
Susan E. Verkade, data technician
Karon White, key entry operator

Survey Section Field Interviewers

Kathryn Bottorff
Carol Bowers
Pamela Brower
Norma Carey
Kathryn Goodwin
Marlys Huff
Bonnie Kardell
Jan Larson
Eleanor Lee
Carolyn Millard
Robinette Morrow
Sue Norman
Mary Rathbone
Barbara Ristau
Clarice Rossow
Charlotte Struble
Miriam Troyer

Craig Beam confers with a student on a problem from Stat. 101. Beam and Nuwan Nanayakkara received Graduate College Teaching Excellence Awards in May for their teaching of undergraduates.

Consulting and Cooperative Research

Statistical consulting and research services are provided to the rest of the university and to local, state, and federal agencies as time and funds permit. Some of this work is supported by contracts and grants.

Agriculture and Home Economics Experiment Station

The Iowa Agriculture and Home Economics Experiment Station and the College of Veterinary Medicine support statistical consulting services for many staff members and graduate students in the biological, agricultural, and health sciences. The core statistical consulting staff in these areas consists of T. B. Bailey, D. F. Cox, Paul Hinz, and D. K. Hotchkiss, who were assisted this year by graduate students Mary Anne Dellva, John Lagus, Mary Sayler, Jim Symanowski, and Ann Weltevreden. Other members of the statistical center interact with the consulting group and, as needed, consult with experiment station researchers.

The consulting work has always been influenced greatly by the computational power available to the users and the consultants. The nature of the work has changed as users have acquired their own personal computers with capabilities of handling systems like SAS*. Historically, consultants necessarily directed or did considerable computational work. Recently it has become much more a case of discussing what computations might be done and leaving that work for the clients, since they have the computers and the expertise. These developments do not mean that statistical consulting has become obsolete, but that the protocols have changed. The need for sound teaching in statistical methods has never been more important, since the chance we once had to correct misunderstandings at the time of consulting on a research project may not now occur.

Research on methods of sustainable agriculture is presenting new challenges to the consulting staff. Sustainable agriculture can be described as farming practices that minimize soil erosion and chemical inputs. The idea is to blend together the 19th century practices of crop rotation and natural fertilizers with modern machinery and technology to minimize environmental damage due to farming. Research problems involve questions of the long-term effects of crop rotations on productivity, tillage practices on soil tilth, and herbicides and pesticides on weed and insect control.

Appropriate experimental designs are critical because of the long-term nature of the experiments. When the experiments are conducted at research centers such as the new Leopold Center, adequate replication should be possible. However, many experiments will be done by cooperating farmers where resources are limited, and choices will have to be made between the use of a few treatments that are replicated or the use of only one replication of a larger number of treatments. Data from such experiments present interesting analysis problems because the responses are multivariate in nature. The challenge is to describe the simultaneous changes taking place in the soil, weeds, insects, and crops, in order to understand the ecology of the cropping systems.

The statistics research assistants supported by the experiment station have helped the climatologists in agronomy continue their studies on summer rainfall patterns in Iowa. Rainfall data from each of Iowa's 99 counties for the last 50 years in the months of June, July, and August have been assembled. The first task was basic data processing to get the 15,000 records into a form amenable to statistical analysis. Iowa summer rains occur in small intense storms that are relatively short-lived, and the amounts of rain form a highly skewed distribution with a few very heavy rains and many very light showers. Statistical considerations in summarizing these data have included choices of statistics; for example, median rather than mean rainfall is more helpful in some summaries. More difficult problems are those related to finding if there are detectable patterns in the distribution of rain over the state, other than the well established west-to-east gradient.

Dave Cox encountered several investigators inquiring about combining experiments done in different years and at different locations. The problem is not new, but still many uncertainties remain. Heterogeneous experimental error seems the rule rather than the exception, and substantial location or year by treatment interaction is almost always present.

Ted Bailey consulted extensively with a plant pathologist concerning an experiment that presented special problems relative to the laying out of the treatments and the analysis of results. The purpose of this study on the biological control of stalk rot of corn was to determine whether grain yield is an effective trait for detecting interactions between selected mycopathogenic fungi and corn genotypes and whether application of mycopathogens to the corn phylloplane had an effect on yield.

A split-split plot design was used, with the whole plot factor representing one of three soil cultural histories. The four mycopathogen treatments were applied to split plots, which were arranged in a Latin square design. The double blocking was used to reduce possible effects of either soil texture and/or spray drift of the mycopathogen treatments. Each split plot was divided into sixteen split-split plots to which genotypes were randomly assigned.

The analysis was completed for each Latin square separately and then combined over squares. Variation of yield of the inbreds indicated significant interactions (statistical) with mycopathogen treatments, but differences among hybrids were not affected.

Bailey also consulted on an analysis of data using restriction fragment length polymorphisms and phenotypic markers to map a genome of a fungus that is the causal agent of southern leaf blight of maize. A major goal of the study is to understand mechanisms of plant pathogenesis.

C. P. Cox and Edward Pollak provided assistance to a graduate student in the Department of Agronomy. The student posed the problem of calculating what family size is large enough so that, if there are two possible sets of underlying frequencies of K types of offspring of a cross, the probabilities of the two kinds of misclassification are each 0.025.

Cox and Pollak developed a procedure for calculating the minimum sample size necessary to have specified low probabilities of incorrectly classifying sample proportions as coming from one of two possible sets of population proportions. This applies to populations with any number of types and generalizes a procedure that has long been known when each of two possible parent populations have two observable types of individuals. The generalized method is widely applicable to problems in both cytogenetics and molecular genetics.

David Harville, under AES Project 101, consulted with various faculty members in the Department of Animal Science, and with their graduate students, concerning the statistical aspects of animal breeding. One topic of consultation was the computation of the standard errors of the estimators or predictors obtained from a mixed-model analysis. It was found that their computation could be facilitated by using a result given by Harville [*Journal of the American Statistical Association,* 74:365 (1979) 200-206].

Statistical Numerical Analysis and Data Processing Section

The Statistical Numerical Analysis and Data Processing Section of the Statistical Laboratory provides statistical computer programming and data processing support for research projects conducted both on and off campus. The section develops software for special applications, designs and installs databases for general use, maintains general-purpose software systems, and consults on problems related to scientific applications of digital computers. Teaching and research activities for the section are led by William J. Kennedy, Vincent Sposito, and Mervyn Marasinghe, and are reported elsewhere in this annual report.

Kathy Shelley received a first place award from Zenith Corporation in the Zenith Data Systems Masters of Innovation Competition. This competition is designed to encourage personal computer use in university settings by rewarding university achievements using PCs for innovative applications. First, second, and third place prizes were awarded in two categories, faculty/staff and student, in each of several application areas.

Shelley's entry was chosen from more than 850 entries. Her prize was a Zenith Data Systems computer for her personal use and an identical computer system for the section, given to the university in her name. Additionally, she received an expenses-paid weekend in Chicago, Illinois, to attend the awards banquet.

Shelley's prize-winning software package, submitted in the application area of business, was produced with help from graduate students Mike Carley and Morgan Wang. It is an information management system designed to support the Iowa Small Business Development Centers (SBDC) and their administrative office, which is on campus. The overall systems design employs relational database management, statistical graphics, and remote PC communications and debug support for the 12 regional SBDC offices in Iowa. The system integrates hardware and software to manage and display client consultant information.

The following reports of activities summarize the work of groups supervised by Bud Meador and Kathy Shelley in 1988-89.

Graduate students in the Statistical Data Processing Group supervised by Meador worked on four continuing projects. Three of these involve mainframe-to-PC transfer problems for applied projects. The other, namely PC/SAS*, involved personal computers only.

New technology, equipment, and client-developer experience are factors that expand the scope of many projects and did so in the State Forest Nursery project. Transfer of previously developed software from mainframe to PC was completed. The introduction of bar code labels, scanners, and printers into the field operations for harvesting, bagging, storage, and shipping of seedlings created a need for additional software development and database support related to tree orders, inventory control, and other components of the nursery database system. This project also afforded an opportunity for the section to produce county maps, graphs, and charts as an extension of data analysis and data presentation techniques. Dave McDonald and Phil Iversen worked on the state nursery project.

Work continued on the mainframe-to-PC transition phase of a project for the ISU Center for Industrial Research and Service (CIRAS). This involves (1) continuing the historic mainframe operations and transferring dynamic or current data from the mainframe to the PC, and (2) developing PC software to effect comparable database support. The project also reflects the benefits of technology and experience and is not necessarily one-to-one in the conversion. Klaus Lemke handled most of the PC components. Interchange of dBASE DBF files and SAS* Datasets facilitated database maintenance and data analysis aspects of the project.

The Iowa Corn Yield project, a "permanent party" application on the university's mainframe computer, was expanded to include a metric protein-and-oil

grain attribute that is currently an item of interest in the marketing of grain. Downloading of summary data to a PC and the use of PC-resident word processing and printing facilities and diskette data files now provide extensions that make information more readily available to interested persons. Dave Steenhard worked on this project. In addition, he served as the primary section representative distributing PC/SAS* software to the university community.

The scope of nonuniversity or offcampus work decreased somewhat from previous years, particularly the portion done for various corn and soybean seed producers. However, Klaus Lemke spent considerable effort on a database system that helps the White Laundry Industries improve their purchasing and product-delivery performance.

Kathy Shelley supervises the second computer support group within the section. Work during the 1988-89 year fell into the following categories: (1) departmental PC hardware and software support, (2) analysis of survey data, (3) presentation graphics and training, (4) development and maintenance of data bases, and (5) other PC data analysis projects.

Mike Carley and Mervyn Marasinghe customized Wordperfect™ 5.0 for scientific word processing for the Department of Statistics secretarial staff. Macros were written to enable the typing of equations with a minimum of keystrokes. Darlene Wicks tested all macros and laser printing setups before general installation, and Carley provided extensive debug support. Alan Zimmermann, Mike Carley, and Kathy Shelley worked on a database mailing label program that many of the statistics secretaries are using with their laserjet printers. This was programmed in dBaseIII.

All of the group fielded questions about personal computing for departmental members. They set up new machines with statistical and graphical software, delivered machines for repair, and provided ongoing support.

Data from a variety of surveys were analyzed using SAS*, mostly for CIRAS, the College of Family and Consumer Sciences, and departments of Architecture, Professional Studies in Education, Economics, Political Science, and Industrial Education. Alan Zimmermann worked on a survey of international women who are ISU alumni. He also generated color graph transparencies for a CIRAS survey of Iowa manufacturers. PC/SAS* and Harvard Graphics were used for these surveys. Zimmermann worked with Mack Shelley on a survey to ascertain training competencies and effectiveness. Kathy Shelley, Zimmermann, and Mack Shelley worked on two separate surveys for the Department of Architecture to analyze use and perceptions of the Memorial Union and determine resident attitudes in retirement communities. Both studies looked at the effect of the architecture on user perceptions. Graphs included 35mm slide shows generated from Harvard Graphics.

For a researcher in industrial education, Mike Carley analyzed data and produced a 35mm slide show examining the use of child restraints in vehicles in several Iowa cities. The slide show was presented to a meeting of highway patrolmen by the researcher. Carley also analyzed data and produced graphics for a study examining state rural economic development measures.

A SAS*/GRAPH short course was given by Kathy Shelley both semesters in the ISU Computation Center. Training in Harvard Graphics was given on a less formal basis to people in statistics, plant pathology, corn breeding, and CIRAS, with emphasis on the production of 35mm colored slides using the ISU Photo Service's Matrix QCR film recorder. High quality color output in both hard copy and transparencies can now be obtained using a Hewlett Packard Paint Jet printer. PC/SAS*, Harvard Graphics, and Wordperfect™ send output to this printer.

Morgan Wang continued to provide graphics support for the section and the department. He refined the Iowa map for the Small Business Development Centers and created a 3,000-county U.S. map for the Survey Section. Later in the year, he ported these two applications to the 386-based PCs. The process of producing these graphs now takes half the time it did when the mainframe was used.

Continuous database development and documentation were done for the SBDC administrative office, using dBaseIII, which connects directly with PC/SAS*. This project began over three years ago. Wang and Shelley provided programming and training support to Holthaus & Associates for easier reporting of their dBaseIII database using Harvard Graphics and Professional File software.

Mike Carley created a database using dBaseIV for the State Forest Nursery, with report generation performed in either dBase or PC/SAS*. He also set up PC communications using Carbon Copy software for file transfers and remote debug support.

Two other major projects include a PC/SAS* windowing program to analyze experimental data from different genotypes of corn and continued support for a herbicide research program, which includes data management, analysis, and production of reports. Zimmermann and Carley developed a user interface using PC/SAS* windows to simplify genotype analysis. Zimmermann also developed keystroke macros in Harvard Graphics to facilitate graph production. Carley provided extensive support for the herbicide project to reduce the time necessary to produce final reports. Previously these were produced page by page using a word processor. Reports are now written in PC/SAS*.

V. A. Sposito assisted various on-campus researchers in using IBM's Mathematical Programming System. Their projects involved the use of special procedures, developed by Sposito, to solve problems with multiple objective functions using a compromise approach. Some of these procedures are based on incorporating the criterion of minimizing the sum of absolute deviations between the objectives formulated in the models. One project involved a large-scale national agricultural model, for the Center for Agricultural and Rural Development, that was formulated with three objective functions, 9,100 constraints, and 131,000 real variables.

Survey Section

The Survey Section of the Statistical Laboratory, under the direction of Roy D. Hickman, provides consultation and direct operational assistance to research workers in sample design and the planning and execution of sample surveys and censuses. Section staff engage in all areas pertaining to the operational conduct of surveys. Professional staff members also conduct research and teach courses in the areas of sampling, survey design, and statistical methods.

The section completed the first wave of data collection for two longitudinal studies of rural Iowa families. The section is collaborating with the departments of Family Environment, Sociology and Anthropology, and Child Development in these studies.

The first project combined research supported by the National Institute of Drug and Alcohol Abuse, the National Institute of Mental Health, and the U.S. Bureau of Maternal and Child Health. The major objectives of the study are to assess the resilience of families to economic stress, to identify the nature, origins, and consequences of the conceptions of parenting, and to investigate the impact of economic stress on emotional and behavioral functioning of parents and adolescents. In each family, both parents and two of their natural children (one of whom must be a seventh grader) are participating in a multifaceted interviewing approach. Personal interviews, audiotaping, self-administered questionnaires, and videotaping of family discussions are being used to meet several research objectives.

Section staff contacted 800 families in eight central Iowa counties, determined eligibility, and recruited 76 percent of all eligible families. During the first of four waves, 451 families were interviewed by section staff, and the data were coded and entered for summary and analysis. The next wave of the study will begin in December 1989.

The objective of the second study, funded by the National Institute of Mental Health, is to assess differences between farm and nonfarm adolescents as they make the transition from elementary to secondary school. Economic hardships and their possible impact on children's coping and adjustment patterns are being evaluated. A total of 398 families, each with a sixth or eighth grader who will be making a school transition, were interviewed. Section staff selected the sample from all eligible schools in Iowa, contacted families to determine eligibility and willingness to participate, and interviewed 86 percent of those eligible. Section staff also coded and entered all data. The second of three waves of data collection from these families will begin in October 1989.

The Survey Section collaborated with nine U.S. universities on a national study of persons who have income-generating operations in their homes. The study will investigate the effects of working from the home upon members of the household. Out of 18,956 households that were screened to determine eligibility, 1,032 households had a worker who met the criterion for the study. The "household manager" was interviewed in 87 percent of these households. The Survey Section staff designed the sample, developed the questionnaire and related forms, conducted the telephone screening and interviews, and is currently coding and entering all data.

Work continues on a three-year study, supported by the National Center for Child Abuse and Neglect, designed to investigate child abuse. Funding has been approved for section staff to interview general population controls in order to compare nonabusers with abusers. Section involvement has included assistance with developing methodology and all field forms, selection of age and sex matched controls, interviewing of all cases and controls, and coding and data entry.

Harold Baker, Wayne Fuller, Roy Hickman, and Debapriya Sengupta are participating in the design and implementation of a national animal health study, cooperating with the National Agricultural Statistics Service and the Animal and Plant Health Inspection Service (USDA). The first phase of the study involves a national sample of swine producers who will maintain records of animal disease and health incidents. Fuller and Sengupta traveled to Fort Collins, Colorado, October 31 to November 1, 1988, to assist with the sample design, data collection, and estimation aspects of the study.

Iowa farm owners and operators from four watersheds that feed into the Red Rock Reservoir are being interviewed by telephone for ISU sociology faculty members. The study is designed to determine farmers' awareness of siltation problems, their use of conservation practices, and the impact of erosion on the reservoir. Section personnel designed the sample, contacted all respondents, and are conducting 15-minute telephone interviews with 400 owners and operators. The staff will be responsible for coding and data entry.

A survey of Iowa State University faculty was carried out to estimate the average number of hours worked per week by faculty members during the 1988-89 academic year. Altogether, 240 faculty were selected to participate. Ten of these were assigned at random to each of 24 "normal" weeks during the period. At the end of a week, the 10 sample subjects received questionnaires asking them to report their hours worked during that week. In addition to the sample selection, the Survey Section was responsible for the data collection, data processing, and analysis. This survey, the third in a series of indeterminate length, was carried out for the State Board of Regents.

Three studies using mail questionnaires, designed to assist the College of Veterinary Medicine with long-range planning, are in various stages of development. The section staff is assisting with study design and questionnaire development and will code and enter all data.

Consultation on sample design was conducted with a variety of clients. Involvement ranged from brief discussions to actually setting up or carrying out the sampling procedure. The more extensive consultations involved a sample of farm implement dealers, for the Department of Economics; a survey of key

informants such as public health nurses, county relief directors, and county attorneys, regarding the needs of the elderly for guardianship, for the Department of Sociology and Anthropology; and a general sample of farms from Farm and Ranch directories, also for Sociology. A sampling plan proposed by a utility company to estimate its peak load demand was evaluated at the request of the Iowa Utilities Board.

Assistance with the statistical aspects of proposals and grant requests was given to two researchers from the Department of Environmental Health, University of Iowa—one investigating farmers and pesticide use and one studying environmental factors affecting women between ages 18 and 44. Similar assistance was given to three ISU groups—one in sociology interested in repeating a nutrition survey originally carried out in 1978, a group from the Department of Food and Nutrition planning to conduct a consumer testing program for a specialized pork product, and a group from the Social and Behavioral Research Center for Rural Health hoping to participate in an evaluation of Youth Employment Competencies training programs.

Assistance with questionnaire construction is given in any project in which the Survey Section is involved in the data collection. In addition, the section is often asked for guidance only in this area. For example, advice on questionnaire construction was given to researchers studying golf course turf grass managers, soccer coaches, departmental graduate student orientation policies, attitudes of high school students and teachers toward science, and the impact of changes in the Iowa law requiring licensing of pesticide applicators.

Harold Baker served as statistical consultant on the Aflatoxin Task Force. This group consisted of representatives of private industry, state agencies, and the university, and was concerned with formulating strategies for coping with the potential threat of aflatoxin contamination in the state's corn crop.

Industry and Engineering Sciences

The Statistical Laboratory, the Engineering Research Institute, and joint faculty appointments in statistics and industrial engineering support statistical consultation with engineering and physical science faculty and graduate students. Consulting with industry is provided through a program of collaborative and affiliate research and consulting.

In addition, Dean Isaacson is serving as the Regents' institutions representative on the board of directors of the Iowa Quality Coalition, a newly formed state-wide council composed of leaders from business, education (Regents' institutions, private institutions, and community colleges), industry, labor, and government (city and state). The coalition's mission is to promote a continuous process of quality improvement in Iowa through awareness, education, and implementation. It will provide direction to the Iowa Productivity Consortium and support establishment of local/regional community quality councils. Isaacson is also on the coalition's Committee on Executive Awareness, for which Robert Hogg, University of Iowa, is co-chair.

Industrial Consulting

Over several years of operation on minimal funding, the ISU Industry/University Affiliate Program in Productivity, Quality, and Reliability has evolved a strategy of operation consisting of industry input and "seed" funding. Affiliate membership provides companies with a natural vehicle for interaction with ISU personnel and input into the selection of faculty and graduate student research topics. Contributed funds are treated as seed money, to support small projects and exploratory research efforts in an area prior to the submission of full-fledged external research grant proposals.

In the 1988-89 fiscal year, for example, cooperation with affiliate member John Deere on an automatic compensation problem for a company bar lathe led to the development of a significant proposal to the National Science Foundation for support of ISU research in the feedback control of machine tools.

As part of the activities of the affiliate program, H. T. David and Michael J. McCann worked with engineers at Sundstrand-Sauer. The project concerned a two-part housing assembly tentatively scheduled for production. One engineering issue requiring analysis was whether the design tolerances would be adequate to guarantee a tight seal of the two parts, while allowing proper clearance for certain internal bearings.

This issue was addressed by (1) interpreting the tolerances statistically, (2) computer-simulating 4,000 housing assemblies, in accordance with the statistically interpreted tolerances, (3) using an algorithm developed by McCann, optically assembling these 4,000 housings, for best rim fit and maximum bearing clearance, (4) verifying that a high proportion of the 4,000 cases yield both satisfactory best rim fit and satisfactory maximum bearing clearance, and (5) exploring the sensitivity to alternative toleranc-ing strategies of the Monte Carlo-derived proportions of satisfactory synthetic assemblies. The kinds of statistically based considerations employed above can also lead to exploring alternative methods of assembly.

During 1988-89 Stephen B. Vardeman served as associate coordinator of the affiliate program, with Roger Berger, Department of Industrial Engineering, as coordinator.

W. Robert Stephenson attended the second annual seminar on Japanese TQC, Total Quality Control in Japan Today, held in Minneapolis, Minnesota, on May 1-3, 1989. The seminar was sponsored by Process Management Institute, Inc.; Associates in Process Improvement; Joiner Associates, Inc.; QUALPRO; and Statistical Studies, Inc., all management consulting organizations.

In a different consulting context, William Q. Meeker, Jr., continued to serve as a consultant to the AT&T Bell Laboratories Quality Assurance Center, Holmdel, New Jersey, throughout the year.

Engineering Research Institute

Herbert T. David and Peter Peterka, whose assistantship was supported by the Engineering Research Institute, met a variety of consulting needs in 1988-89. A substantial proportion of their consulting effort was directed toward the early, planning, stages of research, thus calling for the application of experimental design, response surface methodology, and optimal design. The work in optimal experimental design included an evaluation of ECHIP, an experimental design package for personal computers. Further consulting work involved application of nonlinear regression to engineering mechanistic model building, aiming at improving researchers' understanding of underlying engineering phenomena.

Stephen Vardeman discussed the statistical analysis of the results of a stochastic simulation of a communications network with an industrial engineering faculty member.

Social Sciences and Humanities

Kenneth J. Koehler helped two economics faculty members develop models for discriminating between financially healthy grain elevators and those that are likely to become insolvent within a few years.

Carl Roberts continued as a consultant for IRIS Systems, Inc., in the development of software that prepares texts for statistical analysis. The software makes archival data and data from open-ended interviews more accessible to business and academic researchers. Roberts' consulting role has been in refining this access in ways that afford users information on linguistic interrelations among themes within texts, in addition to the identification of instances of the themes themselves.

Fred Lorenz provided statistical advice to researchers from a variety of disciplines during the 1988-89 fiscal year. For example, he assisted on the analysis of a College of Business Administration study of job applicant and employer physical characteristics and status variables that predict whether an applicant will be hired and later promoted. He helped researchers in the Department of Textiles and Clothing design and analyze a study of the responses of American students to Indian students dressed in a variety of traditional and western clothing. Lorenz also worked with professors in (1) physical education on the effects of weight training on the self-image of men and women, (2) child development on a confirmatory factor analysis of parenting styles, and (3) family environment on a model of family conflict resolution. In addition, Lorenz has been serving on the Iowa Health Data Commission technical advisory committee and a newly created Iowa Health Data Utilization Task Force.

Mack C. Shelley, II, worked with students, faculty, and staff from Harvard University (in political science); the Association of Boards of Certification; ISU departments of Freshman Engineering, Industrial Relations, Family Environment, Sociology and Anthropology, Political Science, Journalism and Mass Communication, Architecture, Industrial Education and Technology, and Professional Studies in Education; and the Council of State Governments.

He was a visiting scholar at the Council of State Governments, in Lexington, Kentucky, through the Martin School of Public Administration, University of Kentucky, from June 26-30, 1989, to study transportation policy and conduct survey data analysis. Shelley also worked with the council in 1988 through a grant from the Urban Mass Transportation Administration. He continued to conduct research on bioethics under grants from the Northwest Area Foundation and the Joyce Foundation.

Robert Strahan consulted with a number of graduate students and faculty in the departments of Psychology; Child Development; Professional Studies in Education; Physical Education and Leisure Studies; Industrial Education and Technology; and Hotel, Restaurant, and Institution Management.

Topics included the effects of informed consent on psychological assessment at a Veterans Administration hospital, paradoxical effects of thermal stress on chicks as mediated by morphine, relations among dimensions of psychological/physical fitness, issues in day care of children, physical/psychological differences between black and white newborn children in South Carolina, correlates of child abuse, and a survey of kindergarten teachers in the Sudan.

Other topics were the examination of factors associated with college freshman dropout/retention at a private Iowa university, a correlational study of the

The Iowa STAT-er reading group meets in the Memorial Union to discuss conceptual statistical papers and issues not dealt with in regular classes. Each time two members present the topic and open the floor to discussion. Topics this year have ranged from historical (Fisher's "Mathematics of a lady tasting tea") to issues in consulting (common misuses of statistics in agronomic studies).

relations between attitudes toward and engagement in physical activities among retirement home Iowans, an experimental study of sensory characteristics of soybean additive to pork sausage, development of a manager survey instrument for a laundromat franchise, and exploration of a physiological arousal measure for infants.

Other Consulting/Cooperation

Noel Cressie consulted on image analysis, variogram model fitting to nitrate-nitrogen data, and spatial sampling for management of gopher tortoises, with graduate students in electrical engineering, agricultural engineering, and animal ecology respectively.

Kenneth J. Koehler consulted with an entomology professor on the comparison of longitudinal effects of various methods for controlling hornflies in cattle. He provided advice on the design and analysis of a Department of Textiles and Clothing study of the instructional use of computers. He also provided advice to researchers in the Department of Food and Nutrition on the analysis of data from a study of heart disease and changes in dietary habits among rural adult males. Harold Baker, in the Survey Section, had aided in the design of the survey.

Statistical guidance and improved statistical methodology are provided to research staff of the Agricultural Research Service, USDA, under a five-year contractual agreement between the USDA-ARS and the Department of Statistics. Project leader is resident collaborator Jerome Sacks. Much of the work relates to investigations at the National Animal Disease Center.

During the year, research assistants Jeffrey Hoffer and Jingyu Liu worked under Sacks' guidance to give consultative support. Also Sheri Cutler worked on one of the ARS projects as part of her creative component.

H. Samuel Wieand has overall responsibility for the statistical conduct of roughly 100 active clinical trials as director of the Cancer Center Statistics at Mayo Clinic and group statistician for the North Central Cancer Treatment Group. He was a co-author on 10 medical publications during the July 1988 to June 1989 period.

Dean Newbauer, Corning Glass Company, presents a $5,000 check from his company to Dean Isaacson to help support outstanding students. Attending are current Corning Glass scholars Jeff Hofer, Mary Anne Dellva, Robert Parker, and Amy Hewitt.

Current Research

Research projects supported by grants or contractual agreements and individual research are summarized in this section. Within the university, funds were 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.

AES Project 2588

Edward Pollak continued research on mathematical and statistical genetics under Project 2588 of the Iowa Agriculture and Home Economics Experiment Station. He derived the rate at which neutral genetic variability is lost within finite populations in which reproduction is partially by the mating of relatives such as uncle and niece and various types of cousins. This rate increases, in comparison with that for random mating, much more than one would guess by just calculating the corresponding equilibrium inbreeding coefficient. Thus random sampling may be even more important in affecting genetic divergence between subpopulations than is usually supposed.

Research work was begun by M. Sabran, working under Pollak's direction, on the problem of calculating the probability that a particular allele survives when there is selection in a finite population that reproduces partially by selfing and partially by random mating.

B. Kuo, working under Pollak's direction, studied conditions under which rare alleles tend to increase in populations of two species that have a predator-prey relationship.

Edward Pollak derived a general expression for the effective population size of an age-structured population with a sex-linked locus. It is also applicable to all loci in species such as those among the social hymenoptera, which have haploid males and diploid females.

Design of Experiments

Research by John Stufken on a number of topics relating to the design of experiments is supported through the statistics department of the Iowa Agriculture and Home Economics Experiment Station under Project 101. In the 1988-89 academic year these included orthogonal arrays, optimal repeated measurements designs, optimal designs for comparing test treatments with a control, balance in block de-

signs, and support size of BIB designs and the trade-off method.

Use of orthogonal arrays as fractional factorial designs has regained a tremendous popularity among research workers in various areas over the last years. Unfortunately there is no source that gives a complete overview of available results on this topic. A book on orthogonal arrays is currently in preparation by Stufken, with co-author A. Hedayat. Also see p. 31 of the current annual report.

Research on optimal designs for comparing test treatments with a control, a continuation of Stufken's thesis research, has taken two directions. One is the study of Bayes A-optimal designs for that problem. The other, with Kwanghun Kim, is to consider the performance of group divisible treatment designs when the main interest is in rectangular simultaneous confidence intervals for the elementary contrasts between a test treatment and the control.

Research on balance in block designs by Stufken is concentrating on the concepts of pairwise balance, variance balance, and efficiency balance.

National Resource Inventories and Soils Data Bases

The Survey Section continued cooperative research with the Soil Conservation Service (SCS), U.S. Department of Agriculture. This joint work has been an important part of the work of the Statistical Laboratory since 1956. The current project is supported through Project 2739 of the Iowa Agriculture and Home Economics Experiment Station and is directed by Roy D. Hickman. Dean Thompson now serves as resident collaborator from SCS on the joint work, replacing Art Kuhl.

The SCS conducts a National Resources Inventory (NRI) of the country's soil and water-related resources every five years. During the past year, Survey Section staff have been editing and processing data for the 1987 NRI. The 1987 inventory is the first NRI specifically designed to estimate changes in land use and cover that have occurred during the past five years. Because of the change aspect, the field work consisted of recording current information as well as verifying and updating data from the 1982 NRI.

Two main types of data are associated with the 1987 National Resources Inventory: county base data and Primary Sampling Unit (PSU) data. County base data provide total acreages for each county in the U.S. for categories such as land area, water area, federal land, roads, and railroads. The PSU's are a set of randomly sampled locations throughout the U.S. The PSU data provide information, for example, on soil characteristics, land use, and soil erosion. The 1987 NRI sample is a stratified sample of about 100,000 PSU's from the 330,000 PSU's used in the 1982 NRI. The sample was supplemented with 2,500 new PSU's selected in swiftly urbanizing areas. The supplemental sample will be used to estimate more precisely the quantity of agricultural land being converted to urban use.

SCS field personnel entered the PSU data on AT&T 3B2 minicomputer systems located in each state SCS office, and transmitted the data to the Statistical Laboratory via floppy disks or cassette tapes. The data, consisting of both 1987 and 1982 information, was uploaded to the ISU mainframe computer for editing and analysis.

During the past year, data editing and correction was completed. A set of preliminary tables was produced for each state for review. A national subsample of PSU's was selected to assist in the estimation of the change in urban areas. The SCS National Cartographic Center at Fort Worth, Texas, obtained aerial photographic coverage of these PSU's, completed photo interpretation for urban land use, and returned the data to the Statistical Laboratory for analysis. Procedures for creating state NRI databases for use with the state NRI Data Users Package were developed and tested. Richard Dorsch is in charge of data processing activities, assisted by Melissa Swanson, Kathie Reinertson, and Sue Verkade.

Rather complex estimation procedures will be required because of the change aspects of the 1987 NRI. Weights for estimation of totals will be constructed using control variables from the larger sample of the 1982 NRI. Software was developed for weight construction, and small area estimation techniques were incorporated into PC CARP. Wayne Fuller is directing the work on estimation, assisted by Harold Baker, Fred Medak, and Steven Haslett. Other staff members working on inventory projects during the year were Linda Brands, Joseph Croos, Dorothy Edwards, Joel Halvorsen, Jeff Helterbrand, Carol Meeder, Heon Jin Park, Todd Sanger, and Gary Sullivan.

Work on the development of a computer software package that will allow users in both the public and private sectors access to the 1987 NRI database was led by Marvin Beck with the assistance of Lee Chu. This database will be stored at the ISU Computation Center using the relational database management system ORACLE.

Another area of the cooperative work is the maintenance, updating, and continuing development of the soil interpretations database of soil series in the United States. This database is of major importance to the work done by the Soil Survey Division of the SCS. It has been used recently to determine hydric soils, highly erodible soils, and soils most prone to cause ground water pollution from farm chemical application. Harvey Terpstra directs this work, assisted by Deborah Reed-Margetan, Jan Seagrave, Janet Schultz, Douglas Tschopp, and Fred Medak.

With the addition of 1,400 new records, the soil interpretations database now contains over 30,900 records, occupying 220 million bytes of storage. With the addition of 130 survey areas, the soil map unit database now contains 2,690 survey areas, occupying 120 million bytes of storage. The soil series description database contains descriptions for over 13,000 soil series and occupies 200 million bytes of storage. The soil series classification database is stored in the SPIRES database management system and contains the official soil classification for over 16,000 soil series.

The work of installing the data into an ORACLE database at the ISU Computation Center has continued. The map unit database was implemented in ORACLE and has performed well. An ORACLE version of the soil interpretations database has been loaded for testing. Work remains to be done in converting current applications to use the ORACLE database. ORACLE will make it possible for local and remote users to interactively query the data and will provide a more productive and flexible environment for program development. Deborah Reed-Margetan and Janet Schultz have led the work on this project.

Much of the recent effort involved maintenance of the existing system. New data elements have been added that necessitated the reformatting of the data structure. Conversion of programs to a new compiler was completed during the year. Providing assistance to remote SCS users and the distribution of soils data to sites all over the country have become major activities.

The staff made numerous trips in connection with resource inventory and soils database activities. Roy Hickman and Wayne Fuller traveled to Washington, D.C., October 3-4, 1988, to discuss estimation and database configuration for the 1987 NRI. Harold Baker and Hickman met with SCS staff in Washington, D.C., September 11-14, to discuss digitization of PSU's and geographic information systems. Fuller discussed special problems of resource inventories in Alaska with SCS staff in Anchorage, October 8-16. Harvey Terpstra traveled to Lincoln, Nebraska, in December to attend a training session in structured systems analysis and modeling, and again in January with Deborah Reed-Margetan to discuss revisions in the soils database structure; to Fort Worth, Texas, January 25-27, 1989, to discuss the distribution of soils and geologic/hydrologic data to states; and to Fort Collins, Colorado, May 9-12, to attend the National Soils Database Managers Workshop.

Roy Hickman attended regional NRI Data Users Workshops in Fort Worth, Texas, March 13-16; in Chester, Pennsylvania, March 28-29; in Portland, Oregon, April 3-6; and in Lincoln, Nebraska, with Dick Dorsch, April 17-20. Reed-Margetan attended the ORACLE/MVS Special Interest Group meeting in Phoenix, Arizona, March 22-24. Douglas Tschopp met with SCS staff in Fort Collins, Colorado, March 27-29, to discuss the state soil survey database program. Wayne Fuller and Harold Baker traveled to Lincoln, Nebraska, to discuss special problems of estimation of urban land in the 1987 NRI.

Measurement and Sampling Error

Joint research in measurement error models, time series, and survey design is supported by the U.S. Bureau of the Census and, through AES Project 2699, by the Iowa Agriculture and Home Economics Experiment Station. The bureau's support for the 1988-1989 year came through Joint Statistical Agreements J.S.A. 88-2 and J.S.A. 89-2. Wayne Fuller is principal investigator. Other personnel working on the project include Gary Sullivan, Heon Jin Park, Sahadeb Sarkar, Dong Wan Shin, and Joseph Croos.

Research was conducted on the use of measurement error to protect the confidentiality of respondents providing data for a microdata release. It was demonstrated that adding error with the same covariance matrix as that of the original variables is superior in protecting the respondent to adding error with a different correlation structure. An initial version of a program to add measurement error to data prior to its release was developed.

Estimation of the population mean using survey data collected from skewed distributions was investigated. The approach uses procedures appropriate for the tail of a Weibull distribution to estimate the mean of the tail portion of the skewed distribution. The study indicates that maximum likelihood estimation may not be robust for the mean. Research on measurement error models and on regression estimation was also conducted under the Census Bureau agreement.

Dietary Intake Estimation

Wayne Fuller, Sarah Nusser, Carol Meeter, and Jeff Helterbrand continued their investigations on methods of estimating usual intake distributions for selected dietary components. This research was supported by a research agreement between the Center for Agricultural and Rural Development (CARD) at Iowa State University and the USDA Human Nutrition Information Service.

The usual intake for an individual is defined to be the long-run average of daily intakes for the individual. Observed daily intakes were assumed to follow a simple measurement error model equal to the usual intake plus a measurement error. Earlier work used the method of moments to arrive at estimates of usual intake distributions assuming an underlying gamma or Weibull distribution. This approach was extended to include the generalized gamma distribution as the assumed form for the usual intake distribution, providing a wider range of distributional behaviors.

Research based on transforming the observed intakes to normality was initiated. The measurement error model for observed intakes was assumed to hold in normal space, and normal theory was used to pre-

Visiting professor Chen Zhao-Guo (center), after giving an Iowa STAT-er seminar, discusses statistics in China with Oscar Kempthorne and STAT-er vice president Steve Rathbun (right).

dict usual intakes in normal space. An inverse transformation was developed to ensure that the mean in the original space is equal to the inverse transformation of the normal mean, and "pseudo usual intakes" in the original scale were generated by applying the inverse transformation to the predicted usual intakes in normal space. The pseudo usual intakes will be used to fit a usual intake distribution in future work.

■ Computing Research for CARD

V. A. Sposito with Stan Johnson of CARD (the university Center for Agricultural and Rural Development) obtained a block grant funded by the ISU Computation Center for the period November 1988-June 1990 to restructure large-scale agricultural models for CARD. The project involves rewriting all CARD's generator programs so that those models are constructed in block diagonal form. A computational study is then to be conducted to study the efficiency of this stairway structure over the present structure of the models.

■ CARP

Development of the CARP family of personal computer programs for complex surveys continued. Gary Sullivan and Heon Jin Park worked on the programs throughout the year. Park completed an addition to EV CARP for instrumental variable estimation, also known as two-stage least squares. Park also worked on a supplement to EV CARP for small area estimation. A supplement to PC CARP for estimation of the proportional hazards model is being planned. About fifty copies of PC CARP were distributed to institutions in the United States, Canada, the United Kingdom, the Netherlands, and other developed countries during the year.

■ Census Undercount

Research by Noel Cressie on census undercount was supported by a joint statistical agreement between ISU and the U.S. Bureau of the Census. Criteria were established to determine when stratification-adjusted counts incur less risk than census counts. Cressie developed regression-adjusted counts for the model that assumes heteroskedastic small-area undercount variances, then compared those counts to the usual homoskedastic-based adjusted counts.

■ Spatial Statistics

Noel Cressie continued research in spatial prediction with support from a National Science Foundation grant. Methods of characterizing spatial dependence using median polish were extended to irregularly located data, and were implemented on an acid-deposition data set taken from a network of monitoring sites over the eastern half of the United States. Spatial prediction techniques, both stochastic and nonstochastic, were compared. Several were identified for further study, including a shrinkage predictor that has uniformly smaller mean squared error than the universal kriging predictor.

Cressie began advising graduate student Jay Ver Hoef (joint statistics and ecology and evolutionary biology) on a research project for building spatial models for plant communities on the Ozark National Scenic Riverway. Ver Hoef's project is being funded by the National Park Service.

■ Statistical Prediction

With support from a grant from the U.S. Office of Naval Research, David Harville is continuing research in the area of statistical prediction. Alicia Carriquiry and Fred Hulting served as research assistants for this work.

■ Bootstrap Asymptotics

Krishna Athreya and Ananda B. Weerasinghe (Department of Mathematics) are project leaders for a National Science Foundation grant project that began July 1, 1988. The 30-month grant supports research on bootstrapping asymptotics, stochastic differential equations and optimal control, and nonparametric estimation for diffusion processes.

During the first year, Cheng-Der Fuh and Athreya established the consistency of the bootstrap procedure for the estimation of the transition probability matrix for an irreducible, aperiodic, and positive recurrent Markov chain. A weak law for the empirical distribution for a double array of Markov chains was also established. Bootstrap procedures exploiting the regenerative structure of Markov chains were proposed for estimating hitting time distributions.

Weerasinghe and Athreya studied the distribution of the local time at the origin for reflecting Brownian motions and diffusions and showed that at the hitting time of levels this distribution is exponential. They also studied Ito processes and diffusions and established the optimality of a diffusion to maximize the probability of reaching a goal before exhausting the fuel when the motion is governed by reflecting Ito processes.

Athreya established a large deviation type result showing the exponential decay of the size of a class of maps on finite sets that have a given fraction of elements not in their range. This problem, posed by computer scientist J. Lutz at Iowa State University, is of importance in the theory of algorithmic complexity.

■ Order Statistics and Robust Inference

Two Ph.D. dissertations have been completed under the direction of H. A. David, principal investigator under a U.S. Army Research Office contract. For an abstract of Song-Ho Kim's dissertation, see p. 34. A paper by Kim and David on the dependence structure of order statistics and concomitants of order statistics will appear in the *Journal of Statistical Planning and Programming*. Douglas Andrew's dissertation investigates the statistical properties of a simple method (H. A. David, *Biometrika,* 1987) for ranking from

unbalanced paired-comparison data. Special attention is given to group-divisible designs. Unbalanced ranked data are replaced by the paired-comparison data entailed; e.g., the ranking (1,2,3) entails the paired-comparison preferences $1 \to 2$, $1 \to 3$, $2 \to 3$). Advantages over existing nonparametric methods are pointed out. An abstract will appear in the 1989-90 annual report.

A paper by Jingyu Liu and H. A. David on quantiles of sums and expected values of ordered sums, suggested by an article in the *Australian Journal of Statistics*, will be published in that journal.

Nondestructive Evaluation

Since February 1989, William Q. Meeker, Jr., has been the coordinator of the statistics staff's part of the National Institute of Standards and Technology (NIST) Program for Integrated Design, Nondestructive Evaluation, and Manufacturing Sciences. Meeker, along with Wayne Fuller, Steve Vardeman, Tod Sanger, Scott Vander Wiel, and Christian Garrigoux, has met with other researchers on the project and identified goals to be met for the program.

Yasuo Amemiya and H. T. David have been involved in research under the industrial affiliate program of the ISU Center for Nondestructive Evaluation. This involves a problem in the inspection protocol for the system of pipes in an oil refinery.

Reliability and Censored Data Analysis

William Q. Meeker, Jr., continued joint research with Luis Escobar on influence analysis with censored data. He has also been investigating, in collaboration with some of his students, new methods of setting simultaneous confidence bands when faced with censored data and a method of planning and analyzing accelerated life tests with nonconstant shape parameter.

Clinical Trials and Diagnostic Tests

At Mayo Clinic, H. Samuel Wieand has been investigating properties of nonparametric statistics that can be used to compare two diagnostic markers for a disease. The statistics take advantage of the correlations obtained when two markers are obtained on the same patient. They allow for a comparison of sensitivities of the markers over a range of specificities. The work, joint with other researchers, has been supported in part by grants from the National Institutes of Health.

Wieand has also been investigating properties of grouped sequential designs applicable in clinical trials. Emphasis has been on choosing which are optimal in the sense of using the fewest patients for a prespecified significance level and power. Both dichotomous outcomes and time-to-event outcomes have been considered.

Wieand is a full member of the graduate faculty in statistics at ISU and directs the thesis work of students interested in biostatistics. Craig Beam completed doctoral research (see p. 33) under Wieand and Herbert T. David in 1989.

Sciences and Humanities Research Institute

Funds from the Sciences and Humanities Research Institute help support research by Yasuo Amemiya, Krishna Athreya, H. A. David, Mervyn Marasinghe, Glen Meeden, and John Stufken. Some of this work also received support from federal grants or contracts in 1988-89 and has been described earlier in this section.

Yasuo Amemiya worked on several problems in multivariate analysis. The limiting distribution of the roots of a determinantal equation involving one or two random matrices was characterized under a very general set of conditions. For the multivariate components of variance model, the percentiles of the limiting distribution of the likelihood ratio statistic for testing the rank of the between-group covariance matrix were tabulated. An estimator of the error covariance matrix and a bias-adjusted estimator of the relationship parameter in the nonlinear functional relationship were studied under the existence of instrumental variables.

Research by Mervyn Marasinghe on nonadditivity in multiway tables was completed. Marasinghe continues to work in the area of model misspecification for unreplicated, structured data.

A continuing research project on solid waste sampling was in part sponsored by a summer salary support grant to John Stufken. This is joint research with A. Hedayat (University of Illinois-Chicago) and Mohsen Mehran (Geosytem Consultants, Inc., Irvine, California).

Other Research

Robert Strahan continued collaboration in the third year of a U.S. Department of Education-funded contract aimed at identifying the coursework patterns associated with general learned abilities of college students (as measured by residualized Graduate Examination Record scores). He supervised testing at Olympia College in Washington state in February. Other research he engaged in dealt with intuitive statistics, graphical methods, teaching aids, personality assessment, and psychophysiology.

Joint research by Richard Groeneveld and Barry C. Arnold, University of California-Riverside, concerned a new sequential sampling method of estimation of N, the finite population size, for finite populations of $N = nr$ objects.

Carl Roberts visited the Sociologisch Instituut of the Katholieke Universiteit in Nijmegen in January. Collaborative research with colleagues there continues on a comparative study of the origins of secularization in the Netherlands and the United States. A second jointly-researched longitudinal analysis investigates the impact of Dutch secularization on Hollanders' political party preference. The ISU Achievement Foundation has provided funding and a travel grant to help support this research.

Frederick Lorenz is one of three co-principal investigators on a new five-year study, beginning in August 1988, of rural family resilience to economic stress. The principal focus is on tracing the mechanisms that make some families break up and others pull together when faced with economic hardship. Methodological strengths of the study include the use of four waves of data collection, multiple sources of information for each family member, and the videotaping of family interactions. The first wave of the panel includes 450 rural Iowa families, each with a mother, a father, a 7th grader, and one other sibling in the home. This study, funded by the National Institute of Mental Health, is one of four grant projects that make up the Iowa Youth and Families Study, headed by Rand Conger, sociologist and director of the ISU Social and Behavioral Research Center for Rural Health. (See also p. 11.)

Mack Shelley has written recently on public choice and interstate migration, U.S. Senate elections, federal budgetary statistics, economic development, biotechnology, and public opinion polls in the 1988 presidential election.

Herbert T. David directed two Ph.D. dissertations for the Department of Industrial Engineering. The dissertation of Noel Artiles-Leon addressed the question of optimal number and optimal placement of warning and related lines in the construction of Wishart control charts. His work led to the conclusion that optimally positioned multiple control limits are more effective for detecting ARMA alternatives than for detecting shift alternatives. The dissertation of Samia Siha involved the construction of Markovian models of multi-stage pull and push production systems, with a view to optimizing work-in-progress inventory levels and work-station production rates. It was found that pull systems tend to outperform comparable push systems, in keeping with recently proposed just-in-time principles. Much of the material in Siha's dissertation is to appear as a chapter in the book *People and Product Management in Manufacturing,* to be published by Elsevier Press.

One of the Stat Lab traditions is the spring pizza party given by students who have passed prelims or final oral examinations during the year. They invite the other statistics graduate students, faculty, and staff, and their families to be their guests. In the foreground, Dan Mundfrom and his son visit with the Carl Roberts family.

Professional Activities

W. Robert Stephenson was elected national president of Mu Sigma Rho, the statistics honor fraternity, and took office August 1988. He had been director-at-large on the Mu Sigma Rho Board of Directors.

Wayne Fuller has been a member of the Institute of Mathematical Statistics Council since summer 1987. He became chair of the Survey Research Methods Section, American Statistical Association, for 1989. He was appointed to the ASA Committee on Fellows for the period 1988-1994.

H. A. David is vice-chair of the ASA Committee on Archives. W. Robert Stephenson has been nominated for the position of chair-elect of the ASA Section on Statistical Education. Stephen Vardeman continued to serve on the ASA Committee on Award for Outstanding Statistical Application and is the 1989 committee chair. David chaired a search committee for the next editor of *JASA*, Theory and Methods section.

A televised short course on Measurement Error Models was given on August 23 during the joint statistical meetings, through the ASA Continuing Education Department. Instructors were Wayne A. Fuller, Stephen Miller (who had joined the Bureau of Labor Statistics), and Dan Schnell. This was a televised version of the live short course offered a year earlier at the joint meetings.

William Q. Meeker was elected president of the Iowa Chapter of the American Statistical Association for 1989/1990.

Noel Cressie was a member of the Scientific Committee for the Third International Geostatistics Congress, held in Avignon, France, September 5-9, 1988. He also was on the organizing committee for the workshop on Robustness, Diagnostics, Computing, and Graphics in Statistics sponsored by the Institute for Mathematics and Its Applications, University of Minnesota, and held July 10-September 1, 1989.

Wayne Fuller continued to serve as a member of the Advisory Committee to Statistics Canada. He attended meetings in Ottawa, Canada, on September 26-27 and April 3-4, 1989. He also continued his service on the National Research Council Panel on Decennial Census Methodology, which met in Washington, D.C., on December 1-2, 1988.

Noel Cressie served on the American Statistical Association's Committee on Energy Statistics, an advisory committee that met in Washington, D.C. on October 27-28, 1988, and April 6-7, 1989.

Krishna Athreya is a member of a panel of the National Science Foundation's Conference Board on Mathematical Sciences, which selects lecture series for NSF support.

During July 1988 Athreya was at the University of Rome, Italy, as visiting professor. He gave a course of six lectures on Markov chains and renewal theory.

H. A. David made a site visit to the Department of Statistics, North Carolina State University, on March 16, 1989, as part of a University of North Carolina review of mathematics, statistics, and computer science degree programs at all of its campuses.

Mack Shelley continued to serve as the Iowa State University Official Representative to the Inter-University Consortium for Political and Social Research. He also continued to serve as a member of the ISU Ethical Issues in Biotechnology Committee.

Two statistics graduate students, Martín Grondona and Nuwan Nanayakkara, won first and second prize awards, respectively, in a competition for Best Student Statistics Paper Presentation sponsored by the Iowa chapter of the American Statistical Association last spring (during the joint meeting of the American Mathematics Society and the ASA chapter at Coe College). Also an ISU team won the 1989 Data Analysis Competition sponsored by the ASA chapter and open to teams of graduate students in Iowa. Contestants were asked to analyze a real data set, suggest new ways of designing a pharmaceutical pill-bottle filling machine, and present their results in written and verbal presentations. The winning team members were Carol Gotway, Martín Grondona, Nuwan Nanayakkara, and Steve Rathbun.

Editorial Activities

William Q. Meeker, Jr., continued his term as editor of *Technometrics,* with Denise Riker as editorial assistant. Stephen Vardeman continued as an associate editor. Meeker is on the editorial board of *Selected Tables in Mathematical Statistics.*

Yasuo Amemiya continues as associate editor of *The American Statistician.* William J. Kennedy remains on the international editorial board of *Communications in Statistics—Simulation and Computation* and is coeditor of its Algorithms section.

Noel Cressie was an associate editor of the *Journal of the American Statistical Association* Theory and Methods Section until the end of 1988 and is on the editorial board of *Chemometrics and Intelligent Laboratory Systems.*

H. A. David is a member of the editorial board for the *Journal of the Indian Society of Agricultural Statistics.*

Wayne Fuller continued as associate editor of *Survey Methodology* and the *Journal of Business and Economic Statistics.*

Krishna Athreya is an associate editor of *Probability Theory and Related Fields* and serves on the editorial board of *Statistics & Probability Letters.*

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

Edward Pollak continues to serve on the editorial board of *Mathematical Biosciences.* He became an associate editor of *Biometrics* in February 1989.

Mack Shelley has been a member of the editorial board of *Agricultural Bioethics Forum* since 1988 and co-editor since 1989. This is an international newsletter disseminating information and opinions about scientific research in agricultural biotechnology.

Leroy Wolins is a member of the board of editors for *Educational and Psychological Measurement.*

Papers Presented, Lectures, and Seminars

At the 1988 joint statistical meetings of the American Statistical Association and the Biometric Society (ENAR and WNAR) in New Orleans, Louisiana, August 22-25:

AMEMIYA, Yasuo: "Improved instrumental variable estimation for the nonlinear errors-in-variables models";

Beam, Craig, and **Sam WIEAND:** "A nonparametric statistic for comparing a continuous diagnostic test to a discrete diagnostic test";

CRESSIE, Noel A. C., Carol A. Gotway, and **Martín O. Grondona:** "Spatial prediction from networks"; also Cressie, discussant, session on Applications of Hierarchical and Empirical Bayes Methods in Survey Sampling, and chairman of the session Toward Improved Coverage and Measurement in the 1990 Census.

Dellva, Mary Anne, and **W. Robert STEPHENSON**: "A simple plot for designing a control charting scheme," poster session contributed paper;

ELTINGE, John L. (Texas A&M University): "Likelihood results for serially correlated measurement error models";

FULLER, Wayne A.: discussant for Session on 125 Years of Statistical Programs at the National Agricultural Statistics Service; also discussion leader on Measurement Error Models at the ASA Business and Economic Statistics Section Roundtable Luncheon;

GENALO, Mary A., and **Roy D. HICKMAN**: "A study of ring/no answer numbers in RDD telephone surveys";

HARVILLE, David A.: "Mixed-model methodology: Theoretical justifications and future directions"; also "Some new algorithms for computing maximum likelihood estimates of variance components" by **Terrance P. Callanan** (Eastman Kodak Co.) and Harville;

Hong, C. S.: "Granularity in regression models";

Jensen, Karen L.: "Optimal adjustment in the presence of process drift and adjustment error";

MEEKER, William Q., Jr. and Luis A. Escobar: "Influence diagnostics for reliability data";

Morel, Jorge G. (Iowa State University and University of South Florida): "Logistic regression under complex survey designs";

POLLAK, Edward: "Survival probabilities for some multitype branching processes in genetics";

Schnell, Daniel J. (Iowa State University and Centers for Disease Control): "A test for error covariance specification in nonlinear measurement error models";

SHELLEY, Mack C. II, William F. Woodman, Brian J. Reichel, and Paul Lasley: "Biotechnology and the land-grant university: The evidence from sample surveys";

STEPHENSON, W. Robert: "Directions for an undergraduate program within an established graduate statistics department";

STRAHAN, Robert F.: "Judged and actual relations among effect strength measures";

Hedayat, A. S., and **John STUFKEN**: "Sampling designs useful for solid waste sampling";

WIEAND, H. Samuel (Mayo Clinic) and Mitchell H. Gail: "Nonparametric statistics for comparing diagnostic tests with paired or unpaired data."

At the 1989 Winter Conference of the American Statistical Association—Statistics in Society, in San Diego, California, January 4-6:

ELTINGE, John L. (Texas A&M University), and **Wayne A. FULLER**: "Time series random component models for sample surveys";

Eltinge, Elizabeth M., and **Carl W. ROBERTS**: "Linguistic content analysis: A method to quantify textual information";

Wilson, Jeffrey R. (Arizona State University), and **Kenneth J. KOEHLER**: "Hierarchical models for data with extra variation."

At the joint meeting of the Biometric Society (ENAR), the Institute of Mathematical Statistics, and three sections of the American Statistical Association in Lexington, Kentucky, March 19-22, 1989:

BATTESE, George (University of New England, Australia), **Sarah Nusser**, and **Wayne A. FULLER** "Estimating the distribution of the usual nutrient intake of individuals";

COX, D. F.: "Teaching statistical methods to research workers";

Grondona, Martín O., and **Noel A. C. CRESSIE**: "Using spatial considerations in experimental design."

At the Midwest Sociological Society annual meeting in St. Louis, Missouri, April 6-9:

Kabagarama, Daisy, **Frederick O. LORENZ**, and Charles L. Mulford: "Development issues from a contextual approach";

Muhwezi, Dan, **Frederick O. LORENZ**, and Vern Ryan: "Social performance: The underlying factors";

Reichel, Brian J., **Mack C. SHELLEY, II**, and William F. Woodman: "Reducing coordination barriers between universities and industry: IORs in biotechnology";

ROBERTS, Carl W.: "Doing field research for the first time: A guide for undergraduate field notes";

Ge, Qin-Qin, and **Carl W. ROBERTS**: "Breaking the ice: The Sino-U.S. media agenda in *Time* Magazine, 1966-1985."

At the Kansas State University Conference on Applied Statistics in Agriculture, in Manhattan, Kansas, May 1-2:

COX, David F.: "Teaching statistical methods to graduate students in colleges of agriculture";

HINZ, Paul N.: "A combined analysis of experiments when treatments differ among experiments";

SHELLEY, Kathleen: "Evaluation of presentation graphics for the agricultural sciences."

At the 1989 meetings of the Society for Clinical Trials, held in Minneapolis, Minnesota, May 15-18:

Therneau, Terry M., **Sam WIEAND** (Mayo Clinic), and Dan Schaid: "How many stratification factors can a study's randomization support?";

WIEAND, Sam: "The design of Phase II clinical trials," for a workshop.

At the 1989 Joint Summer Research Conference: Statistical Analysis of Measurement Error Models and Applications, sponsored by the National Science Foundation and the American Mathematical Society, Institute of Mathematical Statistics, and Society for Industrial and Applied Mathematics, held June 11-15, in Arcata, California:

AMEMIYA, Yasuo: "Instrumental variable estimation of the nonlinear measurement error model";

FULLER, Wayne A.: "Prediction of true values for the multivariate measurement error model."

At the joint Western Regional Meeting of the Institute of Mathematical Statistics and annual meeting of the Biometric Society (WNAR), Davis, California, June 25-28:

STUFKEN, John: "Optimal and efficient repeated measurements designs";

SUKHATME, Shashikala: "Receiver operating characteristic curves with random number of cases—a nonparametric approach."

At other locations:

ATHREYA, Krishna: "Polya urn schemes," seminar for the Department of Statistics, University of Madras, India, August 16, 1988.

"A central limit theorem for Polya urn schemes," Mathematics Colloquium, Iowa State University, September 13; invited talk at the Raj Chandra Bose Symposium, sponsored by the Indian Statistical Institute and the University of Delhi, December 27, New Delhi, India.

"Ferguson processes," colloquium, Department of Mathematics, Iowa State University, November 8.

"Optimality of diffusion in a stochastic gambling problem," colloquium, Department of Mathematics, University of Indiana, Bloomington, April 24, 1989.

"Exponentiality of local times at hitting times for diffusions with an application," colloquium, Department of Mathematics, University of Tennessee, April 28.

"Bootstrap of the mean," colloquium, Department of Mathematics, University of Maryland, College Park, May 4.

"Central limit theorem for Polya urn schemes," colloquium, Department of Mathematics, University of Maryland, Baltimore County campus, May 5.

Carriquiry, A. L.: "A Bayesian approach to prediction when variances are unknown," by Carriquiry and **D. A. HARVILLE**, at the annual meeting of the American Society of Animal Science, held at Rutgers University, New Brunswick, New Jersey, July 19-22, 1988.

"Bayesian point and interval prediction: The mixed linear model with unknown variance components case," by Carriquiry and **D. A. HARVILLE**, at the 3rd Latin American Congress on Probability and Mathematical Statistics, Universidad de la Republica, Montevideo, Uruguay, September 22.

"Bayesian prediction in mixed linear models and its application to the genetic evaluation of livestock," seminar at the Institut National de la Recherche Agronomique, Jouy-en-Josar, France, May 16, 1989.

"Bayesian prediction in mixed linear models: Theoretical considerations" and "Bayesian prediction in mixed linear models: Numerical aspects," seminars, Department of Animal Science, University of Uppsala, Sweden, May 29 and 30.

"Bayesian prediction in large problems: Numerical aspects," seminar, Department of Mathematics, University of Ausburg, West Germany, in June.

COX, David F.: "The use of statistics in the presentation of scientific evidence" and "Evaluating the use of statistics in the

presentations of scientific evidence," American Poultry Science Association 77th annual meeting, in a workshop for the editorial board, at Louisiana State University, July 27, 1988.

CRESSIE, Noel: "Spatial prediction from networks," at USSES 88, the annual meeting of the University Statisticians of Southern Experiment Stations, July 29, 1988, in Lincoln, Nebraska.

"The many faces of spatial prediction," at the Third International Geostatistics Congress, Avignon, France, September 5; also chaired a plenary session on September 8.

"Modeling tumor growth with random sets," Applied Mathematics-Engineering Colloquium, Iowa State University, September 15.

"Spatial prediction and the design of networks," seminar, Department of Statistics, University of Kentucky, November 10.

"Spatial prediction, kriging, and network design," seminar, Department of Statistics, Carnegie-Mellon University, December 5.

"Spatial prediction, kriging, and design," seminar given at the Department of Statistics, University of California-Riverside, and the Department of Mathematics, University of California-Los Angeles, January 27 and 30, 1989, respectively.

"Modeling growth with random sets," seminar, Department of Mathematics, University of California-Los Angeles, January 31.

"Growth models based on random sets," seminar, Department of Statistics, University of Michigan, April 20.

DAVID, H. A.: "Some applications of order statistics," keynote address at the 34th Conference on the Design of Experiments in Army Research, Development, and Testing, Las Cruces, New Mexico, October 19, 1988.

"Order statistics and the treatment of outliers"—a series of three seminars for the Department of Statistics, University of Poona, Pune, India, December 27-29.

"Some applications of order statistics," at the 76th Indian Science Congress, in Madurai, India, January 11, 1989.

FULLER, Wayne A.: "Software for survey analysis," at the 1988 symposium, Impact of High Technology on Survey Taking, sponsored by Statistics Canada, in Ottawa, Ontario, Canada, October 25, 1988.

"Prediction of true values for the measurement error model," seminar, Department of Mathematics, University of Maryland-Baltimore County, March 3, 1989.

"Estimation for nonlinear time series model," at the Workshop on Econometric Estimation and Inference for Nonlinear, Dynamic Macroeconomic Models sponsored by the Division of Social Science, University of Southern California, April 7, in Los Angeles, California.

GROENEVELD, Richard A.: "Maximal deviations between sample and population statistics in finite populations," seminar, Department of Mathematics, Grinnell College, November 16, 1988.

"The undergraduate program in statistics at Iowa State University," as panelist on Teaching Statistics, at the joint meetings of the Iowa sections of the Mathematics Association of America and the American Statistical Association at Coe College, April 8, 1989.

HARVILLE, David A.: "Mean squared error of estimation or prediction under a general linear model," seminar, Department of Statistics, University of California-Riverside, February 28, 1989; also invited paper at a Symposium on Linear Models sponsored by the National Security Agency and held at the University of Maryland-Baltimore County, Catonsville, Maryland, April 29.

"Some new algorithms for computing maximum likelihood estimates of variance components," by T. P. Callanan and Harville, at the 21st Symposium on the Interface of Computing Science and Statistics, Kissimmee, Florida, April 11.

HINZ, Paul N.: "Graduate study in statistics at Iowa State" and "Topics in experimental design," lectures for the Department of Statistics, Luther College, November 18, 1988.

HOTCHKISS, Donald: "Integrating statistics into research, nutrition," Food Technology/Food and Nutrition Seminar, Iowa State University, September 28.

KEMPTHORNE, Oscar: "Design and interpretation of intervention experiments," seminar, Department of Statistics, Kansas State University, December 1.

"Origins and developments of modern statistics," for the Kansas-Western Missouri Chapter of the American Statistical Association, December 1, in Manhattan, Kansas.

"An ancient mariner reflects on statistics," banquet speech, 12th annual Midwest Biopharmaceutical Statistics Workshop, cosponsored by the Biopharmaceutical Section of the American Statistical Association, at Ball State University, May 25, 1989; also discussant, Baseline Comparability Session, May 25.

KENNEDY, William J.: "Comparison and testing of algorithms for obtaining probabilities and percentiles from probability distributions," at the IMSL User Group Meeting, Ann Arbor, Michigan, May 3.

KOEHLER, Kenneth: "Probability plots and goodness-of-fit tests," at the Seventh Midwest Statistics Conference, Columbia, Missouri, October 8, 1988.

MEEDEN, Glen: "Using the 'Polya posterior' in point and set estimation problems in finite population sampling," by Meeden and **Stephen VARDEMAN**, at the 51st annual meeting of the Institute of Mathematical Statistics, Fort Collins, Colorado, August 15.

"Proving admissibility using the stepwise Bayes technique: With applications to maximum likelihood estimation," colloquium for the Department of Statistics and Actuarial Science, University of Iowa, October 27.

"Using the Polya posterior in point and set estimation problems in finite population sampling" and "A normal-like approximation for asymmetric density functions," seminars for the Indian Statistical Institute in Calcutta, India, in December.

"Piecewise conjugate priors," at the Indo-U.S. Workshop on Bayesian Analysis in Statistics and Econometrics, Bangalore, India, in December.

MEEKER, William Q., Jr.: "Future software for life data analysis," at AT&T Bell Laboratories, Murray Hill, New Jersey, August 9, 1988.

"Influence diagnostics for censored survival data," for the North New Jersey Chapter of the American Statistical Association on October 5.

Panel discussant on Uses of Degradation Measures for Reliability Assessment, at a Bell Laboratories/National Science Foundation-sponsored conference on Design, Quality, and Reliability Research, at Murray Hill, New Jersey, October 6-7.

"Assessing local influence in regression analysis with censored data," at the Mayo Clinic, Rochester, Minnesota, December 21.

"Searching for life data models," by David Lubinsky and

Meeker, at the Symposium on the Interface: Computer Science and Statistics, Orlando, Florida, April 11, 1989.

POLLAK, Edward: "Partial uncle-niece and cousin mating in finite populations," poster paper at the Conference on Convergent Questions in Genetics and Demography, October 7, 1988, at the University of Michigan.

"Survival probabilities for multitype branching processes in genetics" and "The theory of finite populations undergoing partial selfing," seminars at the Indian Agricultural Statistics Research Institute, Delhi, India, on December 28, 1988, and January 11, 1989, respectively.

ROBERTS, Carl W., and Andre Goddu: "The decline of Christendom in the Middle Ages: Mannheim's contribution to the Weberian thesis," at the annual meeting of the American Sociological Association, Atlanta, Georgia, August 27, 1988.

SACKS, Jerome M.: "Field design based on spatial relationships," USDA Biometricians' Meeting, Manhattan, Kansas, held on May 2-3, 1989.

SHELLEY, Mack C. II: "Changing attitudes toward women's employment," by Susan C. Daniewicz, Joyce M. Mercier, and Shelley, presented at the 41st annual scientific meeting of the Gerontological Society of America, held in San Francisco, California, November 18-22, 1988.

"Public opinion polls and the 1988 presidential election: Patterns and trends," by Hwarng-Du Hwang and Shelley, presented at the annual meeting of the Midwest Political Science Association, April 13, 1989, in Chicago, Illinois.

Untitled seminar on recent statistical applications in public policy research, emphasizing linear models, at the Council of State Governments, Lexington, Kentucky, June 30.

SPOSITO, Vincent A.: "Review of L_1 estimation, statistical properties and computational procedures," at the Conference of Texas Statisticians held March 31 to April 2, San Antonio, Texas.

STEPHENSON, W. Robert: "Aspects of experimental and sampling designs," for the State University of Iowa Section 1303, American Society for Quality Control, in Cedar Rapids, Iowa, December 7, 1988.

"Quality and productivity improvement," seminar for the Department of Mathematical Sciences, Montana State University, March 10, 1989.

"Data analysis: A quick and dirty approach," invited talk for the local chapter of Pi Mu Epsilon, Department of Mathematics, Iowa State University, March 29.

STRAHAN, Robert F.: "Dealing with multiple dependent measures," at the annual convention of the Iowa Educational and Research Evaluation Association, Des Moines, Iowa, December 2, 1988.

Sullivan, Gary R.: "The use of measurement error to avoid disclosure," seminar, U.S. Bureau of the Census, Washington, D.C. in February 1989.

Other Meetings

William Q. Meeker attended the Gordon Research Conference on Statistics in Chemistry and Chemical Engineering held in New Hampton, New Hampshire, July 29 to August 7, 1988.

Wayne Fuller attended meetings of the Institute of Mathematical Statistics in Fort Collins, Colorado, August 16-19.

Herbert T. David was awarded a National Science Foundation travel grant to attend an NSF-sponsored workshop on Research Opportunities in Mechanical Tolerancing, held in Orlando, Florida, September 28 to October 1.

William Q. Meeker attended the annual Fall Technical Conference, sponsored by the American Statistical Association and the American Society for Quality Control, held in East Rutherford, New Jersey, October 20-21 and chaired its *Technometrics* session.

Krishna Athreya, Cheng-Der Fuh, and Patrick Homblé attended the 10th Midwest Probability Colloquium at Northwestern University on October 21-22. Homblé also went to the Mini-Conference on Lyapunon Exponents preceding the colloquium.

Jerome Sacks attended the 44th Conference on Applied Statistics, sponsored by the American Society for Quality Control, in Atlantic City, New Jersey, December 4-7.

Mervyn Marasinghe participated in the Second International Workshop on Artificial Intelligence and Statistics held in Fort Lauderdale, Florida, on January 4-7, 1989.

Ted Bailey attended the Gordon Research Conference on Quantitative Genetics and Biotechnology held in Oxnard, California, January 9-13.

Douglas Andrews and Marie Coffin attended the winter meetings of the American Mathematical Society and the Mathematical Association of America in Phoenix, Arizona, January 10-14.

Jerome Sacks attended the Conference on Agricultural Statistics held at Kansas State University on May 1-2 and the Midwest Biopharmaceutical Statistics Workshop at Ball State University May 24-26. On June 5-6 he lectured and otherwise participated in a Flow Cytometry Workshop given by the Iowa State University Department of Biochemistry and Biophysics.

Dianne Anderson and Toni Genalo attended the first annual joint meeting of the Field Directors and Field Technologies Conferences in St. Petersburg, Florida, May 14-18, 1989.

Kenneth J. Koehler attended the Conference Board of the Mathematical Sciences 1989 regional Conference on Modern Computer Intensive Methods for Exploring and Modeling Multivariate Data, held at the George Washington University June 11-16.

Todd Sanger attended the 1989 Joint Summer Research Conference on Measurement Error Models held in Arcata, California, and sponsored by the American Mathematical Society, Institute of Mathematical Statistics, and Society for Industrial and Applied Mathematics in June.

On June 21-28, Shashikala Sukhatme attended the Regional Research Conference of the National Science Foundation-Conference Board of the Mathematical Sciences, on Function Estimation in the Context of Independent and Dependent Observations, held in Davis, California.

Stephen Vardeman attended the "Applications of Statistical Tools" Summer Symposium sponsored by the Math Applications Group of Dow Chemical Company, Midland, Michigan, on June 25-27.

Publications and Dissertation Abstracts

In the Statistical Laboratory preprint series, 24 titles (#88-14 to 88-37) were added during the last half of 1988 and 12 more (#89-1 to 89-12) in the first half of 1989. Copies of the most recent set of abstracts are available on request. Any preprint may be requested by number directly from the author. A new set of preprint abstracts will be released in fall 1989.

Books and Monographs

Groeneveld, Richard A. *Introductory Statistical Methods: An Integrated Approach Using Minitab.* PWS-KENT Publishing Company (Boston). 1988. xv + 655 pp.

This text is written for an introductory course in statistics. Standard topics through multiple regression are covered. Three features emphasized are: (1) the use of data sets from contemporary real-life situations in examples and problems; (2) concentration on statistical methods concerned with the relationships between variables with focus on the role played by statistics in the scientific method; and (3) frequent use of computer printouts to introduce, illustrate, and emphasize statistical analyses and ideas. The book is one of the Duxbury Series in Statistics and Decision Sciences.

Minitab is chosen as the most effective and "user friendly" statistical package for students in their first statistics course. The package is used to provide a means of performing routine, but tedious, computations quickly and correctly and to display data via various visual methods (e.g., graphs, histograms, and EDA techniques). It is also used to simulate selection of samples to demonstrate statistical principles.

Krause, Robert A., Kathy Sebesta, and **Mack C. SHELLEY, II.** *Views and Attitudes of Legislative Leaders in Transportation: Private Sector Involvement in Public Transit.* Lexington, Kentucky: The Council of State Governments. 1988. xvi + 159 pp.

This monograph reports on a study, sponsored by the Urban Mass Transportation Administration, that was designed to measure attitudes held by the transportation legislative leadership group concerning various private sector implementation alternatives in public transit. The monograph emphasizes the priorities for technical assistance available for local governments from the states.

Krause, Robert A., **Mack C. SHELLEY, II**, and Gaye Horton. *State Policies in Transit: Public and Private.* Lexington, Kentucky: The Council of State Governments. 1989. v + 29 pp.

This monograph presents the results of a survey of state transportation committee chairs regarding private-sector involvement in public transit. It was designed to establish boundaries within which related state transportation policy research can evolve. The study summarizes state policy options as seen by the chairs of transportation committees, and presents various scenarios that may govern the direction that these legislative views may take.

Schmidt, Steffen W., **Mack C. SHELLEY, II**, and Barbara A. Bardes. *American Government and Politics Today*, third edition. St. Paul: West Publishing Company. 1989. xxxiv + 700 pp.

This is the third edition of a comprehensive introductory textbook in American government and politics. It includes discussions of political culture, the Constitution, federalism, civil liberties, minority rights and the rights of other disadvantaged groups, public opinion, interest groups, political parties, campaigns and elections, the mass media, Congress, the presidency, the bureaucracy, the judiciary, economic policy, domestic policy, and foreign and defense policy. This book was selected as the recommended text for the new Dallas County Community College District telecourse, **Government by Consent**. The telecourse will be distributed through Dallas Telecourse and the PBS Adult Learning Service to educational institutions throughout the United States, and will be available on January 1, 1990.

A set of supplementary lectures and a handbook, *An Introduction to Critical Thinking in American Politics*, to accompany the textbook, are available under separate covers.

Woodman, William F., **Mack C. SHELLEY, II**, and Brian J. Reichel. *Biotechnology and the Research Enterprise: A Guide to the Literature.* Ames, Iowa: Iowa State University Press. 1989. xviii + 358 pp.

The authors suggest that the connection between organizational theory and public policy should be viewed as an object of public policy. In order to identify the actors involved in biotechnology research networks, the policy context in which such networks emerge must be fully understood. Thus a careful analysis of federal science and R & D policies directed at biotechnology research reveals three distinct actors involved in funding, coordinating, sanctioning, and conducting biotechnology research activities: universities, industry, and government. The advent of biotechnology has provided a new setting and new rationales for their collaboration. This book represents an attempt to map the nature and interrelationships of the workers involved in the biotechnology enterprise by offering historical perspectives and the societal implications of their actions.

Two chapters are specifically by Mack Shelley: "International Biotechnology Research," pp. 243-272, and "Related Issues in Biotechnology," pp. 273-301. The first of these emphasizes research in biotechnology outside of the United States—particularly in Japan, Great Britain, the European Economic Community, and the Third World. The second chapter covers a grab bag of diverse impacts, real or anticipated, that biotechnology has had through gene splicing, monoclonal antibodies, protein engineering, agricultural research, microbiological engineering, and other applications. Emphasis is placed on opportunities and problems associated with biotechnology for scientific communication and university-based research.

SPOSITO, Vincent A. *Linear Programming with Statistical Applications*. Iowa State University Press, Ames, Iowa. 1989. x + 278 pp.

This book is an outgrowth of research on regression under the criterion of minimizing the sum of absolute deviations, L_1. It is the first book that presents a thorough development of the theory and computational algorithms in linear programming with statistical applications. The book was written for advanced undergraduate and first-year graduate students in statistics, operations research, economics, or mathematics.

The first three chapters emphasize the basic concepts, theory, and computational techniques in linear programming. This is followed by a chapter on the theory of linear duality that includes the Kuhn-Tucker theory of linear programming. A large chapter then emphasizes topics in statistics. Appealing to the theory of linear programming, various properties of L_1 are developed. In particular, these properties are shown to be useful to establish an equivalence between Median-Polish estimators and L_1 estimators.

Subsequent chapters address the transportation problem and show how the dual of a two-way classification model under L_1 can be solved, as well as formulated, as a capacitated transportation problem.

Linear programming problems with more than one objective function are covered in a final chapter. Computational procedures for solving these types of problems are given, as well as several control programs that can be used with IBM's MPSX370 system.

■ Published Research

Anderson, T. W., and **Yasuo AMEMIYA**. Asymptotic distributions in factor analysis and linear structural relations. Pp. 1-22 in *Proceedings of the International Conference on the Advances in Multivariate Statistical Analysis* (held in December 1985), edited by S. Das Gupta and J. K. Ghosh. Indian Statistical Institute. 1988.

The observed vector variable is treated as the sum of a "systematic part" and a random error. The lower-dimensional linear space of the systematic parts is defined by the matrix of factor loadings in the case of factor analysis and by the matrix of coefficients in the case of linear functional or structural relations. The literature on the asymptotic normal distribution of the maximum likelihood estimator is reviewed. Very general conditions are given for this asymptotic theory to hold.

Anderson, Kevin K. (ISU and Lawrence Livermore National Laboratory), and **Krishna B. ATHREYA**. A strong renewal theorem for generalized renewal functions in the infinite mean case. *Probability Theory and Related Fields* 77 (1988) 471-479.

Let $F(x)$ be a nonarithmetic c.d.f. on $(0,\infty)$ such that $1 - F(x) = x^{-\alpha}L(x)$, where $L(x)$ is slowly varying and $0 \leq \alpha \leq 1$. Let $a(x)$ be regularly varying with exponent $\beta \geq -1$. A strong renewal theorem (of Blackwell type) for generalized renewal functions of the form $G(t) \equiv \Sigma_{n=0}^{\infty} a(n)\, F^{n}(t)$ is proved here, thus extending the recent work of Embrechts, Mejima, and Omey [*The Annals of Probability* 12 (1984) 561-570] and that of Erickson [*Transactions of the American Mathematical Society* 151 (1970) 263-291].

ATHREYA, K. B., W. Kliemann, and G. Koch. On sequential construction of solutions of stochastic differential equations with jump terms. *Systems & Control Letters* 10:2 (1988) 141-146.

Stochastic differential equations of a general type are considered. The usual conditions are assumed for the coefficients of the diffusion part, which would guarantee the (weak) existence of a Feller diffusion solution if the jump part were missing. But only growth (no continuity) conditions are assumed for the jump part.

It is shown that a sequential construction of the equation solution exists, provided some recurrence properties of the diffusion part are satisfied. Uniqueness then follows from known results on the martingale problem.

Vakili, N. G., and **T. B. BAILEY, Jr.** Yield response of corn hybrids and inbred lines to phylloplane treatment with mycopathogenic fungi. *Crop Science* 29:1 (1989) 183-190.

USDA-ARS and Journal Paper No. J-12822 of the Iowa Agriculture and Home Economics Experiment Station, Project 2849.

The objectives were to determine if grain yield is an effective trait for testing the interaction of selected mycopathogenic fungi with corn genotypes and whether the application of mycopathogens to the corn phylloplane had an effect on yield. Seven corn hybrids and nine inbred lines were planted in a Spillville clay loam with three cultural histories: oat-corn-soybean rotation, continuous corn cultivation, and fumigation. Plants were treated in the phylloplane with aqueous spore suspension of three mycopathogenic fungi, and water as control. (See p. 8 for more information about the experimental design and field layout.)

It was found that hybrid yields were not affected by the treatments, whereas inbred yields differed significantly. Fumigation of the soil with methyl isothiocyanate resulted in a significant response by inbreds to treatment with mycopathogens. Differences in the yields of the inbreds planted in corn-soybean-oat rotation were nonsignificant. Variation in the yield of the inbreds indicated that there was a highly significant interaction between inbred genotypes and mycopathogens in continuous corn culture and in fumigated soils. Selection and breeding of inbreds with high yield response to mycopathogens could result in genotypes that, in the presence of a compatible mycopathogen, would suppress stalk rot development and have greater yield potentials.

Cormack, Jean B., **D. F. COX**, and Peter A. Peterson. Presence of the transposable element *Uq* in maize breeding material. *Crop Science* 28:6 (1988) 941-944.

Journal Paper No. J-12844 of the Iowa Agriculture and Home Economics Experiment Station, Project 2381.

The insertion and excision of transposable elements often lead to alterations in the base pair sequence of a gene. This could contribute to polymorphism and genetic variation in maize (*Zea mays* L.) germ-plasm. The objective of this experiment was to establish whether or not breeding material that showed genetic variability contained the transposable element *Uq*. Populations and inbred lines were crossed with a genetic tester containing *c-ruq*, the receptor for *Uq*. Populations that contained the element *Uq* include Iowa Stiff Stalk Synthetic, Burrs White, Hays Golden, Iowa Long Ear, Lancaster, Kolkmeier, Bs11, and the inbred I159. This study screened for only one of nine genetically characterized elements. The absence of *Uq* does not indicate the absence of other known or unknown elements.

CRESSIE, Noel. Estimating census undercount at national and subnational levels. *Proceedings of Bureau of the Census Fourth Annual Research Conference* (held in Arlington, Virginia, March 21-23, 1988). Bureau of the Census (Washington, D.C.). Pp. 123-150. 1988.

Before estimation of census undercount can be carried out, several questions need to be answered. Which estimators will be considered, at what level will they be applied, and how should aggregation and disaggregation proceed? Answers to these questions are given and then applied to the 1980 Census.

CRESSIE, Noel. Spatial prediction and site selection. *Proceedings of ASA/EPA Conferences on Interpretation of Environmental Data. III. Sampling and Site Selection in Environmental Studies.* Environmental Protection Agency (Washington, D.C.). Pp. 25-30. 1988.

This article considers various stochastic models that could be used in the prediction of pollutants at locations where no data are available, based on data taken from a spatial network of monitoring sites. The design problem of selecting those sites is also discussed.

CRESSIE, Noel. To adjust or not to adjust: U.S. census counts. *Stat Lab News*, No. 2 (1988) 7-8.

CRESSIE, Noel. Variogram. Pp. 489-491 in *Encyclopedia of Statistical Sciences, Vol. 9—Strata Chart to Zyskind-Martin Models*, edited by Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, executive editor. John Wiley & Sons (New York). 1988.

CRESSIE, Noel. A graphical procedure for determining nonstationarity in time series. *Journal of the American Statistical Association* 83:404 (1988) 1108-1116.

Integrated processes as models for time series data have proved to be an important component of the highly flexible class of ARIMA (p, d, q) models. Determining the amount of differencing, d, has been a difficult task: too little and the process is not yet second-order stationary; too much and the process is more variable than it need be. It is shown that by introducing the notion of generalized covariances, developed by Matheron (1973) for spatial processes, the amount of differencing needed can be read easily from a sequence of graphs showing averages of squares of primary data increments. Formal inference to determine if the last difference really is necessary can then be carried out. Time series data are analyzed in this way and compared with the hypothesis-testing approach illustrated by Dickey, Bell, and Miller (1986). Once the order of differencing has been diagnosed, either the differenced time series can be analyzed or the generalized covariance of the undifferenced series can be estimated.

CRESSIE, Noel. When are census counts improved by adjustment? *Survey Methodology* 14:2 (1988) 191-208.

There are persuasive arguments for and against adjustment of the U.S. decennial census counts, although many of them are based on political rather than technical considerations. The decision whether or not to adjust depends crucially on the method of adjustment. Moreover, should adjustment take place using, say, a synthetic-based or a regression-based method, at which level should this occur and how should aggregation and disaggregation proceed? In order to answer these questions sensibly, a model of under-count errors is needed that is "level-consistent" in the sense that it is preserved for areas at the national, state, county, etc. level. Such a model is proposed in this article; like subareas are identified with strata such that within a stratum the subareas' adjustment factors have a common stratum mean and have variances inversely proportional to their census counts. Empirical Bayes estimators that combine information from the stratum average and the sample

value, can be constructed by taking into account sampling of the areas (e.g., by dual-system estimation). These estimators are evaluated at the state level (51 states, including Washington, D.C.), and stratified on race/ethnicity (3 strata) using data from the 1980 post-enumeration survey (PEP 3-8, for the non-institutional population).

CRESSIE, Noel. The many faces of spatial prediction. Pp. 163-176 in *Geostatistics, Volume 1*, edited by M. Armstrong. Kluwer Academic Publishers. 1989.

This article presents stochastic and nonstochastic methods of spatial prediction, using a unified notation. The geostatistical method (i.e., kriging in its various forms) has an advantage over other predictors in that it adapts to the quantity and quality of spatial dependence demonstrated by the data. Properties of the various methods are discussed very briefly.

CRESSIE, Noel, and Ngai H. Chan. Spatial modeling of regional variables. *Journal of the American Statistical Association* 84:406 (1989) 393-401.

In this article, accumulated sudden infant death syndrome (SIDS) data, from 1974-1978 and 1979-1984 for the counties of North Carolina, are analyzed. After a spatial exploratory data analysis, Markov random-field models are fit to the data. The (spatial) trend is meant to capture the large-scale variation in the data, and the variance and spatial dependence are meant to capture the small-scale variation. The trend could be a function of other explanatory variables or could simply be modeled as a function of spatial location. Both models are fit and compared. The results give an excellent illustration of a phenomenon already well-known in time series, that autocorrelation in data can be due to an undiscovered explanatory variable. Indeed, for 1974-1978 we confirm a dependence of SIDS rate on proportion of nonwhite babies born, along with insignificant spatial correlation. Without this regressor variable, however, the spatial correlation is significant. In 1979-1984, perhaps due to reporting bias or the effect of public-education programs in infant health, the proportion of nonwhite babies born is no longer an important explanatory variable.

CRESSIE, Noel, and Timothy R. C. Read. Cressie-Read statistic. Pp. 37-39 in *Encyclopedia of Statistical Sciences, Vol. 10—Supplement Volume*, edited by Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, executive editor. John Wiley & Sons (New York). 1989.

CRESSIE, Noel, and Timothy R. C. Read. Pearson's X^2 and the loglikelihood ratio statistic G^2: A comparative review. *International Statistical Review* 57:1 (1989) 19-43.

The importance of developing useful and appropriate statistical methods for analyzing discrete multivariate data is apparent from the enormous amount of attention that subject has commanded in the literature over the last thirty years. Central to those discussions has been Pearson's X^2 statistic and the loglikelihood ratio statistic G^2. Our review seeks to consolidate that fragmented literature and develop a unifying theme for much of that research. The traditional X^2 and G^2 statistics are viewed as members of the power-divergence family of statistics, and are linked through a single real-valued parameter. The principal areas covered in this comparative survey are small-sample comparisons of X^2 and G^2 under both classical (fixed-cells) assumptions and sparseness assumptions, efficiency comparisons, and various modifications to the test statistics (including parameter estimation for ungrouped data, data-dependent and overlapping cell boundaries, serially dependent data, and smoothing). Finally some future areas for research are discussed.

Kernan, W. J., Jr., P. J. Mullenix, R. Kent, D. L. Hopper, and **N. A. C. CRESSIE**. Analysis of the time distribution and time sequence of behavioral acts. *International Journal of Neuroscience* 43 (1988) 35-51.

A technique for analyzing the temporal structure between various initiations of a particular behavioral act has been developed using a parameter known as the K-function, the cornerstone of recent statistical research on spatial point processes and patterns. The technique has been extended to the study of the joint relationship of separate acts. Bootstrap methods are used to estimate the uncertainty in these measures. The usefulness of these techniques is demonstrated using data from studies of rats exposed to phenytoin and nitrous oxide.

Ruppert, David, **Noel CRESSIE**, and Raymond J. Carroll. A transformation/weighting model for estimating Michaelis-Menten parameters. *Biometrics* 45:2 (1989) 637-656.

There has been considerable disagreement about how best to estimate the parameters in Michaelis-Menten models. We point out that many fitting methods are based on different stochastic models, being weighted least squares estimates after appropriate transformation. We propose a flexible model that can be used to help determine the proper transformation and choice of weights. The method is illustrated by examples.

DAVID, H. A. General bounds and inequalities in order statistics. *Communications in Statistics—Theory and Methods* 17:7 (1988) 2119-2134.

This article is primarily a review of recent work on inequalities requiring no or only mild assumptions. As a special feature, unified approaches are given for the derivation of algebraic inequalities involving linear functions of order statistics. Various inequalities for the expected value of such functions are presented. A new result is that a class of these inequalities can be improved by use of a theorem for

ordered sums. Some other recent results are noted. Applications are indicated throughout.

DAVID, H. A. Studentized range. Pp. 39-43 in *Encylopedia of Statistical Sciences, Vol. 9—Strata Chart to Zyskind-Martin Models*, edited by Samuel Kotz and Norman L. Johnson, editors-in-chief, and Campbell B. Read, executive editor. John Wiley & Sons (New York). 1988.

This entry deals with the range of a random sample divided by a root-mean-square estimator calculated from either the same sample (internal studentization) or an independent sample (external studentization).

DAVID, H. A. Note on "An extreme null distribution approach to the problem of paired comparisons" by Patricia S. Costello and Douglas A. Wolfe. *Communications in Statistics—Theory and Methodology* 17:11 (1988) 4005-4009.

A suggestion made by David [in *The Method of Paired Comparisons*, Griffin, London (1963)] has been partially misinterpreted by Costello and Wolfe [*Communications in Statistics—Theory and Methodology* 16 (1987) 2327-2341]. Their proposed procedure is critically discussed. The general issue of what constitutes an appropriate test under possibly dependent observations is not confined to the method of paired comparisons.

HARVILLE, David A. Invariant inference for variance components. Pp. 117-133 in *Probability and Statistics: Essays in Honor of Franklin A. Graybill,* edited by J. N. Srivastava. Elsevier Science Publishers B. V. (Amsterdam). 1988.

Consider a general mixed linear model in which an observable random column vector $\mathbf{y}$ follows a multivariate distribution with mean vector $\mathbf{X}_0\beta_0$ and variance-covariance matrix $\theta_{k+1}\mathbf{I} + \Sigma_{i=1}^{k}\theta_i\mathbf{X}_i\mathbf{X}_i'$. Let $\mathbf{X}_i^* = (\mathbf{X}_0, \ldots, \mathbf{X}_i)$. A function $\mathbf{g}(\mathbf{y})$ of $\mathbf{y}$ is defined to be $\mathbf{X}_i^*$-invariant if $\mathbf{g}(\mathbf{y} + \mathbf{X}_i^*\mathbf{u}) \equiv \mathbf{g}(\mathbf{y})$ for every $\mathbf{u}$. Point estimators of $\theta_{i+1}, \ldots, \theta_{k+1}$ that are $\mathbf{X}_i^*$-invariant can be obtained via the method of fitting constants or via modified versions of the maximum likelihood, minimum variance quadratic unbiased, and Bayesian approaches. A general bootstrap-like method can be used to obtain $\mathbf{X}_i^*$-invariant approximate confidence intervals for $\theta_{i+1}, \ldots, \theta_{k+1}$.

Sallas, William M., and **David A. HARVILLE**. Noninformative priors and restricted maximum likelihood estimation in the Kalman filter. Chapter 17 in *Bayesian Analysis of Time Series and Dynamic Models*, edited by J. C. Spall. Marcel Dekker, Inc. (New York). Pp. 477-508. 1988.

In applications, Kalman filters formulated from a full Bayesian perspective frequently assume too much is known about the state-space model to be of use by themselves. The model may contain unknown parameters that must be estimated. These unknown parameters could enter (1) as fixed states in the state equation and/or (2) as elements in the state transition matrix or state- or observational-error variance-covariance matrices. The use of a noninformative (diffuse) prior distribution is shown to be useful in understanding and estimating these unknown parameters. In this framework, recursive mixed model estimators [Sallas and Harville, *Journal of the American Statistical Association* 76 (1981) 860-869] useful for (1) are reviewed. The estimator derived for (2) is a restricted maximum likelihood estimator [Patterson and Thompson, *Biometrika* 58 (1971) 545-554]. In many applications, existing programs can be used to compute these estimators. A least squares program, a Kalman filter program, and an optimization program provide the necessary software.

HONG, Chong Sun (Sung Kyun Kwan University, Seoul, South Korea), and **H. T. DAVID**. Granularity and efficiency. *Journal of the American Statistical Association* 83:403 (1988) 880-885.

J. M. Hammersley [*Journal of the Royal Statistical Society*, Series B, 12 (1950) 192-240] considered the asymptotic relative efficiency (ARE) of the rounded sample median M_ε with respect to the rounded sample mean $\bar{X}_\varepsilon$ as estimate of a Normal population mean restricted to a uniform grid of mesh size 2ε. This article extends Hammersley's work to a certain class of *two-sided extended increasing failure rate* (TEIFR) distributions for which the (grid-valued) population mean and median coincide, their common value designated as μ. The ARE of M_ε with respect to $\bar{X}_\varepsilon$ as estimators of μ, is examined for our class via the theory of large deviations.

Hulting, Fred, and **Sarah Nusser**. The Iowa Staters. *Stats*, No. 1 (Spring 1989) 16-17.

Tips for activating student organizations, based on the experiences of the Iowa STAT-ers, the statistics graduate student club at Iowa State University, are presented.

Jensen, Karen L., Stephen V. Crowder (ISU and Corning Glass Works), and **Stephen B. VARDEMAN**. An interactive probability plotting program. *Journal of Quality Technology* 20:3 (1988) 196-210.

An interactive FORTRAN program is presented that allows the user to produce probability plots (theoretical quantile-quantile plots) for an input data set based on several types of theoretical distributions. The program provides normal, two-parameter lognormal, three-parameter lognormal, right-tail half-normal, left-tail half-normal, exponential, two-parameter Weibull, and three-parameter Weibull plots. The present version of the program allows data entry and editing from the keyboard (not from stored files) and will accept up to 100 data values. This upper limit could easily be modified.

Anderson-Hsieh, Janet, and **Kenneth KOEHLER**. The effect of foreign accent and speaking rate on

native speaker comprehension. *Language Learning* 38:4 (1988) 561-613.

This study investigated the effect of foreign accent and speaking rate on native speaker comprehension. The speakers for the study were three native speakers of Chinese, with TSE (Test of Spoken English) comprehensibility scores of 180, 200, and 260, and one native speaker of American English. The speakers each read passages at three different speaking rates. The tape-recorded passages were then presented to native speakers of American English who responded to them by taking a listening comprehension test and rating the speech samples. The results showed that the comprehension scores were significantly higher for the native passages than for the nonnative passages and significantly higher at the regular rate than at the fast rate for all speakers. It was also found that the increase in speaking rate from the regular to the fast rate resulted in a greater decrease in comprehension for the most heavily accented speaker than for the other speakers, indicating that speaking rate is more critical for the comprehension of heavily accented speech. In addition, the results suggested that prosodic deviance may affect comprehension more adversely than does segmental deviance.

LORENZ, Frederick O., and Dan Muhwezi. How some regional councils have survived. *Sociology and Social Research* 73:2 (1989) 99-104.

Regional councils are voluntary planning associations of local governments. As federal support for planning has waned, many regional councils have not survived. Using published data on 325 U.S. regional councils, we found that many councils have survived, even thrived, by enacting proactive strategies that redirect efforts away from federally encouraged projects to locally encouraged priorities.

Saenz, Rogelio, Willis J. Goudy, and **Frederick O. LORENZ**. The effects of employment and marital relations on depression among Mexican American women. *Journal of Marriage and the Family* 51:2 (1989) 239-251.

Using data from a 1979 National Chicano Survey, this paper found that employed women received more help from their husbands with housework. Those receiving more help from their husbands reported higher marital satisfaction even though employed women experienced overall lower levels of marital satisfaction. Using path analysis, the results showed support for a model that marital satisfaction and husband's help with housework both decreased women's depression. Depression was not related to employment status but, among employed women, depression was significantly higher among those holding less prestigious jobs.

POLLAK, Edward. On the theory of partially inbreeding finite populations. II. Partial sib mating. *Genetics* 120:1 (1988) 303-311.

Journal Paper No. J-12797 of the Iowa Agriculture and Home Economics Experiment Station, Project 2588.

It is assumed that a population has M males in every generation, each of which is permanently mated with $c - 1$ females, and that a proportion β of matings are between males and their full sisters or half-sisters. Recurrence equations are derived for the inbreeding coefficient of one random individual, coefficients of kinship of random pairs of mates, and probabilities of allelic identity when the infinite alleles model holds.

If F_t is the inbreeding coefficient at time t and M is large, $(1 - F_t)/(1 - F_{t-1}) \to 1 - 1/(2N_e)$ as t increases. The effective population number $N_e \doteq aM/[1 + (2a - 1)F_{IS}]$, where F_{IS} is the inbreeding coefficient at equilibrium when M is infinite and the constant a depends upon the conditional probabilities of matings between full sibs and the two possible types of half-sibs. When there are M permanent couples, an approximation to the probability that an allele A survives if it is originally present in one $A\bar{A}$ heterozygote is proportional to $F_{IS}s_1 + (1 - F_{IS})s_2$, where s_1 and s_2 are the selective advantages of AA and $A\bar{A}$ in comparison with $\bar{A}\bar{A}$.

The paper concludes with a comparison among the results when there is partial selfing, partial full sib mating ($c = 2$), and partial sib mating when c is large.

Jung, Y. C., M. F. Rothschild, M. P. Flanagan, **E. POLLAK**, and C. M. Warner. Genetic variability between two breeds based on restriction fragment length polymorphisms (RFLPs) of major histocompatibility complex class I genes in the pig. *Theoretical and Applied Genetics* 77:2 (1989) 271-274.

Journal Paper No. J-12957 of the Iowa Agriculture and Home Economics Experiment Station, Projects 1901, 2594, and 2609.

Restriction fragment length polymorphism analyses of SLA class I genes were performed on 55 Duroc and 24 Hampshire boars from the 1986-87 national performance tests of each breed. Few boars were inbred. Southern blotting and hybridization procedures were performed on genomic DNA isolated from white blood cells by using Pvu II, Bam HI, and Eco RI endonucleases and a swine MHC class I probe. Genetic variability within and between the two breeds was estimated in terms of nucleotide diversity, by using a mathematical analysis based on the different RFLP patterns. The nucleotide diversity calculated within each breed was less than that between the two breeds. The results from the nucleotide diversity analysis suggested that genetic variability was greater in the Duroc breed than in the Hampshire breed. A relatively high level of genetic variability was shown in the class I major histocompatibility complex genes in the pig.

ROBERTS, Carl W. Imagining God: Who is created in whose image? *Review of Religious Research* 30:4 (1989) 375-386.

Evidence is presented of a correspondence between images of God and images of self among a sample of 185 residents of a Midwestern university town. Respondents' God-images follow the well-established pattern of a two-dimensional characterization of the godhead as both nurturing and disciplining. Although the analysis provides support for self-esteem theory, this and other projection theories of the development of divine images do not explain why those two dimensions have been recurrently found in the literature. A variety of theoretical arguments are given that portray social processes potentially involved in the emergence of the nurturing and disciplining images.

SACKS, Jerome M., Steven R. Bolin, and **Stephen V. Crowder** (Corning Glass Works). Prevalence estimation from pooled samples. *American Journal of Veterinary Research* 50:2 (1989) 205-206.

Under certain conditions, the prevalence of pathogen-carrying members of a population can be estimated by testing samples from individual members or by pooling samples from members into a group and testing the sample from the group as a single unit. The study reported here was made to develop P rates from pooled tests and to determine the optimal group size to estimate low P rates. Pooled tests are more accurate than individual tests when P is <10 percent. Optimal group size is 1.6/P. Efficiency decreases slowly with suboptimal size and rapidly with overly large size.

Thurston, John R., **Jerome M. SACKS**, John L. Richard, W. Michael Peden, and Kim Driftmier. Complement, bacteriostatic, and enzymatic activities in sera from guinea pigs given aflatoxin and/or rubratoxin. *American Journal of Veterinary Research* 50:3 (1989) 356-358.

The relationship of serum complement activity and bacteriostatic activity was investigated in two experiments involving male guinea pigs given aflatoxin and/or rubratoxin. Aflatoxin (0.02mg/kg) had no effect alone, but potentiated the effect of rubratoxin. In both experiments, changes in complement activity were accompanied by similar but not always statistically significant ($P < 0.05$) changes in bacteriostatic activity of serum. Guinea pigs given rubratoxin or rubratoxin with aflatoxin were consistently lighter than guinea pigs not given rubratoxin.

Schnell, Dan (Centers for Disease Control), **William J. KENNEDY**, **Gary Sullivan**, **Heon Jin Park**, and **Wayne A. FULLER**. Personal computer variance software for complex surveys. *Survey Methodology* 14:1 (1988) 59-69.

A personal computer program for variance estimation with large scale surveys is described. The program, called PC CARP, will compute estimates and estimated variances for totals, ratios, means, quantiles, and regression coefficients.

SHELLEY, Mack C., II, William F. Woodman, Brian J. Reichel, and Paul Lasley. On the role of universities and biotechnology in economic development and public policy. *Policy Studies Journal* 17:1 (1988) 95-108.

This study examines the complicated relationship between high-technology industry as an engine of economic development and the public policy-making process. Without question there are extant economic benefits accruing from high technology industries, as well as a widely-held faith that the proper policy steps will lead first to the attracting of high technology industries and subsequently to greater prosperity.

As a case study, the State of Iowa's investment of $17 million (over four years) for a "center of excellence" in biotechnology represents an excellent opportunity to examine the policy-development connection. Toward that end, this analysis examines the opinions of key groups involved in the policy development process. The pertinent groups surveyed in the present paper include university administrators; faculty (both those doing biotechnology research and those not involved); graduate students; all U.S. biotechnology companies having university research activities; Iowa farm operators; and, finally, legislators in the State of Iowa. The results of this study are examined, and some implications for further research directions are discussed.

Lasley, Paul, William F. Woodman, **Mack C. SHELLEY, II**, Gordon L. Bultena, and Brian J. Reichel. Social considerations of transgenic animal research. Pp. 121-139 in *Proceedings of the Transgenic Animal Research Workshop*. (Ames, Iowa: Studies in Technology and Social Change No. 10, Technology and Social Change Program, Iowa State University) 1989.

Transgenic animal research and the closely related scientific achievements made possible under the generic label of biotechnology represent a paradigm shift (Kuhn, 1970). In this sense, DNA recombinant techniques represent a fundamental shift from traditional genetic research. Beyond the new research techniques developed over the past decade is the set of social values and beliefs that surround this research thrust. Thus, not only is society faced with a new set of technological skills to understand better and in some cases manipulate the basic building blocks of life, but there are also numerous, often troubling, questions about the moral, ethical, and social dimensions of these techniques.

It is apparent that the questions being raised are complex, and there is little societal concensus over them. The scant literature on the public perception of transgenic research is elementary and suggestive. The larger body of literature on biotechnology provides little guidance to answering the question of the social considerations. This paper reviews several studies that specifically address transgenic research, and concludes by identifying likely social issues that will become more pronounced as transgenic research moves from theoretical considerations into practice.

Gentle, James E., **V. A. SPOSITO**, and Subhash C. Narula. Algorithms for unconstrained L_1 simple linear regression. *Computational Statistics and Data Analysis* 6:4 (1988) 335-339.

Many algorithms have been proposed for L_1 simple linear regression computations, and several codes implementing these algorithms are now available. Some of these algorithms are based on a linear programming formulation, while others propose a descent approach.

We report on a computational study comparing L_1 computer programs for solving the simple linear regression problem.

SPOSITO, V. A., and **M. B. Tirol** (University of Iowa). Computational aspects of the two-way classification model under L_1. *Journal of Computational Statistics Quarterly* 4:4 (1989) 289-298.

It is initially shown how the dual problem of the general classification model under L_1 (minimizing the sum of absolute deviations), can be formulated as a capacitated transportation problem. It is well-known that obtaining an initial feasible solution for such problems is not as straightforward as in the uncapacitated situation; in particular, these procedures will not necessarily generate a feasible solution for the capacitated problems.

A computational procedure is given that will *always* generate a feasible solution for the dual problem of the two-way classification model under L_1; moreover, a simple upper bounding computational procedure is presented to solve this type of problem.

STEPHENSON, W. Robert. Mu Sigma Rho ($\mu\sigma\rho$): The national statistical honor fraternity. *Stats*, No. 1 (1989) 17-18.

This article is a brief discussion of the origins and growth of Mu Sigma Rho and minimum qualifications for membership.

STRAHAN, R. F. Productivity, reputation, and correlational metric. *American Psychologist* 44:4 (1989) 736-737.

This note examines inter-study differences in the relation between reputational ratings and research productivity of United States psychology departments. It shows that part of the discrepancy is due simply to metric differences in the Kendall's tau and Spearman's rho correlation coefficients that were used in the different studies. It further demonstrates that a correlational approach is inappropriate if one's interest lies in individual psychology departments.

STUFKEN, J. On bounds for the efficiency of block designs for comparing test treatments with a control. *Journal of Statistical Planning and Inference* 19:3 (1988) 361-372.

We study the class of augmented balanced incomplete block designs. These designs are used to compare a standard treatment with a set of test treatments under a one-way elimination of heterogeneity. Under the A-criterion we establish a condition that enables us to determine the most efficient augmented designs. We suggest some methods to compute a lower bound for the efficiency of these designs. For $3 \leq k \leq 10$, $k \leq v$ we list the parameters of the most efficient designs with a lower bound for their efficiency or, if known, indicate their optimality.

Hedayat, A. S., C. R. Rao, and **J. STUFKEN**. Designs in survey sampling avoiding contiguous units. Pp. 575-583 in *Handbook of Statistics 6: Sampling*, edited by P. R. Krishnaiah and C. R. Rao. North-Holland, Amsterdam. 1988.

We consider fixed size sampling plans for which the second order inclusion probabilities are zero for pairs of contiguous units and constant for pairs of noncontiguous units. These plans were first studied by Hedayat, Rao, and Stufken, *Journal of Statistical Planning and Inference* 19:2 (1988) 159-170. Additional results on the implementation and construction of these plans are obtained.

Hedayat, A., and **J. STUFKEN**. Two-symbol orthogonal arrays. Pp. 47-58 in *Optimal Design and Analysis of Experiments*, edited by Y. Dodge, V. V. Fedorov, and H. P. Wynn. North-Holland, Amsterdam. 1988.

Orthogonal arrays were introduced by C. R. Rao, *Proceedings of the Edinburgh Mathematical Society* 8:2 (1947) 119-125. In recent years these combinatorial structures have been rediscovered as useful fractional factorial designs by workers in areas of quality control. Arguably the most useful orthogonal arrays are those in which all factors are at two levels. Results on the construction and the maximum number of factors in such orthogonal arrays are presented.

STUFKEN, J. On the existence of linear trend-free block designs. *Communications in Statistics—Theory and Methods* 17:11 (1988) 3857-3863.

We present a class of counterexamples for a conjecture on the existence of linear trend-free block designs. We also prove a considerably weakened version of this conjecture, that will determine all combinations of design parameters for which the class of linear trend-free block designs is non-empty.

Hedayat, A., and **J. STUFKEN**. On the maximum number of constraints in orthogonal arrays. *The Annals of Statistics* 17:1 (1989) 448-451.

We show that a bound by Bush [*Annals of Mathematical Statistics* 23 (1952) 426-434] for the maximum number of constraints in orthogonal arrays of index unity is uniformly better than a bound by Rao [*Proceedings of the Edinburgh Mathematical Society* 8:2 (1947) 119-125].

SUKHATME, S. Kriging with perturbed variogram. *Journal of the Indian Statistical Association* 27 (1989) 79-88.

It is well known that the kriging weights used in "block kriging" depend upon three parameters: (i) variogram model for the underlying intrinsic stochastic process, (ii) the geometrical configuration of the sample locations, (iii) block shape and geometrical relationship of the block to the sample location configuration. Recently, D. E. Myers and M. Armstrong (Technical report Centre de Geostatistique) have shown that, if one or more of these parameters are perturbed, the kriging weights can be obtained by solving an equation of the form $(A + \varepsilon B)\ \mathbf{x}(\varepsilon) = \mathbf{b}(\varepsilon)$. In this note the author has exploited a special form of the kriging equation by using perturbation theory to obtain approximations to kriging weights. The technique is particularly applied when the variogram is of the form (i) $\gamma_1 + \varepsilon\gamma_2$ or (ii) $(1 - \varepsilon)\gamma_1 + \varepsilon\gamma_2$, $0 < \varepsilon \leq 1$, that is, the variogram belongs to a neighborhood of γ_1 in the direction of γ_2.

VARDEMAN, Stephen B. The discipline of statistics in 20th century American industry and technology. Pp. 21-31 in *The Balomenos Lectures: Mathematics in Society and the Curriculum*, D. H. Van Oscol, ed. University of New Hampshire. 1988.

The last ten years have been ones of rapid expansion and rethinking of the statistical profession's role in American industry and technology. This lecture describes one mathematically trained statistician's views on the origins of these changes, the form they've taken, some implications for teaching, research and university/industry cooperation and the opportunities and pitfalls they present in the late 1980s and the 1990s.

Lee, Ted S., Eric M. Malstrom, **Stephen B. VARDEMAN**, and Volker P. Peterson. On the refinement of the variable lead time/constant demand lot-sizing model: The effect of true average inventory level on the traditional solution. *International Journal of Production Research* 27:5 (1989) 883-899.

This paper considers lot-sizing situations where lead time is allowed to vary in accordance with a known, discrete probability distribution. The demand during lead time is assumed to be constant. This paper refines the traditional analysis approach by redefining the base average inventory to account for lower average values under conditions of stockouts. An inventory-level correction factor is introduced that results in order quantity polynomials. Differences in lot-sizing policies between the two methods are enumerated, as are conditions where the two approaches yield approximately the same results.

Chang, M. N., **H. S. WIEAND**, and V. T. Chang. The bias of the sample proportion following a group sequential Phase II clinical trial. *Statistics in Medicine* 8 (1989) 563-570.

Group sequential testing procedures have seen wide use in phase II clinical trials. The sample proportion $\hat{p}$ of responders is the commonly used estimator for the binomial response probability p. It can be shown that $\hat{p}$ is the maximum likelihood estimator (MLE) of p. It is well known that the MLE in general and $\hat{p}$ in particular can be biased if their computation follows a group sequential procedure. The bias of $\hat{p}$ is numerically investigated and shown to be less than 0.025 in cases of interest. A bias-adjusted estimator is proposed that in some cases is preferable to the MLE and the uniformly minimum variance unbiased estimator.

Schaid, D. J., J. N. Ingle, **S. WIEAND**, and D. L. Ahmann. A design for Phase II testing of anticancer agents within a phase III clinical trial. *Controlled Clinical Trials* 9 (1988) 107-118.

A design for testing new anticancer agents is proposed such that the initial testing of new agents (phase II trials) is included within the framework of a comparative clinical trial (phase III). Randomization between phase II trials and the treatment groups of the phase III trial enforces consistency of patient selection and evaluation of response criteria. Patients who progress on the phase II trials of the new agents are randomized to one of the treatments of the phase III trial. Design issues, such as sample size and power, and analysis of the proposed design, are discussed. Advantages and disadvantages of the design are illustrated by sample size calculations for a current clinical trial in advanced breast cancer.

Lundholm, Jean K., Dominick D. Pellegreno, **Leroy WOLINS**, and Samuel L. Graham. Predicting eating disorders in women: A preliminary measurement study. *Measurement and Evaluation in Counseling and Development*. 22:1 (1989) 23-30.

This study identified Millon Clinical Multiaxial Inventory (MCMI) items that differentiated eating-disordered women from university women. Item content revealed the eating-disordered women to be socially withdrawn and depressed.

Pease, Damaris, Robert Boger, Janet N. Melby, Judy Pfaff, and **Leroy WOLINS**. Reliability of the *Q*-Sort Inventory of Parenting Behaviors. *Educational and Psychological Measurement* 49:1 (1989) 11-17.

Test-retest reliability on the *Q*-Sort Inventory of Parenting Behaviors was obtained by using a sample of 30 mothers of 3-year-old children. The inventory consists of 72 statements, each of which describes a different parenting behavior and utilizes a forced-choice format. Mothers independently sorted the statements into nine ordered categories along a continuum from "most like me" to "least like me" and repeated the sort 2 weeks later.

Analysis of variance and Pearson product-moment correlations indicated that the within-subject correlation between first and second sorts was 0.72. Of this total variability, 0.37 was common to all mothers. This variability was probably engendered by variance in social desirability of the items. Of the variance, 35 percent was due to reliable differences among respondents in the profile of item responses.

Zimmerman, Dale L. (University of Iowa), and **David A. HARVILLE**. On the unbiasedness of the Papadakis estimator and other nonlinear estimators of treatment contrasts in field-plot experiments. *Biometrika* 76:2 (1989) 253-259.

Spatial methods for the analysis of field-plot experiments are considered. Estimators of treatment contrasts obtained by these methods are generally complicated nonlinear functions of the observations. Sufficient conditions for these estimators to be unbiased under a postulated true model are obtained.

Book Reviews, Etcetera

CRESSIE, Noel. *Asymptotics for Generalized Chi-square Goodness-of-fit Tests* (CWI Tract 48), by F. C. Drost. ISBN 90 6196 348 6. Centrum voor Wiskunde en Informatica. Stichting Mathematisch Centrum, Amsterdam, 1988. Dfl 16.50. Reviewed in *Journal of the Royal Statistical Society, Series A* 152:Part 2 (1989) 258-259.

STUFKEN, John. *Optimal Paired Comparison Designs for Factorial Experiments*, by E. E. M. van Berkum. Amsterdam: Centre for Mathematics and Computer Science, 1987. ii + 153 pp. Dfl. 24.20. Reviewed in *Journal of the American Statistical Association* 83:403 (September 1988) 909-910.

VARDEMAN, Stephen B. *Acceptance Sampling in Quality Control*, by E. G. Schilling. Statistics: Textbooks and Monographs Series, Vol. 42, Marcel Dekker, Inc., New York, 1982, ISBN 0-8247-1347- 8, xx + 775 pp., $65.00. Reviewed in *Journal of Official Statistics* 4:3 (1988) 272-273.

Thesis Abstracts

Beam, Craig Allen. The comparison of diagnostic tests when one is based upon a discrete separator variable and the others are based upon continuous separator variables. Ph.D. thesis, Iowa State University Library. May 1989.

A statistical method is developed for the comparison of diagnostic tests when one test is based upon a discrete separator variable and the other(s) is/are based upon a continuous separator variable(s). This is a situation in which present statistical methods are not always appropriate.

The method so developed makes "point-wise" comparisons of the sensitivities of the diagnostic tests after they have been set to have each of the specificities attainable by the one with the discrete separator variable. It is shown that, under very mild conditions, the vector of such comparisons is asymptotically multivariate normal. Monte Carlo studies show hypothesis testing procedures based upon this method have good power, but also tend to be anticonservative. This latter problem is seen to arise mainly from the required specificity estimation and to be alleviated with greater sample sizes. Several additional "fixes" to this problem are also examined. Application of the method to two published data sets is presented.

Carriquiry, Alicia Laura. Bayesian prediction and its application to the genetic evaluation of livestock. Ph.D. thesis, Iowa State University Library. May 1989.

Let y represent an $n \times 1$ observable random vector that follows the mixed linear model $\mathbf{y} = \mathbf{X}\underset{\sim}{\beta} + \mathbf{Zs} + \mathbf{e}$. Here, $\mathbf{X}$ and $\mathbf{Z}$ are specified matrices, $\underset{\sim}{\beta}$ is a vector of unknown fixed parameters, and $\mathbf{s}$ and $\mathbf{e}$ are statistically independent random vectors with $E(\mathbf{e}) = \mathbf{0}$, $E(\mathbf{s}) = \mathbf{0}$, $\text{var}(\mathbf{e}) = \sigma_e^2\mathbf{I}$, and $\text{var}(\mathbf{s}) = \sigma_e^2\gamma\mathbf{A}$, where $\mathbf{A}$ is a known, positive definite matrix. Further, σ_e^2 and γ are unknown, scalar-valued parameters such that $\sigma_e^2 > 0$ and $0 \leqq \gamma \leqq u$, where u is a specified constant.

The problem considered is that of Bayesian inference for a predictable random variable $w = \underset{\sim}{\lambda}'\underset{\sim}{\beta} + \underset{\sim}{\psi}'\mathbf{s}$, for the case where the prior distribution of $\underset{\sim}{\beta}$ is noninformative. It is shown that the problem of computing the posterior mean, variance, and density of w can be reduced to that of numerically evaluating one-dimensional integrals, provided the distribution of σ_e^2 and γ is of a given general form.

The mean of the posterior distribution of w can be approximated by $\hat{w} = \underset{\sim}{\lambda}'\underset{\sim}{\hat{\beta}} + \underset{\sim}{\psi}'\hat{\mathbf{s}}$, where $\underset{\sim}{\hat{\beta}}$ and $\hat{\mathbf{s}}$ are the mode of the joint posterior distribution of $\underset{\sim}{\beta}$ and $\mathbf{s}$. If there is no upper bound on γ, the computation of $\hat{w}$ does not require numerical integration. The problem of computing a $100(1-\alpha)\%$ highest posterior density (HPD) credible set for w can be reduced to that of solving a constrained minimization problem.

The feasibility of the Bayesian methodology was evaluated by applying the methodology to predict the genetic merit of a large number of dairy bulls.

Guo, Renkuan. Bayesian component reliability assessment with system data. Ph.D. thesis, Iowa State University Library. May 1989.

This work provides a Bayes approach to inference on a particular parameter p_1, when the sample likelihood depends on P_1 only through a function $\Theta = g(p_1,p_2)$ of p_1 and a second parameter p_2; in that case, the posterior mean of p_1 turns out to be a generalized posterior moment of Θ. An example of this is the case when only system performance data are available but component performance evaluation is desired.

Bayes inference on p_1 is addressed from both the small-sample and asymptotic points of view, includ-

ing the comparison of the posterior mean of p_1 with several of its approximations. For a certain special case of the system example above, hypergeometric forms are given for the posterior mean of p_1, and its approximations.

Hong, Chong Sun. Granularity and efficiency. Ph.D. thesis, Iowa State University Library. August 1988.

The asymptotic relative efficiency (ARE) of the rounded sample median M_r with respect to the rounded sample mean $\bar{X}_r$ has been considered in the literature for estimating of a Normal population mean restricted to a uniform grid of mesh size 2ε. This dissertation extends that work, using large deviations, to a certain class of symmetric "two-sided extended increasing failure rate" (TEIFR) distributions.

Even within our somewhat narrow class, we find the ARE of M_r with respect to $\bar{X}_r$ to be surprisingly sensitive to distribution shape, as well as to grid mesh size and to the actual definition of the ARE. Among our findings is the fact that, in the symmetric TEIFR class, the ARE of M_r with respect to $\bar{X}_r$ is continuous in ε at $\varepsilon = 0$ under a definition of the ARE closely related to the commonly used limiting ratio of equivalent sample sizes. A related finding is that, within the TEIFR class, the "asymptotic effective variance" of the sample median M equals its asymptotic variance as usually defined.

Another finding is that, in the case of the Laplace distribution, M_r is asymptotically more efficient than $\bar{X}_r$, as estimator of the grid-valued population center, when the grid is fine (ε small), but an asymptotically less efficient estimator when the grid is coarse (ε large). This finding bears on certain tests of hypotheses.

Multivariate and regression aspects also are considered.

Jensen, Karen Lorraine. Optimal adjustment in the presence of process drift and adjustment error. Ph.D. thesis, Iowa State University Library. May 1989.

A state space process control model involving deterministic drift of the process mean and adjustment error is presented. A Kalman filter estimator of the process mean is developed. Optimal adjustment strategies based on this Kalman filter estimator are developed by the technique of dynamic programming for two special cases of the model and for the general model. The optimal policy in the general case calls for an adjustment to the process when the estimate of the process mean is outside an interval bounded by lower and upper action limits. The action limits depend on the variability associated with the Kalman estimator. The optimal adjustment consists of compensation for the currently perceived misadjustment of the process mean and the anticipated drift, and possibly, depending on the cost of adjustment and the size of the drift, a small overcompensation to anticipate future drift. Computational methods for approximating the action limits and overcompensation constants are presented. The effects of parameter values on these limits and constants are described.

Kim, Song-Ho. Stochastic comparisons of order statistics. Ph.D. thesis, Iowa State University Library. December 1988.

Let $X_1, \ldots, X_n$ and $Y_1, \ldots, Y_n$ be independent random samples from distributions with respective c.d.f.s $F(x)$ and $G(x)$. If X is stochastically smaller than Y ($X \underset{st}{\leq} Y$), i.e., $F(x) \geq G(x)\ \forall\ x$, then it is well known that $X_{r:n} \underset{st}{\leq} Y_{r:n}$. Stochastic ordering is a very strong kind of ordering. Consequently, many other weaker orderings have been studied in the statistical literature. In this dissertation, the properties of order statistics under these orderings are investigated extensively.

Order statistics are dependent because of the inequality relations among them. It is well known that $\mathrm{cov}(X_{r:n}, X_{s:n}) \geq 0$ under the i.i.d. assumption. However, $\mathrm{cov}(X_{r:n}, X_{s:n})$ can be negative if $X_1, X_2, \ldots, X_n$ are sufficiently negatively dependent. More generally, the following question arises: Is it necessarily true that in random samples the covariance of two order statistics $X_{i:n}$, $X_{j:n}$ decreases as i and j draw apart? Tukey [*Annals of Mathematical Statistics* 29:588-592, 1958] was the first to study this and related questions. Here Tukey's pioneering results are corrected, extended, and illustrated numerically for selected distributions.

Mingoti, Sueli Aparecida. Estimating the total number of distinct species when quadrat sampling or sampling by elements is used. Ph.D. thesis, Iowa State University Library. May 1989.

The problem of estimating the total number T of distinct species in some specified region based on a random sample from the region is discussed. Two sampling procedures are of interest, sampling by elements and quadrat sampling.

In the case of sampling by elements, we assume that the investigator has available a list containing a total of M known species. The population of species in the region is assumed to be the union of two groups. Group one contains all those species that are on the list and appear in the region. Group two contains the remaining species that are unknown and do not appear on the list. An admissible stepwise Bayes estimator is derived for T by imposing a known distribution ϕ on the total number of species in group two and a Dirichlet density on the relative abundances of the species in group two. (Admissible estimators are also presented for the case where $\beta \to 0$ and $\beta \to \infty$.)

In the case of quadrat sampling, two models are discussed. The first is basically a version of the Efron and Thisted (*Biometrika*, 1976) model adapted to the case of quadrat sampling. Some empirical Bayes estimators for T are derived and compared to the jackknife and the bootstrap estimators proposed by

Heltshe and Forrester (*Biometrics*, 1983), and Smith and Belle (*Biometrics*, 1984). The second model discusses the case where the species in the region have exactly two replicas. Admissible stepwise Bayes estimators are derived for T in this case, and an application in archaeology is presented.

Nanayakkara, Nuwan. Heteroskedasticity-robust estimation. Ph.D. thesis, Iowa State University Library. May 1989.

The properties of the usual one-sample T-statistic under nonnormal universes are investigated using Edgeworth expansions, and the findings reinforce the observations made by many authors in the past.

Sufficient conditions for combining two independent unbiased estimators of a common mean in order to obtain a uniformly better (in variance sense) unbiased estimator are given. An upper bound for the inefficiency of such an estimator is also presented using a Kantorovich inequality.

Heteroskedasticity-robust test procedures for the one-sample and two-sample problems are developed. An unbiased estimator of the variance of the ordinary least squares estimator of the slope parameter of a heteroskedastic simple linear regression model without intercept is given, and performance of this estimator is assessed using Monte Carlo simulations.

Sung, Nae Kyung. Cramér-Rao analogues for median-unbiased estimators. Ph.D. thesis, Iowa State University Library. December 1988.

Building on the work of Alamo, and Stangenhaus and H. T. David, in this dissertation we develop analogues of the Cramér-Rao inequality for median-unbiased estimators having absolutely continuous distributions, based on certain measures of dispersion that we call diffusivity. Three kinds of the diffusivity are defined.

When we have a distribution depending upon a single real-valued parameter, the analogues of the Cramér-Rao inequality for median-unbiased estimators show the same pattern as the Cramér-Rao inequality itself, with the Fisher information and the variance in the Cramér-Rao inequality replaced by the first absolute moment of the sample score and the diffusivity of the median-unbiased estimator, respectively. An analogue of the Chapman-Robbins inequality that is free from regularity conditions is also given.

We identify optimal median-unbiased estimators of the location and scale parameters for special location and scale families of distributions. The multivariate and multi-parameter cases also are studied, and the role of mode-unbiasedness in median-unbiased estimation is discussed.

Department of Statistics

The Department of Statistics offers courses leading to the degrees 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 by the Graduate College. A Master of Science degree in operations research is offered jointly with the Department of Industrial Engineering.

Because of low enrollment, it was decided to remove from the next catalog the undergraduate curriculum in biometry, which has been administered by the Department of Statistics and led to a B.S. degree conferred by the College of Agriculture.

Undergraduates in statistics may choose co-majors if they wish. M.S. candidates may choose either the thesis or the nonthesis option. The latter requires completion of additional credits, including a creative component representing at least two credits of independent work. Joint majors are not frequent at the M.S. level but a Ph.D. student may choose a joint major in order to add depth in an area of application. More information is given in the departmental brochure, "Iowa State University—Graduate Program in Statistics," which is available upon request.

Two experimental courses were offered during the year. Stat 333x, Probability and Statistics for Electrical and Computer Engineers, offered in the fall and spring, becomes a regular offering starting with the 1989-91 ISU catalog. It has been approved for graduate minor credit. The course is an accelerated introduction to applied probability and statistical methods, including applications in reliability and quality control. Stat 557x, Statistical Methods for Counts and Proportions, is a graduate-level course designed (1) to introduce some of the statistical methods commonly used to analyze discrete data, (2) to illustrate how the analyses may be performed with available software packages like SAS* and BMDP, and (3) to develop general large sample methods that can be applied to a great variety of problems.

In addition, an introductory course on business statistics was offered in Des Moines, Iowa, as Stat 227x, by Brian Teasley.

Informal seminars on Time Series and Spatial Processes were held on February 21, 22, 23, and 28, during the visit of Chen Zhao-Guo from the Chinese Academy of Sciences. Speakers included Chen, Noel Cressie, and Heon Jin Park.

Paul Hinz gave a guest lecture, on the topic of statistics and experimental design for controlled ex-

periments, for Hort 521, Controlled Plant Environments, on February 9, 1989. On March 15 he conducted a statistics workshop for in-service training for area crop production specialists.

In 1988-89, progress continued on equipping research and consulting faculty and secretarial staff in the Statistical Laboratory and Department of Statistics with Zenith-386 and Zenith-248 microcomputers and software.

Course offerings for the 1988-89 academic year and the 1988 summer session, with primary catalog listing in statistics, are listed below. A few courses with primary listing in mathematics or industrial engineering may also be taken for statistics credit at the undergraduate or graduate level.

1988-89 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,SS Andrews Beam Long	 Mundfrom Russey Stephenson
104	Introduction to Statistics	3	F,S,SS Coffin Freire Hotchkiss	 Long Rathbun Sukhatme
105	Introduction to Statistics	2	F,S Isaacson Kennedy	 Vardeman
201	Regression Analysis for Business	2	F	Nanayakkara
227	Introduction to Business Statistics	5	F,S,SS Castrogiovanni Cutler Homblé Iversen Lindstrom	 McKeown Meeker Nanayakkara Robison-Cox Symanowski Takle
227x	Introduction to Business Statistics	5	F	Teasley
231	Probability and Statistical Inference for Engineers	4	F,S Meeden Pollak Sarkar	 Sengupta Sukhatme
305	Engineering Statistics	3	S	Hulting
328	Applied Business Statistics	3	F,S Groeneveld Meeker	 Zakaria
333x	Probability and Statistics for Electrical and Computer Engineers	3	F,S	Vander Wiel
341	Introduction to Theory of Probability and Statistics	3	F Groeneveld	 Pollak
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 Carriquiry C. P. Cox D. F. Cox Hotchkiss Mundfrom	 Nanayakkara Roberts Shelley Stephenson Wolins
402	Statistical Design and the Analysis of Experiments	3	F,S Hinz & D. F. Cox Hotchkiss	 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	Marasinghe
421	Survey Sampling Techniques	3	S	Amemiya
436	Genetic Statistics for Research Workers	3	F	Bailey
447	Statistical Theory for Research Workers	4	S,SS H. A. David	 H. T. 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	Marasinghe

Courses Primarily for Graduate Students, Major or Minor

500	Statistical Methods	4	F	Hinz
501	Multivariate Statistical Methods	3	S	Koehler
511	Theory and Application of Linear Models	3	S	Harville
512	Design of Experiments	3	F	Stufken
513	Response Surface Methodology	3	S	Stufken
521	Theory of Sample Surveys I	3	S	Sengupta
531	Statistics for Quality and Productivity	3	S	Stephenson
535	Biological Statistics	2	S	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	H. A. David
543	Theory of Probability and Statistics	3	S	Cressie
546	Theory of Nonparametric and Asymptotic Methods	3	S	Sukhatme
557x	Statistical Methods for Counts and Proportions	3	SS	Koehler
579	Introduction to Computer Hardware and Software Systems for Statistical Computing	1	F	Kennedy
580	Statistical Computing	3	F	Kennedy
590A	Special Topics: Theory	4	SS	Pollak
590B	Special Topics: Methods	var	F,SS Sposito	Stephenson
599	Creative Component	Var	F,S,SS Amemiya Marasinghe H. A. David Meeker H. T. David Sacks Fuller Sposito Hickman Stephenson Hinz Strahan Hotchkiss Stufken Kennedy Vardeman Koehler	

Courses for Graduate Students, Major or Minor

611	Advanced Linear Model Theory	3	F	Harville
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
699	Research	Var	F,S,SS Athreya Kennedy Cressie Koehler H. A. David Meeden H. T. David Meeker Fuller Sukhatme Harville Vardeman	

Graduate Students

Industrial support for graduate student education continues to grow. For 1988-89 we received fellowship/scholarship money from Corning Glass, Dow Chemical, Process Management Institute, Procter & Gamble, and Shell Oil. This support has helped us recruit some excellent graduate students. We expect the list of supporting companies to grow as many of those students take important positions in industry.

Graduate College Teaching Excellence Awards were given to Craig A. Beam and Nuwan Nanayakkara at the ISU commencement in May in recognition of outstanding contributions in the teaching of undergraduate students while working toward a degree.

A contribution from an alumnus, Dan Mowrey, to the Department of Statistics, made possible the first Dan Mowrey Consulting Awards. Certificates and cash awards were presented spring semester to Mark Bryan and Peter Peterka, recognizing outstanding contributions in statistical consulting while working toward a degree.

Nine Ph.D. degrees and 16 M.S. degrees were granted in the Department of Statistics during the fiscal year. All of the masters' degrees were conferred on a nonthesis basis, with candidates completing creative components based on independent study. Abstracts of Ph.D. dissertations appear in the Publications Section.

Names of graduate degree recipients, with names of major professors, time of graduation, and employment or educational decisions, are given below. An asterisk signifies that the student has chosen to remain at Iowa State to work toward a doctorate in statistics.

M.S. Recipients

Carl A. Castrogiovanni (Spring 1989; Stephen B. Vardeman) is a statistician with Intel Corporation, Rio Rancho, New Mexico.

Barbara Ann Chisolm (Spring 1989; W. Robert Stephenson) is a statistician with SQC Statistical Quality Assurance, Boeing Military Airplane Company, Wichita, Kansas.

Sheri Lynn Cutler (Spring 1989; Jerome Sacks) has accepted a position with Abbott Laboratories, Abbott Park, Illinois.

Fredolin Tajudin Tangang (Fall 1988; Paul N. Hinz) returned to the National University of Malaysia Sabah Campus as lecturer in statistics, Faculty of Science and Natural Resources.

Shiow-Lan Gau (Summer 1988; Kenneth J. Koehler).

Deanna Lynn Graf (Summer 1988; Kenneth J. Koehler) is a research statistician with Dow Chemical USA, Midland, Michigan, in the Math Applications unit, Information Systems and Communications Services.

Joel David Halvorson (Spring 1989; Paul N. Hinz) has joined Stone & Webster Management Consultants, Inc., Englewood, Colorado.

Mu-Yeh Huang (Summer 1988; V. A. Sposito) returned to Chung Yu College of Business Administration, Keelung, Taiwan, as an instructor in the departments of Industrial Engineering and Statistics.

***Alice S. Lay** (Summer 1988; W. Robert Stephenson) is continuing graduate study in statistics with an assistantship in the College of Business Administration.

Todd Eric Melander (Summer 1988; Herbert T. David) joined IBM Corporation in Rochester, Minnesota, in July as a statistician.

Dennis John Murphy (Fall 1988; W. Robert Stephenson).

Darrell Robert Shroeder (Fall 1988; Stephen B. Vardeman) is a statistical consultant with Process Management Institute, Bloomington, Minnesota.

Hussein Hani Shamsuddin (Spring 1989; W. Robert Stephenson) is working as an underwriter with Blue Cross-Blue Shield in Des Moines, Iowa.

Brian Lemay Teasley (Spring 1989; Herbert T. David) is employed by Rosemount Inc., Eden Prairie, Minnesota.

Ann Mary Weltevreden (Spring 1989; Paul N. Hinz) joined the Cleveland Clinic Foundation, Cleveland, Ohio, as biostatistician in the Department of Biostatistics and Epidemiology.

Susan Anne Wettstein (Summer 1988; William Q. Meeker, Jr.) is an associate engineer in IBM's Mechanical Integration Reliability Department in Rochester, Minnesota.

Ph.D. Recipients

Craig Allen Beam (Spring 1989; H. Samuel Wieand and Herbert T. David) accepted a position as assistant professor, Department of Biometry, Duke University Medical Center.

Alicia Laura Carriquiry (Spring 1989; joint major in statistics and animal breeding; David A. Harville and Albert E. Freeman) accepted a nine-month position as postdoctoral associate in economics at the Center for Agricultural and Rural Development, Iowa State University, beginning January 15, 1990.

Renkuan Guo (Spring 1989; Herbert T. David) accepted an academic research position abroad.

Chong Sun Hong (Summer 1988; Herbert T. David) returned to Sung Kyun Kwan University, Seoul, Korea, as an assistant professor in its Department of Statistics.

Karen Lorraine Jensen (Spring 1989; Stephen B. Vardeman) is a senior project engineer in the General Motors Chevrolet-Pontiac-Canada Group, based at the GM Technical Center, Warren, Michigan.

Song-Ho Kim (Fall 1988; H. A. David) is an assistant professor in the Department of Computer Science and Statistics, Kyung Sung University, Pusan, Korea.

Sueli Aparecida Mingoti (Spring 1989; Glen Meeden) is returning to the Universidade Federal de Minas Gerais, Departamentao de Estatistica, in Minas Gerais, Brazil, as a full professor.

Nuwan Nanayakkara (Spring 1989; Noel A. C. Cressie) accepted a position as assistant professor, Department of Statistics, North Dakota State University, beginning September 1, 1989; he was an instructor in statistics at Iowa State University during summer 1989.

Nae Kyung Sung (Fall 1988; Herbert T. David) went to Harvard University for seven months as a postdoctoral fellow in the Department of Statistics, before returning to Seoul, Korea, where he will take a position as assistant professor in the new Women's University in Seoul.

M.S. Candidates

Agatep, Maria Theresa
Al-Zaid, Munther Ali
Andersen, Scott W.
Brands, Linda M.
Castrogiovanni, Carl
Chen, Chao-Yin
Chen, Ching-Ju Diane
Chen, Shih-Neng
Chen, Yu-Ming
Cheng, Man-Lai Alice
Chisolm, Barbara A.
Chiu, Jia-Chyi
Cho, Tae-Kyoung
Cutler, Sheri L.
Dellva, Mary Anne
Djamal (operations research)
Fagih, Abdullah Y.A.K.
Fredolin Tangang @ Tajudin Mahmud
Garrigoux, Christian
Gau, Shiow-Lan
Griffiths, Richard
Halvorson, Joel D.
Helterbrand, Jeffrey
Hewitt, Amy L.
Hofer, Jeffrey D.
Hoge, Stanley
Huang, Mu-Yeh
Hwang, Taekyu
Iversen, Philip W.
Karabulut, Ihsan
Ko, Seoung-Gon
Kuo, Bojein
Lagus, John P.
Lay, Alice S.
Lee, Kye-Don
Lee, Kyung-Hee Ghang
Lee, Ming-Yu
Lee, Yung-Seop
Li, Chia-Lin
Lindstrom, Brian
Liu, I-Ming
Long, Cynthia
Luk, Stella Chueck-wah
Lyan, Dze-Hwei
Marketti, Michael J.
Marsh, Pamela A.
McKeown, Jae P.
Meeter, Carol A.
Melander, Todd E.
Murphy, Dennis J.
Newman, Daniel R.
Nininahazwe, Yvon
Park, Chongsun
Park, Kwan Soo
Park, Sangun
Parker, Robert L.
Pepper, Dwayne
Peterka, Peter
Prestwar, Amanda
Remadi, Sallem
Russey, Ann C.
Sabran, Muhamad
Salihima, Astini
Sanger, Todd M.
Sayler, Mary E.
Scheetz, Theresa
Schroeder, Darrell
Shamsuddin, Hussein
Shyu, Chii-Jyh
Smith, Blake A.
Steenhard, David
Suharno
Sun, Pei-Ying
Swanson, Wendy
Takle, Teresa A.
Talib, Ibrahim O. A.
Teasley, Brian L.
Tiro, Muhammad A.
Wall, Steven J.
Wang, Shu-Chia Joanna
Wellman, Mark (operations research)
Weltevreden, Ann
Wettstein, Susan
Wouhib, Abera
Yang, Ching-Ching
Yansaneh, Ibrahim S.
Yen, Shu-Yuan
Yoo, Seongmo
Yu, Yunn-Hwu

Graduate Student (Nondegree)

Khan, Abdul M.

Ph.D. Candidates

Adam, Abdoulaye
Al-Mahmoud, Ahmad M. A.
Andrews, Douglas M.
Beam, Craig
Biele, Jonathan
Brescia, Victor P. (joint statistics-economics)
Bryan, Mark F.
Carley, Michael R. (joint statistics-economics)
Carriquiry, Alicia (joint statistics-animal breeding)
Coffin, Marie A.
Cranford, B. Keith
Croos, Joseph H. R.
Davis, Paula Lasack (joint entomology-statistics)
Freire, Clarice
Fuh, Cheng-Der (joint mathematics-statistics)
Funo, Eiichiro
Gotway, Carol A.
Grondona, Martín O.
Guo, Renkuan
Han, Geun-Shik
Homblé, Patrick R.
Hong, Chong Sun
Hulting, Frederick
Jensen, Karen
Kim, Song-Ho
Lemke, Klaus (joint statistics-economics)
Li, Seung-Chun
Lin, Chiou-Hua
Liu, Jingyu
Lu, Chi-hsien Joseph
McDonald, David G.
Medak, Frederick M.
Mingoti, Sueli
Mundfrom, Daniel J.
Nanayakkara, Nuwan
Navvabpour, Hamid R.
Nusser, Sarah M.
Park, Heon Jin
Rathbun, Steven L.
Robison-Cox, James
Sarkar, Sahadeb
Shin, Dongwan
Sriplung, Kai-One (joint economics-statistics)
Sullivan, Gary R.
Sung, Nae Kyung
Symanowski, James T.
Tollefson, Margot H.
Vander Wiel, Scott
Ver Hoef, Jay (joint botany-statistics)
Vidyashankar, Anand N. (joint mathematics-statistics)
Wang, Chung-Ching Morgan
Wang, Kui-Jang William
Wilmarth, Steven R.
Zakaria, Rahmat S. (joint statistics-industrial engineering)
Zimmermann, Alan

Nine students completed internships or traineeships during summer 1988, as mentioned in the last annual report. Other cooperative internships were held by the following graduate students during the year: Jae McKeown (summer and fall semester 1988 at Process Management Institute, Bloomington, Minnesota), Hussein Shamsuddin (statistical intern/data analyst, Weyerhaeuser Southern Research Center, Hot Springs, Arkansas, summer and fall 1988), and Brian Lindstrom (statistical intern working at

Weyerhaeuser Corporate Headquarters in Tacoma, Washington, for 12 months starting summer 1989). Also on internships were Michael Marcketti (beginning June 1989 at PMI), Rochelle Milbrath and Barbara Worth (summer 1989 at the Mayo Clinic, Rochester, Minnesota), and Theresa Scheetz (summer 1989 working with reliability engineers at IBM, Rochester, Minnesota). Scott Vander Wiel worked fulltime as a contract consultant with General Electric Corporate Research & Development, Schenectady, New York, during summer 1989 starting in May.

George Zyskind Memorial Lecture

Zyskind lecturer A. Philip Dawid.

The 14th George Zyskind Memorial Lecture, titled "Statistical Models for Experimental Inference," was presented on August 29 by A. Philip Dawid, professor and head of the Department of Statistical Science, University College London. He holds the degree of Doctor of Science from Cambridge University and is well known for his major contributions to statistical inference. Dawid has described his research as principally motivated by the desire to understand and explore the connections between (i) logical principles of inference, (ii) mathematical structures, and (iii) the analysis of data.

The Zyskind lecture series honors the late George Zyskind, professor of statistics at ISU from 1959 to 1974. Dawid also presented a seminar in the regular Statistical Laboratory series on August 30.

Iowa STAT-ers

The graduate statistics club, Iowa STAT-ers, continued its active and varied program under the leadership of Gary Sullivan, president. The club is featured in an article written by Fred Hulting and Sarah Nusser for the first issue of *Stats: The Magazine for Students of Statistics*, published by the American Statistical Association. (See p. 28 of this annual report.)

The Iowa STAT-er seminar series, coordinated by Steve Rathbun, is described on p. 43. For a second year, the reading group organized by Sarah Nusser held bimonthly discussion meetings on statistical literature and concepts not focused on in coursework. Carol Meeter served as editor for the occasional newsletter *Iowa STAT-er Chatter.*

Social events organized by Cyndy Long and Mary Sayler included the fall pizza party, a Halloween party, a holiday gift exchange, and the STAT-ers Winter Party for statistics students, faculty, staff, and families. On April 22 a music recital was presented by the STAT-er Clatter, a newly organized graduate student group featuring classical brass instrumentalists. The second annual Iowa STAT-ers Cultural Party, organized by Morgan Wang, as international-student representative, and the social committee, offered food typical of Saudi Arabian, Chinese, Korean, Taiwanese, Norwegian, German, and Pennsylvania Dutch cultures.

ISU statistics t-shirts and can coolers were sold to help support academic and social activities. Also an Iowa STAT-er birthday calendar was sold.

Officers for the year were Gary Sullivan, president; Steve Rathbun, vice president; Todd Sanger, treasurer; and Carol Meeter, secretary. Fred Hulting was the student representative at statistics faculty meetings. Noel Cressie served as faculty adviser to Iowa STAT-ers. Joel Halvorson, Cyndy Long, and Sueli Mingoti served as members of the ISU Graduate Student Senate.

Snedecor and Bancroft Awards

The 1989 George W. Snedecor Award was presented to Sahadeb Sarkar as the most outstanding Ph.D. candidate in the Department of Statistics. The award honors the founder and first director of the Statistical Laboratory. It is open to all Ph.D. or joint Ph.D. students who have completed the preliminary examination in statistics during the preceding calendar year.

Sarkar received his bachelor's degree (honors) and master's in statistics in 1984 and 1986 at the Indian Statistical Institute, Calcutta, then came to ISU. His doctoral thesis research, directed by Wayne Fuller, is on the large sample properties of least squares estimators of the parameters of nonlinear models. He is studying models that contain regressor variables whose sums of squares increase at different rates as the sample size increases. An example of such models is the autoregressive moving average model with an autoregressive part that contains a unit root. Sarkar has held a research assistantship in the Survey Section and a teaching assistantship in statistics.

The T. A. Bancroft award was given to Mike Carley, a joint Ph.D. candidate in statistics and economics, and to Noel Artiles, a Ph.D. major in industrial engineering with a statistics minor. This award recognizes achievements in statistics of students who have completed doctoral prelim examinations in the past calendar year and have either a joint major in statistics and some other area or a declared minor in

statistics. The award honors Theodore A. Bancroft, who was director of the Statistical Laboratory and head of the Department of Statistics from 1950 to 1972.

Carley received his B.S. degree in economics at ISU in 1983, then completed a master's in statistics here under William J. Kennedy in 1987. He is a research assistant in the Statistical Numerical Analysis and Data Processing Section. Kennedy and economics professor Wallace Huffman are his Ph.D. advisers.

Artiles received his undergraduate degree in civil engineering at the University of Nicaragua in 1980, then taught at Centralamerican University in Nicaragua through March 1983. He received his M.S. degree in industrial engineering at ISU in 1985 and his doctorate in that field in May 1989. His dissertation was written under the direction of H. T. David and Howard Meeks (see p. 19). Artiles held a research assistantship in statistics, supported by the Engineering Research Institute, during the summer 1986, and in 1988 received a Graduate College Teaching Excellence Award for his teaching in industrial engineering. Following commencement he accepted a position as assistant professor in the Industrial Engineering Department, R. U. M., University of Puerto Rico in Mayaguez, Puerto Rico.

Presentation of the three awards took place in March at a Statistical Laboratory seminar.

Mu Sigma Rho

Dr. J. Stuart Hunter presented the 18th annual Mu Sigma Rho lecture on April 26. His talk, "Statistics: The Science of Empiricism," traced the empirical activities of scientists from the earliest gathering of measurements on the motions of the stars to today's research into mapping the human genes. The theme of the talk was that in these empirical activities the scientist employs the language and logic of the statistician. There was a large and varied audience for the talk, which was sponsored by Mu Sigma Rho, Iowa STAT-ers, the Statistics Club; the departments of Statistics, Chemical Engineering, Materials Science and Engineering, Economics, Mechanical Engineering, Political Science, Sociology and Anthropology, Finance, Mathematics, and Industrial Engineering; the Graduate College; and the ISU Committee on Lectures.

Dr. Hunter is professor emeritus of the School of Engineering and Applied Science at Princeton University and currently a consultant to industry and government agencies. He has been a leader in the exposition of statistical methods; his areas of expertise include the fractional factorial and response surface experimental designs and, more recently, quality control technology. Hunter is an editor of the John Wiley series on probability and statistics, founding editor of *Technometrics*, and co-author of *Statistics for Experimenters* and *Introductory Engineering Statistics*. While at Iowa State, he presented seminars in the regular Statistical Laboratory series and in the Department of Materials Science Engineering, on April 26 and 27, respectively.

J. Stuart Hunter, Mu Sigma Rho lecturer.

Prior to the lecture, 23 members were initiated into the Iowa Alpha chapter of Mu Sigma Rho at the annual banquet. These new members included graduate and undergraduate students from the Department of Statistics and other departments who had demonstrated ability in statistics courses. J. Stuart Hunter was also initiated as an honorary member.

Serving as faculty adviser for Mu Sigma Rho this year was W. Robert Stephenson. Mike Carley was president, Jim Symanowski vice president, and Rochelle Milbrath secretary-treasurer. Officers have not yet been elected for the 1989-90 academic year.

B. V. Sukhatme Memorial Lecture

The 7th B. V. Sukhatme Memorial Lecture was presented by Ronald H. Randles on May 10, 1989. He spoke on the topic "A Distribution-free Multivariate Sign Test Based on Interdirections." Dr. Randles, formerly on the faculty of the University of Iowa, is currently a full professor in the Department of Statistics, University of Florida. He received his doctorate at Florida State University and is a fellow of the American Statistical Association. The Sukhatme lecture series honors the late B. V. Sukhatme, professor of statistics at ISU from 1968 to 1979, well known for his work in survey sampling.

Undergraduates

Undergraduate majors in statistics received a number of recognitions and awards during the academic year. Douglas J. Jensen was tapped during Veishea for membership in Cardinal Key, which selects members on the basis of leadership, service to Iowa State University, scholarship, and character. Six undergraduates were initiated by the Iowa State chapter of Phi Kappa Phi at a banquet on March 30, 1989: Anita M. Hinkeldey, Kathy Anne Jenkins,

Douglas Jensen, Rochelle L. Milbrath, Cho-Kwong Ng, and Barbara J. Worth.

At the annual Scholarship Recognition Dinner on April 25, seniors Kathy Jenkins and Barbara Worth were recognized as standing in the top two percent of their class. Jenkins was also recognized as the highest graduating senior in statistics. Susan K. Heineman, Anita Hinkeldey, Douglas Jensen, Daniel J. Parks, Annette M. Pippert, Joseph C. Surber, Michael E. Tott, and Barbara Worth were elected to membership in Mu Sigma Rho, the national statistics honorary society, at its annual banquet on April 26.

On April 30, Hinkeldey, Jensen, Milbrath, and Ng were initiated into Phi Beta Kappa at the spring meeting of that academic honorary society. Anita Hinkeldey was the recipient of a Laura Vernon Scholarship for 1989-90.

Thirteen students received B.S. degrees in statistics or biometry during the period July 1, 1988 to June 30, 1989; three of these had joint majors. Names and employment or study plans, when definite, follow. An asterisk indicates that the student is continuing in the graduate program in statistics at ISU.

Michael John Flaherty (Spring 1989, statistics) accepted a position as research assistant in the Department of Quantitative Genetics, Northrup King Company, Stanton, Minnesota.

Jeff Darren Frye (Spring 1989, statistics).

Kathy Anne Jenkins (Spring 1989, statistics, with distinction) accepted a position as statistician at the General Motors Proving Grounds, Milford, Michigan.

Douglas John Jensen (Spring 1989, journalism & mass communications and statistics, with distinction) has taken a position as statistician/data analysis with A. C. Nielsen Company, Northbrook, Illinois.

Scott Vance Kongable (Spring 1989, mathematics and statistics, with distinction) is working in engineering statistics as a test engineer with Rockwell International in Cedar Rapids, Iowa.

***Rochelle Lynette Milbrath** (Spring 1989, statistics, with distinction).

Thomas W. Owens (Spring 1989, statistics) is working as a junior statistician with Pioneer Hi-bred International in Johnston, Iowa.

William Paige Rudolph (Spring 1989, statistics and mathematics).

Max Otis Schnepf (Spring 1989, statistics).

Bruce J. Schnicker (Spring 1989, biometry) is continuing in the graduate program in agronomy at Iowa State.

Michael Joseph Sondgeroth (Spring 1989, statistics) is employed as a quality control technician with the UNIMIN Corporation in Oregon, Illinois.

***Barbara Jean Worth** (Spring 1989, statistics, honors).

Mark Andrew Yoshimura (Spring 1989, statistics) accepted a position as a forecast analyst for the Wilson Jones Company, Niles, Illinois.

Tom Owens had an internship at Asgrow Seed Company in Ames, Iowa, from June 1988 through December and continued to work there part-time during spring 1989. Anita Hinkeldey was a co-op student intern with Weyerhaeuser, Inc., in Hot Springs, Arkansas, from January to July 1989.

Statistics Club

The aim of the Statistics Club is to promote interest in the field of statistics among undergraduates. The club arranges for talks by visiting statisticians, meetings, and social events throughout the academic year.

Fall activities began with a Sunday get-together at the Bagelworks at the beginning of September. Besides socializing, the members made plans for the year. These included regular monthly meetings.

At the September meeting several students talked about their summer internships. Rochelle Milbrath worked as a data analyst in the Biostatistics section at Mayo Clinic, Rochester, Minnesota. Kathy Jenkins worked as a statistician at Pioneer Hi-bred in Johnston, Iowa, and Bruce Schnicker had a similar summer internship with Asgrow Seed Company in Ames. During October the club participated in a campus clean-up of the area around Lake LaVerne and entered a team, the Random Samplings, in the Homecoming volleyball tournament. At the October meeting, Julie Haubrich (B.S. 5/88) from Central Life Assurance Company in Des Moines spoke to the club about actuarial science. In November Joe Surber, a junior, spoke to the club about microcomputers. Besides being a statistics major, Surber works at the Microcomputer Products Center. The semester closed with a pizza party in December.

The first meeting after semester break was held in February. This meeting was called to come up with ideas for events in the spring. Stat Club T-shirts were distributed, and the Statistics Club prize was discussed. The March meeting focused on graduate school. Former Stat Club members, both ISU B.S. graduates in statistics, Jae McKeown and Mary Anne Dellva talked about their experiences applying to and being in graduate school. The April meeting was reserved for campaigning for the various Statistics Club officers for next year. May brought an end-of-the-year pizza party and elections. The officers for 1989-90 are:

president: Anita Hinkeldey
vice president: Dan Parks
treasurer: Mike Tott
secretary: Lynne Carber

Susan Heineman and Dan Parks were chosen as co-recipients of the 1989-90 Statistics Club Award. W. Robert Stephenson serves as faculty adviser to the club.

Seminars

The series of regular weekly noncredit seminars offered by the Statistical Laboratory and the Department of Statistics throughout the 1988-89 year was planned by Glen Meeden, Herbert T. David, Dean Isaacson, Mark Bryan, Alicia Carriquiry, and Stephen Haslett.

Statistical Laboratory Seminars

Summer 1988

July 6 Ethnocentrism in the Netherlands: A typological analysis. Peer Scheepers, Sociologische Instituut, Katholieke Universiteit, Nijmegen, the Netherlands

20 Automated fitting of nonstandard models. Michael W. Browne, Department of Statistics, University of South Africa, Pretoria, and Department of Psychology, University of Minnesota

27 Estimation in conditionally specified models. Barry C. Arnold, Department of Statistics, University of California at Riverside

Fall 1988

August 30 The symmetry analysis of structured data. A. Philip Dawid, Department of Statistical Science, University College London

September 7 Graduate assistantships in statistics. Dean L. Isaacson

9 Stochastic comparisons of order statistics. Song Ho Kim

14 Kernel regression estimation for a growth curve model. Thomas E. Wehrly, Department of Statistics, Texas A&M University

28 The use of statistics in the presentation of scientific evidence. David F. Cox

October 5 Prescribed conditional interaction structure models for contingency tables. Tamas Rudas, Institute of Sociology, Eotvos University, Budapest, Hungary

12 Cramér-Rao analogues for median-unbiased estimators. Nae Kyung Sung

19 Bayesian component reliability assessment with system data. Renkuan Guo

26 Statistical computing at Iowa State: Past and present. William J. Kennedy

November 2 On the asymptotic inference procedures for factor analysis. Yasuo Amemiya

9 Uniform bounding of probability generating functions and the evolution of reproduction rates in birds. Hans J. Schuh, Department of Mathematics, Johannes Guttenberg Universität Mainz, West Germany, and Iowa State University

16 Methodology for the 1987 Census of Agriculture. Cynthia Z. F. Clark, Agricultural Division, U.S. Bureau of the Census

30 Estimating the total number of distinct species when quadrat sampling is used. Sueli Ap. Mingoti

December 7 Fixed and stochastic censoring. Lidia Rejtö, Mathematical Institute of the Hungarian Academy of Sciences, Budapest, and Department of Mathematical Sciences, University of Wisconsin-Milwaukee

Spring 1989

January 18 Optimal process adjustment in the presence of process drift and adjustment error. Karen L. Jensen

25 Heteroskedasticity-robust inference on means. Nuwan Nanayakkara

February 1 A stochastic gambling problem. Krishna Athreya

8 Efficient estimation in the heteroscedastic semiparametric linear model. Beong-Soo So, Department of Statistics, University of California, Berkeley

9 A covariate adjustment with functions of the probability of selection in complex surveys. Louis Rizzo, Department of Statistics, University of Chicago

15 Subset regression time series and its modeling procedure. Chen Zhao-Guo, Academy of Sciences, Beijing, People's Republic of China

17 On bootstrapping M-estimators of a regression parameter. Soumendra Nath Lahiri, Department of Statistics and Probability, Michigan State University

22 A statistical perspective of biotechnology. Theodore B. Bailey

23 Estimation of the number of species through presence/absence data. James Norris, Department of Statistics, Florida State University

March 1 Some topics in shrinkage estimation theory. Debapriya Sengupta

8 Mixtures and paradoxes: A topological approach. Nell Sedransk, Department of Mathematics, University of Iowa

22 Some issues in statistical computing arising in the social sciences. Leroy Wolins

29 On optimal and efficient repeated measurements designs. John Stufken

April 5 Bayesian prediction and its application to the genetic evaluation of livestock. Alicia Carriquiry

12 L_1 estimation: Properties and computational procedures. Vincent A. Sposito

19 A bivariate logistic model with applications to ordered categorical data. James Symanowski

26 The EWMA: A second look. J. Stuart Hunter, emeritus, School of Engineering and Applied Science, Princeton University

May 3 Biased estimation and prediction. Carol A. Gotway

4 The distributions of the run lengths of CUSUM and EWMA schemes when observations are exponentially distributed. F. F. Gan, Department of Mathematics, National University of Singapore

8 Control charting: An alternative viewpoint. Steven Fahrenholtz, Pillsbury Company, Minneapolis, Minnesota

30 Proving admissibility using the stepwise Bayes technique: With applications to maximum likelihood estimation. Eiichiro Funo

Summer 1989

June 14 The bootstrap method for Markov chains. Cheng-Der Fuh

19 The comparison of a discrete diagnostic test with several continuous diagnostic tests. Craig A. Beam

21 Using spatial considerations in the analysis and design of experiments. Martín O. Grondona

28 Nonparametric analysis of unbalanced paired-comparison or ranked data. Douglas M. Andrews

Special Lectures and Seminars

August 29 14th George Zyskind Memorial Lecture: Statistical models for experimental inference. A. Philip Dawid, University College London

February 16 Department of Statistics Seminar: Bootstrapping applications in the pharmaceutical industry. Stephen J. Ruberg, Merrell Dow Research Institute, Cincinnati, Ohio

April 25 Joint Mathematics and Statistics Colloquium: Total positivity and hypergeometric functions of matrix argument. Donald Richards, Department of Mathematics and Statistics, University of Virginia

26 Mu Sigma Rho Lecture: Statistics: The science of empiricism. J. Stuart Hunter, emeritus, School of Engineering and Applied Science, Princeton University—cosponsored by Iowa STAT-ers; the Statistics Club; the departments of Statistics, Industrial Engineering, Mate-

rials Science Engineering, Mechanical Engineering, Chemical Engineering, Mathematics, Economics, Finance, Political Science, and Sociology; the Graduate College; and the Committee on Lectures

27 Materials Science and Engineering Seminar [cosponsored by Mu Sigma Rho, Iowa STAT-ers, the Statistics Club, the Department of Statistics, and other groups mentioned above]: Design of experiments: Theory and practice in science, engineering, and industry. J. Stuart Hunter

May 10 7th B. V. Sukhatme Memorial Lecture: A distribution-free multivariate sign test based on interdirections. Ronald H. Randles, Department of Statistics, University of Florida

Iowa STAT-ers Seminar Series

September 12 Illustrated methods for the analysis of spatial point patterns. Stephen Rathbun

October 10 The Dow Chemical Company: Statistical applications and careers in a chemical company. Bob Kasprzyk, Dow Chemical Company, Kalamazoo, Michigan

24 The usual nutrient intake of an individual: Estimating the distribution of an unobserved quantity. Sarah Nusser

November 7 Intriguing patterns of incomplete data. Jon Lemke, Department of Preventive Medicine and Environmental Health, University of Iowa

14 Comparing medical diagnostic tests when one is based upon a continuous measurement and the other upon a discrete measurement. Craig A. Beam

28 Applications of resampling methods in the estimation of number of species. Clarice Freire

January 30 Statistical research at the National Agricultural Statistics Service. Robert D. Tortora, Research and Applications Division, NASS, U.S. Department of Agriculture, Washington, D.C.

February 13 Past, present, and future of statistics in China. Chen Zhao-Guo, Academy of Sciences, Beijing, People's Republic of China

20 Career planning for statisticians. Al Swarts and Jay Meyer, Trilogy Consulting Corporation, Waukegon, Illinois

27 Internships in statistics. Todd Sanger, Mary Saylor, Peter Peterka, Ann Weltevreden, Jae McKeown, and Carol Meeter

March 6 Statistical involvement in agriculture, chemistry, and toxicology. Dan Mowrey, Eli Lilly, Greenfield, Indiana

27 Using improper prior distributions to obtain admissible estimators. Ed Funo

April 10 Statistical process monitoring versus automatic control theory—viva l'interaction! Scott Vander Wiel

May 1 Inferential and ethical issues in clinical trials. Donald A. Berry, School of Statistics, University of Minnesota

8 Designing a study in experimental pain. Albert J. Getson, Merck, Sharp & Dohme Research Laboratories, West Point, Pennsylvania

In Memoriam

Bertha Eastman, 1907-1989

Bertha Joyce McLaughlin was born in Nevada, Iowa, August 26, 1907, and married Charles Eastman in 1927. She was employed at Iowa State University for 45 years, employed as a statistical clerk in agricultural economics from 1928 to 1936 and joining the Statistical Laboratory Computing Service in 1937 to work under her sister, Mary Clem. For years these two women essentially managed the Computing Service as an all-college service unit, with Clem as supervisor and Eastman as immediate assistant and congenial colleague. In the mid-1940s under a joint appointment with the Bureau of Agricultural Economics, USDA, Eastman worked on the Master Sample Project.

When the hardware of the Computing Service was separated from the Statistical Laboratory in 1962 to become part of the university Computation Center, Eastman and Clem transferred to the new unit. Eastman continued to work there until she retired as a data analyst in 1973. She died of heart failure in Ames on April 2, 1989. She is survived by two other sisters, Madeline Mathison of Ames and Florence West of Sacramento, California.

John Roe Goodman, 1907-1989

Born in Bronson, Kansas, Roe Goodman received the A.B. degree in mathematics at Friends University, Wichita, in 1931, and the M.S. in statistics at Iowa State College under George W. Snedecor in 1944. He had been transferred to Ames in 1941 by the U.S. Department of Agriculture, Bureau of Agricultural Economics, after working in Florida, North Carolina, and Arkansas as junior agricultural statistician. Goodman was one of a number of resident collaborators stationed in the Statistical Laboratory during the 1940s. After completing his master's he worked on the Master Sample of Agriculture developed here, and became a resident collaborator for the Bureau of the Census.

He remained at the Statistical Laboratory until 1947, then went to the University of Michigan to become head of the sampling section in its Survey Research Center. Following consulting and technical assistance assignments in Puerto Rico and Thailand he decided to resign from the University of Michigan and devote his life to sample survey consultation in developing countries. Working for the UN and/or the U.S. Bureau of the Census, he served as agricultural statistician, consultant, and adviser

on sample surveys and census programs in such wide-ranging places as Jamaica, Chile, Pakistan, Argentina, Malaysia, and Washington, D.C.

Goodman married Helen Smallwood in 1935. He died in Ypsilanti, Michigan, on April 5, 1989. Surviving children are Neil and Jeanne. He was a fellow of the American Statistical Association.

Charles Roy Henderson, 1911-1989

A long-time friend of the Statistical Laboratory, Charles R. Henderson died on March 14, 1989, in Urbana, Illinois, where he had been a visiting professor at the University of Illinois since 1984. Henderson received his academic education at Iowa State—completing the B.S. in animal husbandry in 1933, M.S. in animal nutrition in 1935, and Ph.D. in genetics and animal breeding, with a minor in mathematical statistics, in 1948. He was employed by the Iowa Extension Service 1935-40 and by Ohio University 1941-42 before serving in the U.S. Army at its Army Medical Nutrition Laboratory until 1946. Upon completing work for his doctorate he joined the Department of Animal Science at Cornell University, contributing through the years to the application of statistical theory and methods for the genetic improvement of animals. He was a senior Fulbright research scholar in New Zealand 1955-56. In 1976 he was named professor emeritus at Cornell.

Henderson led an active retirement, with short-term appointments at the University of Wisconsin, the University of California at Davis, Massey University, and work at Cornell, then at Illinois. He was a visiting professor of statistics at Iowa State for part of summer 1981. In 1984 he received the Henry A. Wallace Award from the ISU College of Agriculture. In 1985 he was elected to the National Academy of Sciences. Henderson was a fellow of the American Statistical Association and received numerous other honors during his career.

Campbell C. Mosier, 1921-1989

C. C. Mosier was born in Linden, Iowa, April 5, 1921, and received his B.S. degree from Iowa State College in general engineering in 1944. As an undergraduate he worked part-time in the Statistical Laboratory. After graduation, he worked for a year as budget control analyst in the Boeing Aircraft Company, Seattle, Washington. On January 13, 1945, he married Barbara Hostetter. In July he returned to the Statistical Laboratory as a research associate, working under Raymond J. Jessen. In 1946 Mosier took leave of absence to serve in the U.S. Army Air Force for 18 months. This involved working with IBM equipment—first at Lowrie Field in Denver, Colorado, then at the Pentagon, where he was assigned to the War Department General Staff with the Research & Development Division.

From late 1947 on, Mose, as he was called, held a joint appointment as assistant professor in the Department of Statistics at Iowa State and as manager of the IBM Service Unit (forerunner of the Administrative Data Processing Unit). He taught Stat 480 and 481, courses in data processing, for a number of years and was concerned with administrative work for the Accounting and Treasurer's Offices and the Ames Laboratory of the Atomic Energy Commission and the handling of student registration information for the Registrar's Office. He also did calculation work, primarily on subcontracts from the Statistical Laboratory.

On April 1, 1962, Mosier was named operations manager of the university Computing Center, which had developed from the Statistical Laboratory's Computing Service. Also in 1962 he was appointed associate professor in the new Department of Computer Science. Later he transferred from the Computation Center to take charge of the Administrative Data Processing Unit and become director of institutional research for the university.

Mose was active in professional organizations and a member of the Governor's Committee on Development in Data Processing. He received a Superior Service Award from ISU in 1985 and retired in 1987. He died at home in Ames on May 21, 1989. Survivors include his wife and two children, Curtis Mosier of Denton, Texas, and Nancy Mosier of St. Paul, Minnesota.

Pei-Ching Tang, 1903-1989

Born in King-Tan, Kiang-Su Province, China, on April 30, 1903, P. C. Tang was educated at National Central University, Nanking, China, and University College, London (Ph.D. 1937 in statistics). He returned to National Central University as professor in 1937, and served as Dean of Faculties 1944-46 and head of the Department of Mathematics 1946-47. He was a Rockefeller Foundation research fellow 1949-50, then joined the United

Nations Food and Agriculture Organization as statistician.

Tang came to Iowa State as visiting lecturer in the Department of Statistics winter 1948 and again spring 1951, then joined the staff as associate professor for a year. The drive to contribute significantly to international development took him back to UN assignments in 1952. He played a leading role in the Latin American Agricultural Statistics Training & Demonstration Center in Quito, Ecuador and gave technical assistance to the Government of Panama. This work led to further lengthy FAO assignments as an agricultural statistician in South America working primarily on census and sample survey projects.

Tang retired in Alexandria, Virginia. He was married and had one daughter. He was the author of two statistics textbooks in Chinese. When he was named a fellow of the American Statistical Association in 1952, he was cited "for his tables and other statistical researches in the testing of hypotheses, which have led to worldwide recognition."

Photo Credits

The photo of J. Stuart Hunter on p. 40 is courtesy of the speaker. Photos on pp. 1, 2, and 44 are from Statistical Laboratory archives and the ISU Parks Library Special Collections. Photos on p. 3, except (a), (c), and (d), and on pp. 13 and 19 are by Eiichiro Funo. The remaining photos and the layout design are by Jauvanta Walker. Captions for photos on p. 3 appear below.

The Kempthorne reception, conference, and banquet brought together present and former colleagues, former graduate students, and spouses. Clockwise, from upper left:

(a) Wayne Fuller, chair of the Kempthorne conference organizing committee, with speaker Frank Graybill (Ph.D. 1952), Colorado State University;
(b) Krishna Athreya (L) with speaker J. N. K. Rao (Ph.D. 1961), Carleton University;
(c) From L to R, at the opening reception, Mrs. Graybill; Virgil Anderson (Ph.D. 1953), professor emeritus, Purdue University; Frank Graybill; and Bernard Ostle (Ph.D. 1949), professor emeritus, University of Central Florida;
(d) Oscar Kempthorne;
(e) A. W. Nordskog, ISU professor emeritus of animal and poultry science, one of several presenting informal remarks at the conference banquet;
(f) L to R, Oscar Kempthorne with speaker W. G. Hill, University of Edinburgh, and Judson McGuire (Ph.D. 1954 with statistics minor), retired entomologist/statistician, Culebra, Puerto Rico;
(g) Bruce Griffing (L) (Ph.D. 1948 with statistics minor), former colleague in genetics, now department chair at Ohio State University;
(h) Seymour Geisser (R), University of Minnesota, conference speaker.

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